State of California
Department of Fish and Wildlife

Memorandum

Date: January 7, 2013

To: Sonke Mastrup
Executive Director
Fish and Game Commission

From: Charlton H. Bonham
Director

Subject: **Submission of CESA Petition Evaluation Re: White Shark**

On August 20, 2012, the Commission received a petition to list the Northeast Pacific population of white sharks as threatened or endangered under CESA. On August 27, 2012, pursuant to Fish and Game Code Section 2073, the Commission transmitted the petition to the Department for review. The Department has completed its review, and the petition evaluation report is attached.

Pursuant to Fish and Game Code Section 2072.3 and Section 670.1(d)(1) of Title 14 of the California Code of Regulations, the Department evaluated whether the Petition includes sufficient scientific information regarding each of the petition components. The Department evaluated the sufficiency of the scientific information presented in the Petition, using information in the petition as well as other relevant scientific information available at the time of review.

In completing its petition evaluation, Department has determined there is sufficient scientific information to indicate that the petitioned action may be warranted, and recommends the petition be accepted and considered.

If you have any questions or need additional information, please contact Mr. Paul Hamdorf, Acting Manager of the Marine Region, at (562) 342-7210.

Attachment

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STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

REPORT TO THE FISH AND GAME COMMISSION

EVALUATION OF THE PETITION FROM OCEANA, CENTER FOR BIOLOGICAL DIVERSITY AND SHARK STEWARDS TO LIST NORTHEAST PACIFIC WHITE SHARK (*Carcharodon carcharias*) AS THREATENED OR ENDANGERED

Photograph Courtesy of Buzz Brizendine

PREPARED BY
DEPARTMENT OF FISH AND WILDLIFE
MARINE REGION
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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

1. Executive Summary

Oceana, Center for Biological Diversity, and Shark Stewards jointly submitted a petition (Petition) to the Fish and Game Commission (Commission) to list the North Eastern Pacific (NEP) population of White Shark (*Carcharodon carcharias*) as threatened or endangered pursuant to the California Endangered Species Act (CESA), Fish and Game Code Section 2050, et seq.

Pursuant to Fish and Game Code Section 2073.5 and Section 670.1 of Title 14 of the California Code of Regulations, the Department of Fish and Wildlife has prepared this evaluation report for the white shark Petition (Petition Evaluation). The report is an evaluation of the scientific information discussed and cited in the Petition in relation to other relevant and available scientific information possessed by the Department during the evaluation period. The Department's recommendation as to whether to make white shark a candidate for listing under CESA is based on an assessment of whether the scientific information in the Petition is sufficient under the criteria prescribed by CESA to consider listing white shark as threatened or endangered.

In completing its petition evaluation, the Department has determined there is sufficient scientific information to indicate that the petitioned action may be warranted. Therefore, the Department recommends the Commission accept the Petition for further consideration under CESA.

After reviewing the Petition and other relevant information, the Department makes the following findings:

- Population Trend. The scientific information in the Petition demonstrates or creates a reasonable inference that the NEP population of white shark is genetically distinct and likely isolated from other global populations. There are no historic population estimates, and there is insufficient information available at this time to assess whether the population is increasing, decreasing, or stable. Therefore, a review of available scientific information supports the Petition's statement that the trend in population size for the NEP population is unknown. However, the Department notes that there may be some indirect evidence for an increasing population, such as increased incidental fishery interactions with juvenile white sharks, primarily in the set gill net fishery off southern California. Despite increasing restrictions and decreased fishing effort in gill net fisheries, records of interactions have increased. Additionally, increased mortality rates to

sea otters resulting from white shark bites may indirectly indicate white shark populations may be on the rise in waters off California since gill net restrictions and protections for white sharks went into effect in the early 1990's. Other sources of indirect evidence of population trends, such as frequency of beach closures due to presence of sharks, could not be fully reviewed in time for this Petition Evaluation.

- Range. The scientific information in the Petition demonstrates or creates a reasonable inference that the NEP population of white shark extends from Mazatlan, Mexico and the Gulf of California north to the Bering Sea; and from the West Coast of North America to the Hawaiian Islands.

- Distribution. The scientific information in the Petition demonstrates or creates a reasonable inference that the NEP population of white shark is primarily distributed along the continental shelf from Oregon to Mexico, and west to an area between the West Coast and the Hawaiian Islands known as the Shared Offshore Foraging Area (SOFA). Additionally, existing scientific information supports the inference that adult white sharks in the NEP exhibit philopatric behavior (site fidelity); returning to aggregation locations where they have been tagged by researchers.

- Abundance. The scientific information in the Petition demonstrates or creates a reasonable inference that there are substantive issues in making a determination regarding the actual size of today's NEP white shark population. Although two recent studies estimate the current population size, inadequate sampling and a failure to meet population modeling assumptions (Domeier 2012b; Sosa-Nishizaki 2012) reduces confidence in the accuracy of these two estimates. Also, the two cited population estimates only quantify the number of adults. Because of life history characteristics, and known behavioral and geographic differences between juveniles, sub-adults and adults, estimates of total population size cannot confidently be derived solely from adult estimates.

- Life History. The scientific information in the Petition demonstrates or creates a reasonable inference that white sharks are large apex predators, which are by nature relatively low in abundance. There are still large gaps in our understanding of basic life history for this species due to its pelagic and migratory nature, although recent advances in electronic tagging technology have enabled significant progress in research in the last decade.

- Kind of Habitat Necessary for Survival. The scientific information in the Petition demonstrates or creates a reasonable inference that marine habitat and water conditions necessary for survival of the NEP population of white sharks may be diminished or threatened due to contamination, habitat loss, climate change, and other factors. The adult population utilizes deep offshore areas during their migration phase, coastal habitat for pupping and nearshore aggregation sites

associated with pinniped rookeries are important for foraging. Juveniles are known to use the Southern California Bight as a nursery area.

- Factors Affecting the Ability to Survive and Reproduce. The scientific information in the Petition demonstrates or creates a reasonable inference that factors negatively affecting the NEP white shark population's ability to survive and reproduce include incidental and directed fishing pressure, historically reduced prey availability on the West Coast due to past over-exploitation of pinniped populations, contamination, habitat loss, climate change, and other factors. However, historical reductions in pinniped population trends have been reversed for decades for most species off California, and some West Coast pinniped populations are considered to be at or near the carrying capacity of the environment.

- Degree and Immediacy of Threat. Overall, the Petition presents adequate information that threats exist, and it is reasonable to further infer that these threats could pose immediate and significant impacts to the population. However, further analysis is needed to evaluate both degree and immediacy of these threats.

  However, existing regulations afford this species protection from fishery exploitation. In California, take and possession of white shark is expressly prohibited by law for those who engage in sport and commercial fishing activities, with one exception allowing for incidental take in select commercial fisheries which target other species. However, while "take" is authorized under this exception, possession, retention and sale of white shark taken incidentally under this exception is not. White shark take and possession is also prohibited by federal regulations which apply to all West Coast states. There are also state and federal bans on the practice of shark finning, and state and federal prohibitions on possession and sale of shark fins.

  The only other take of white sharks authorized pursuant to state law is for scientific research purposes (Fish and Game Code Section 5517). Depending on the specific terms of each scientific research permit, take, retention, and possession of white shark may be authorized.

  The Department agrees that the species may be vulnerable to known threats, and there is need for continued research on white sharks in the NEP to better assess the degree and immediacy of known threats.

- Impacts of Existing Management. The scientific information in the Petition demonstrates or presents a reasonable inference that though the population currently experiences significant regulatory protections, it may benefit from specific forms of additional regulation or management activities in California waters. However, the Department notes that California's existing regulations governing white shark take and fishery operations for gill net fisheries have

become increasingly restrictive and likely have reduced the incidental take of white sharks in gill net fisheries, possibly allowing for improved survivorship of young-of-the-year and juveniles (Lowe *et al*. 2012). The Department agrees there are gaps in catch monitoring data for fishery interactions, and investigation into the level and impacts of incidental catch is warranted.

- Suggestions for Future Management. The information in the Petition demonstrates or presents a reasonable inference that the Petition's suggestions for future management are reasonable considerations. Several suggestions are already recognized as needs in the federal Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species (HMS FMP).

2. Introduction

a. Candidacy Evaluation Process

CESA sets forth a two-step process for listing a species as threatened or endangered. First, the Commission determines whether a species is a candidate for listing by determining whether "the petition provides sufficient information to indicate that the petitioned action may be warranted." (Fish & Game Code, § 2074.2, subd. (a)(2).) Within 10 days of receipt of a petition, the Commission must refer the petition to the Department for evaluation (Fish & Game Code, § 2073.) The Commission must also publish notice of receipt of the petition in the California Regulatory Notice Register. (Fish & Game Code, § 2073.3.) Within 90 days of receipt of the petition, the Department must evaluate the petition on its face and in relation to other relevant scientific information and submit to the Commission a written evaluation report with one of the following recommendations:

- Based upon the information contained in the petition, there is not sufficient information to indicate that the petitioned action may be warranted, and the petition should be rejected; or

- Based upon the information contained in the petition, there is sufficient information to indicate that the petitioned action may be warranted, and the petition should be accepted and considered.

(Fish & Game Code, § 2073.5, subd. (a)(1).)

If the petition is accepted for consideration, the second step requires the Commission to determine, after a year-long "scientific-based review of the subject species," whether listing as endangered or threatened is or is not actually warranted. (Fish & Game Code, § 2075.5.)

In *Center for Biological Diversity v. California Fish and Game Commission* (2008) 166 Cal.App.4th 597, the California Court of Appeals addressed the parameters

of the Commission's discretion in its application of the threshold candidacy test. The court began its discussion by describing the candidacy test previously set forth in *Natural Resources Defense Council v. California Fish and Game Commission* (1994) 28 Cal.App.4th 1104, 1114:

As we explained in *Natural Resources Defense Council* [citation], "the term 'sufficient information' in section 2074.2 means that amount of information, when considered with the Department's written report and the comments received, that would lead a reasonable person to conclude the petitioned action may be warranted." The phrase "may be warranted" "is appropriately characterized as a 'substantial possibility that listing could occur.'" [citation] "Substantial possibility," in turn, means something more than the one-sided "reasonable possibility" test for an environmental impact report but does not require that listing be more likely than not.

(*Center for Biological Diversity*, at pp. 609-10.) The court acknowledged that "the Commission is the finder of fact in the first instance in evaluating the information in the record." (*Id.* at p. 611.) However, the court clarified:

> [T]he standard, at this threshold in the listing process, requires only that a substantial possibility of listing could be found by an objective, reasonable person. The Commission is not free to choose between conflicting inferences on subordinate issues and thereafter rely upon those choices in assessing how a reasonable person would view the listing decision. Its decision turns not on rationally based doubt about listing, but on the absence of any substantial possibility that the species could be listed after the requisite review of the status of the species by the Department[.]

(*Ibid*.)

b. Petition History

On August 20, 2012, the Commission received the Petition to list the NEP population of white sharks as threatened or endangered under CESA. On August 27, 2012, pursuant to Fish and Game Code Section 2073, the Commission transmitted the petition to the Department for review.

The Department evaluated the sufficiency of the scientific information presented in the Petition, using information in the Petition as well as other relevant scientific information available at the time of review. Pursuant to Fish and Game Code section 2072.3 and Section 670.1(d)(1) of Title 14 of the California Code of Regulations, the Department evaluated whether the Petition includes sufficient scientific information regarding each of the following petition components:

- Population trend;

- Range;
- Distribution;
- Abundance;
- Life history;
- Kind of habitat necessary for survival;
- Factors affecting ability to survive and reproduce;
- Degree and immediacy of threat;
- Impacts of existing management;
- Suggestions for future management;
- Availability and sources of information; and
- A detailed distribution map.

c. Overview of Biology of the White Shark

The white shark (*Carcharodon carcharias*), a member of the Lamnidae family, is a cosmopolitan species found primarily in temperate seas. They are large apex predators that can be found in a wide variety of environments from the intertidal zones and the continental shelf to deep offshore areas. They are naturally low in abundance, late to mature, and have few offspring. The NEP population of white shark found in California waters is a demographically isolated population that shows significant genetic divergence from other global populations in Australia and South Africa. The NEP population's full range extends from Mexico north to the Bering Sea and west to Hawaii, but they are primarily found from Mexico to Oregon and west to a common foraging area between the West Coast of North America and Hawaii.

Though little is known about their breeding habits, it is thought to occur in the winter at two coastal aggregation sites in central California and Guadalupe Island, Mexico. Individuals in this population show high site fidelity to these aggregations, reinforcing the notion that the NEP population is geographically isolated from other populations worldwide. Due to the difficulty in studying this species and a lack of research before the late 1970s, there are no historic population estimates of the NEP population.

The Petition cites a current population estimate of 339 adult and sub-adults, which would be dangerously low. However, this estimate is based on debatable assumptions such as a closed population at one of the aggregation sites. No population trend information is available for the NEP. The Petition assumes a declining population based on population declines for white shark populations in other areas of the world, and for other species of sharks. However, the NEP population is protected by numerous sport and commercial fishing regulations in California and there has been an increase in white shark interactions even as fishing effort has decreased.

3. Sufficiency of Scientific Information to Indicate the Petitioned Action May Be Warranted

a. Population Trend

The Petition addresses NEP population trend by relying primarily on inferences from studies of other global populations of white shark, since the population trend for the NEP population is not known. Key citations used include, but are not limited to studies of the US East Coast populations (Baum *et al*. 2003), Australia (Reid and Krogh 1992), Africa (Dudley 2012), and Adriatic Sea (Soldo and Jardas 2002).

The Petition states there are no historic estimates of the NEP white shark population but that the NEP population is not expected to be abundant given the rarity of white sharks throughout their known ranges. The Petition further states that since other global white shark populations are in decline or show negative growth, it can be assumed that the NEP population is in decline as well. The Petition cites population estimates conducted off the coast of Australia (Reid and Krogh 1992) and in the Northwestern Atlantic (Baum *et al*. 2003) which show a dramatic decline in abundance. The Petition cites an initial population estimate of 1,279 white sharks for waters adjacent to 1,500 kilometers of the eastern South Africa coastline in 1996 (Dudley 2012). This abundance-to-coastline ratio is then compared to the 1,200 km of coastline for the NEP population. The Petition cites initial efforts to establish a baseline population census of 339 individuals for the NEP derived by adding totals together from studies at two localized aggregation sites within the 1,200 km of coastline. The Petition then concludes the baseline population is alarmingly low and warrants listing under CESA based on this ratio comparison.

The Department finds that the scientific evidence cited in the Petition and otherwise available does not necessarily demonstrate that the NEP population is in decline. For a pelagic species such as white shark, the length of coastline may not be relevant when trying to calculate species abundance. In addition, the adult and sub-adult population estimates from the two aggregation sites likely do not comprise the entire NEP population.

The Department agrees that available scientific information supports the Petition's finding that the historic population levels are unknown, so it cannot be determined whether the NEP population is increasing, decreasing or stable. However, the Department notes that some catch trends cited in the literature (Lowe *et al*. 2012) suggest the population may be increasing, due to a rise in the incidental catch of juvenile white sharks by commercial fisheries. Lowe correlates increases in juvenile white shark fishery interactions with possible increased abundance due to added regulatory protections primarily enacted in the 1990's, including state and federal prohibitions on take of white shark, and progressively

restrictive regulations on gill net gear. Likewise, a dramatic increase in otter bite interactions (Mike Harris personal communication) suggests there is a possibility of an increasing white shark population in the NEP.

b. Range

The petition addresses NEP range by relying primarily on catch records, mark and re-capture (tagging) studies, and genetics studies covering the Eastern Pacific from Canadian waters to Mexican waters and west to the Hawaiian Islands. Scientific studies discussed in the Petition include but are not limited to "Philopatry and Migration of Pacific White Sharks" (Jorgensen 2010), "Assessment and Status Report of the White Shark in Canada" (COSEWIC 2006), and "Records of White Shark in the Gulf of California, Mexico" (Galvan-Magana *et al*. 2010), and "The Northeastern Pacific White Shark Shared Offshore Foraging Area (SOFA)" (Domeier 2012c).

Based on these scientific studies, the Petition states that the NEP population of white sharks found in California waters is a demographically-isolated population that shows significant genetic divergence from other global populations in Australia and South Africa. (Jorgensen 2010; Gubili *et al*. 2012). The petition accurately describes the known range of the NEP population of white shark as extending from Mazatlan, Mexico and the Gulf of California north to the Bering Sea; and from the West Coast of North America to Hawaii. White sharks inhabit both inshore and offshore areas, from the continental shelf to the Shared Offshore Foraging Area (SOFA) between California and Hawaii. The SOFA is vast area of deep open water habitat that is shared by white sharks from both central California and Guadalupe Island, MX during the offshore phase of their migration. Adults from the NEP white shark population spend 6-16 months in this area feeding, and do not usually encounter other white sharks.

The Department agrees that the scientific information presented in the Petition is generally accurate and complete in its description of range for this species.

c. Distribution

The Petition addresses NEP distribution by relying primarily on studies using satellite tagging and telemetry, catch records, and behavioral observations. Scientific studies discussed in the Petition include but are not limited to "Philopatry and Migration of Pacific White Sharks" (Jorgensen 2010), "Insights into Young of the Year White Shark Behavior in the Southern California Bight (Dewar *et al*. 2004), "Records of White Shark in the Gulf of California, Mexico" (Galvan-Magana *et al*. 2010), " The Northeastern Pacific White Shark Shared Offshore Foraging Area (SOFA)" (Domeier 2012c), and "A first estimate of White Shark Abundance off Central California" (Chapple *et al*. 2011).

Based on these scientific studies, the Petition states that, while the NEP population of white sharks can range as far north as the Bering Sea, most of the population is distributed along the continental shelf from Oregon to Mexico, and west to the SOFA during offshore migrations.

Research cited in the Petition suggests adult males migrate from inshore aggregation sites in central California and Guadalupe Island, Mexico to the SOFA located mid-way between North America and the Hawaiian Islands. Adult females migrate offshore in a much more diffuse pattern, and are only found passing through the SOFA while males are absent. This sex-specific difference in use of offshore habitat might be due to a difference in prey preference between males and females during the pelagic portions of their migrations (Domeier and Nasby-Lucas 2012e). The SOFA has been characterized as an epipelagic "cold spot" with low epipelagic productivity, consisting primarily of sperm whales and three species of mesopelagic squid. It has been suggested that these sharks are feeding on a diet of squid or species that target squid, but this has not been confirmed. In contrast, females do not return to the aggregation sites annually and can be considered primarily pelagic. While their migration is much more dispersed and less predictable than males, they have been tracked going back and forth between the eastern edge of the SOFA and the continental shelf of North America (Domeier and Nasby-Lucas 2012e).

Some adult NEP individuals, both male and female, make a separate and distinct migration to the Hawaiian Islands (Domeier 2012a). This occurs at the same time as the other offshore migrations, but these animals avoid the SOFA altogether passing to the north or south. These sharks are potentially targeting small cetacean prey not available in the SOFA, but it is unclear why they would migrate such a great distance when similar prey is available near the continental shelf of North America.

Tagging studies cited in the Petition also show that white sharks in the NEP exhibit philopatric behaviors and usually return to the same aggregation site where they were tagged (Anderson and Pyle 2003; Domeier and Nasby-Lucas 2007; Jorgensen 2010). This provides strong evidence that the NEP population is demographically isolated from populations near Australia/New Zealand and western South Africa, even though these populations show little genetic difference. When returning to the adult aggregation sites (central California and Guadalupe Island) males generally arrive over a few weeks from late July through early August, while most females return in October. Unlike males that generally migrate directly between their offshore and aggregation sites, pregnant females will migrate to the nearshore waters of the SCB and Baja California, Mexico to give birth before returning to the adult aggregation sites (Domeier 2012a).

The Department agrees that the scientific information presented in the Petition is generally accurate and complete in its description of distribution for this species.

d. Abundance

The Petition addresses NEP abundance by relying primarily on two studies using photographic mark-recapture methods at aggregation sites. " A First Estimate of White Shark Abundance off Central California" (Chapple *et al*. 2011), and "Problems with Photo Identification as a Method of Estimating Abundance of White Sharks, An Example from Guadalupe, Mexico" (Sosa-Nishizaki *et al*. 2012)

Based on these scientific studies, the Petition states that recent abundance estimates for the NEP population of white sharks are "alarmingly low" and "dangerously low". The Petition states that the NEP population of white sharks is depleted and likely in decline. The Petition concludes that, due to low population estimates for adult and sub-adult white sharks, vulnerability in life history characteristics, vulnerability to exploitation, and vulnerability to random impacts—whether naturally occurring or human caused, the size of the NEP population of white sharks is "dangerously low" and there is "substantial risk of extinction." "There is no evidence of recovery," and "immediate listing under CESA is warranted."

The Petition states that an initial effort had been made to estimate the abundance of white sharks that aggregate near the Farallon Islands, San Francisco County and Tomales Point, Marin County (Chapple *et al*. 2011). Using photo-identification surveys over three field seasons, an estimate of 219 adult and sub-adult white sharks was made, based on a Bayesian mark-recapture algorithm assuming a closed population. A similar study was performed at Guadalupe Island, Mexico (Sosa-Nishizaki *et al*. 2012) over a period of nine years which estimated a total of 120 adult and sub-adult white sharks. The sum estimate of these two studies comes to a total of 339 adult and sub-adult sharks. From these studies, the Petition concludes that the majority of the NEP population is represented by the estimates from these two studies and that this population level is dangerously low, below the levels necessary for a healthy, discrete population.

The Petition acknowledges concern that this method may under-estimate population size (Sosa-Nishizaki 2012).This estimate of 339 individuals may not be an accurate population estimate because it does not account for adults and sub-adults that may aggregate in other areas and may not accurately reflect the entire population of visiting sharks at these two locations. Most notably, white sharks that may congregate in areas such as Año Nuevo (Jorgensen *et al*. 2010) were not included in the estimate. The Department notes that the authors of the Sosa-Nishizaki research caution that their research should not be used as to determine absolute abundance until methods can be improved, and recommend their work as an index of abundance only.

The Department notes that the methods used to calculate these population indices have also been questioned. The assumption of a closed population for the mark-recapture algorithm has been contested (Domeier 2012b) as large sharks have been observed leaving the study sites and not returning within the study period as predicted. It is unlikely that all of these non-returning sharks would have died or succumbed to predation. Furthermore, previously un-described sharks have appeared at the study sites (Domeier *et al*. 2012d) during the study period. These observations conflict with the closed-population assumptions that individual adults will always return to the site and be counted unless they have died. Domeier asserts it is possible that sharks may frequent other sites not yet sampled or remain in movements as yet not fully described (Domeier 2012a). According to Domeier, current aggregation site estimates similarly under-represent the sub-adult portion of the population and the existing aggregation site estimates do not include or consider population information for juvenile white sharks (Domeier 2012b).

Issues with inadequate sampling and failure to meet assumptions in use of population estimation models (Domeier 2012b; Sosa-Nishizaki 2012), as well as the larger context of unknown aspects of white shark behavior with respect to distribution and range throughout the life cycle (Domeier 2012a), create uncertainty around currently available estimates of population abundance. With respect to Chapple *et al*. (2011), Domeier (2012b) states: “It is clear the population estimate was based on several faulty assumptions and therefore the estimate is not valid. The actual population is likely dramatically larger than the values presented in this paper.” Sosa-Nishizaki *et al*. (2012) note that their modeling effort underestimates the actual population size and that their estimate is lower than the number of known, photo-identified sharks.

The Department concludes that existing scientific information on abundance suggests that there remain substantive issues in the determination of NEP white shark abundance, indicating a need for additional research and analysis that includes all age classes and integrates additional available information to more fully assess abundance. Despite the clear deficiencies in methodology previously described (Sosa-Nishizaki *et a*l. 2012; Domeier 2012b), the current abundance estimates comprise the best available scientific information to date about the minimum NEP population size. The site-specific estimates from the central California and Guadalupe Island aggregation sites can alternatively be used as indices of abundance for gauging overall population trends (Domeier 2012b), and estimates at other aggregation sites such as Año Nuevo could be conducted in the future to provide a more complete view of the entire NEP population size and distribution. Ultimately, Sosa-Nishizaki *et al*. (2012) cautions that “our results, and that of Chapple *et al*. (2011), indicate that adult White Shark populations in the NEP are small, highlighting the need for continued monitoring and precautionary management.”

Despite uncertainty in the numeric estimates, the abundance of the NEP population is likely low, although this is generally consistent with patterns of abundance for apex predators.

e. Life History

The Petition relies upon cited research including but not limited to the following studies covering movements and migrations (Klimley and Anderson 1996; Domeier and Nasby-Lucas 2006; Jorgensen 2010), reproductive biology (Compagno 1997; Francis 1996; Domeier 2012a), and growth and development (Cailliet 1985; Anderson *et al.* 2011).

Based on these scientific studies, the Petition accurately describes the life history of the white shark. They are large apex predators. The maximum size has not been established, but specimens have been documented to 6 meters (19.7 feet) total length for females, and 5.5 meters (18 feet) total length for males (Cailliet *et al*. 1985; Castro 2012; Wilson and Patyten 2008).

Individuals of this species mature late (females 4.5-5 meters, 9-10 years old; males 3.6-4.6 meters), and have few offspring (2-14 pups) over the course of their lifetime (Cailliet *et al*. 1985; Francis 1996). Females breed every two to three years (Francis 1996; Compagno *et al*. 1997; Domeier 2012a). Parturition (live birth) is believed to occur in or near the warm waters of the Southern California Bight (SCB) and northern Mexico in the summer and early fall. Few pregnant females have ever been caught or studied, but pups are believed to be 1.2-1.5 meters (3.9-4.9 feet) at birth, and usually weigh 45 kilograms (100 pounds) by the end of their first year. At approximately three years of age sub-adults begin to migrate into colder waters, ranging widely from Oregon to southern Mexico and the Gulf of California. Juvenile white sharks feed on fish and invertebrates. As they grow in size and skill they begin to forage on marine mammals. It is unclear when sub-adults begin to make inshore/offshore migrations or utilize aggregation sites. Little is known about the mating habits of white sharks, and there have been no verified observations of mating, but it is believed that the aggregation sites in central California and Guadalupe Island, Mexico are not just due to large populations of pinnipeds available for forage but for mating opportunities as well. This is speculated due to the presence of spermatophores in the claspers of captured males and fresh conspecific bite marks observed on mature females (Domeier 2012a).

The life history information in the Petition is generally accurate for this species. Like other large pelagic apex predators, because white sharks mature late in life and have low fecundity, there are numerous life stages where individual animals may be vulnerable to mortality or harm from natural or man-made sources of harm. However, as a top predator, it is expected that there is little natural mortality from predation and survivorship is high, particularly as individuals enter adulthood.

f. Kind of Habitat Necessary for Survival

The Petition relies primarily on studies of habitat used as nursery grounds (Klimley 1985; Domeier 2012a; Weng *et al*. 2007), association with sea temperature ranges (Wang *et al.* 2007; Dewar 2004), association with depth zones (Domeier 2012d), and coastal habitat and aggregation site usage (Weng *et al*. 2007; Domeier *et al*. 2012e; Domeier and Nasby-Lucas 2006).

Based on these scientific studies, the Petition accurately represents current scientific knowledge relative to essential white shark habitat for the purpose of survival. The Petition states that warmer coastal waters within the California Current are likely being utilized as nursery areas for juvenile white sharks and young-of-the-year. This range includes the Southern California Bight (SCB) south into Mexican waters. Use of this coastal habitat varies seasonally, which may be associated with temperature or availability of desired prey. The notion that these waters are nursery areas is supported by the presence of juvenile white sharks in the incidental catch of commercial and recreational fisheries throughout this range.

The Petition cites studies that compare water temperatures of nursery areas in other parts of the world, and suggests there is an ideal temperature range for juvenile white sharks present in the coastal waters of southern California and northern Mexico (Weng *et al*. 2007). As white sharks mature, it is believed they become more tolerant of temperate ocean conditions, allowing them to migrate farther north and take advantage of the cool productive waters off the coast of central and northern California (Weng *et al*. 2007).

Adult white sharks have an offshore pelagic phase to their migration pattern, and the Petition accurately states that coastal habitat is likely essential for foraging. This is primarily due to the occurrence of large pinniped colonies along the coastal mainland and nearshore islands off California and Mexico. These pinniped colonies may be a primary factor in attracting the presence of adult white sharks at aggregation sites such as the Farallon Islands and Año Nuevo during late summer and fall. Departure from these aggregation sites has been documented to coincide with the decline in peak abundance of young seals in the late fall (Weng *et al*. 2007).

The Petition accurately describes existing scientific knowledge suggesting that both as nursery and foraging grounds, coastal California waters provide the kind of habitat necessary for survival of the NEP of white shark, recognizing that adequate suitable habitat is necessary to ensure sustainability of the population. Although the term “habitat” is construed broadly to include prey, the discussion of adequacy of prey and how this may impact survival is addressed in more detail in the section to follow. Additionally, marine habitat and water conditions necessary for survival of the NEP population of white sharks may be diminished or

threatened due to contamination, habitat loss, climate change, and other factors, which are also described in more detail in the sections to follow.

g. Factors Affecting the Ability to Survive and Reproduce

To discuss the factors affecting the ability of the white shark to survive and reproduce, the Petition relies primarily on scientific knowledge of apex predators related to the life history of this species (MacArthur and Wilson 1967; Cailliet *et al.*1985; Domeier 2012a).

Based on these scientific studies, the Petition states that, as with other sharks, white sharks are slow growing, late maturing fish, and have a small number of offspring per reproductive cycle, exhibiting more life history similarities to terrestrial vertebrates than most other fish species. Apex predators such as white sharks tend to have inherently small adult populations.

The Petition states that the nursery area for juvenile white sharks is within the California Current (Dewar *et al*. 2004), and that juveniles a few months old are found in coastal waters of California and Mexico, suggesting that pupping occurs nearby (Klimley 1985). As described above, adequate water temperature is necessary for survival of the species, but a number of other factors affect the NEP population's ability to survive and reproduce. The following describes several of the principal factors affecting survival and reproduction:

Contaminants: Within the Southern California Bight, coastal waters inhabited by white sharks are close to urban centers and subject to urban runoff, coastal development, and interactions with fisheries, and other anthropogenic activities. Because contaminants such as PCBs and DDT have been observed in very high levels in some NEP white sharks (see discussion in "Contaminants" in Section H: Degree and Immediacy of Threat), there is concern that these contaminants could cause physiological and reproductive impairments, but the level of impact is unknown.

Overexploitation: Take for commercial, recreational, and research purposes are each described below:

> Incidental Take in Commercial Fisheries: White shark offspring are relatively few in number and have a trophic position high in the food web (MacArthur and Wilson 1967). As the Petition states, offspring may be more vulnerable to fishing pressure and other mortality sources than most bony fishes, and survival of young-of-the-year may be low. The Petition infers that flat sandy bottom habitat may be important nursery areas, since young white sharks are primarily caught in this habitat incidental to the set gill net fishery.
>
> The Petition concludes that the main factor affecting juvenile survival is incidental take in commercial fisheries in California and Mexico. White shark

interactions with commercial fishing gear in California primarily occur with set and drift gill net fisheries, accounting for 81 percent of the incidental fishery interactions (Lowe *et al*. 2012). The Petition notes 111 juvenile white sharks were taken between 1999 and 2010 in Mexican commercial fisheries (Santana-Morales *et al*. 2012). In 2004 and 2007 the Monterey Bay Aquarium received live juvenile white sharks caught in gill net fisheries, supporting the evidence that fishery interactions continue to occur with the gear (Larese 2009). The Department agrees that existing scientific information from fisheries data suggests that set and drift gill net fisheries account for the greatest level of incidental take of the NEP population of white sharks.

Incidental Take in Sport Fisheries**:** Although not specifically addressed in the Petition, the Department notes that white shark interactions in recreational fisheries have been documented off California, although interactions appear to be low. Marine recreational fishery survey data collected in California from the Marine Recreational Fisheries Statistics Survey (MRFSS) from 1980 through 2003 contained no records of white shark observed or reported as retained or returned catch for boat and shore based fishing trips. Survey data collected from 2004 through the present through the California Recreational Fishery Survey (CRFS) had only one record of white shark reported caught and released by a private boat angler.

Although not documented in angler surveys, white sharks are known to occasionally be caught from public fishing piers. In recent years, the Department has issued two citations for illegal take of juvenile white sharks off of fishing piers in southern California (Hartman personal communication) Additionally, during the summer of 2012, there were several media reports of juvenile white sharks being caught and released alive off of Manhattan Beach Pier in southern California.

Department logbook records for Commercial Passenger Fishing Vessels (CPFV) also indicate white sharks are occasionally hooked by party boat anglers at sea. For the period from 1980 through 2011, there are seven records of white shark in the catch record (CFIS 2012).

Directed Take by Research Fishing: By law, fishing specifically for white shark is authorized both by the Department and federal agencies for purposes of research under permits issued to individuals or entities. However, the Petition does not acknowledge this source of take as a concern. It is not clear how much mortality, if any, results to the population from this research fishing activity. Most of this research involves catching, tagging, and subsequently releasing white sharks back into the water at the location of capture. The Department has not yet completed its review of these research reports or conducted any follow-up questioning of permittees and thus cannot evaluate the number of sharks taken or characterize the extent of this research at this time. The Department finds that evaluating take and mortality levels, methods

of fishing, and the extent of the parties involved in authorized research fishing activities that target white sharks is a high-priority need.

Prey Abundance and Availability: California pinniped species (elephant seals, California sea lions and harbor seals) underwent declines in previous centuries but have since experienced population expansions (Stewart *et al*. 1994; Carretta *et al*. 2011; Cass 1985; Bartholomew and Boolootian 1960). The Petition accurately represents the federal stock assessment status for the three primary California pinniped species found at the Farallon Islands (California sea lion, northern elephant seal, and harbor seal). The local populations for these species have increased in recent decades. According to recent estimates of population size and annual growth, each of the three California populations is thriving.

- California sea lions (2011): ~297,000 at 5.4 percent/year
- northern elephant seals (2005): ~124,000 at 5.9 percent/year
- harbor seals (2011): ~30,000 at 3.5 percent/year

The Petition states that pinniped stocks remain below pre-hunting levels, but the Department notes that there is no historic data on the size of pinniped stocks before hunting, and populations have increased dramatically since the Marine Mammal Protection Act prohibited their hunting or harassment in 1972.

It is noted in the Petition that "white sharks may play a major role in regulating the population of northern elephant seal." The Petition states "there is evidence of prey saturation occurring in some years, indicating a threshold prey level above which additional shark predation does not occur."

However, the Department notes that it is unclear whether all white sharks depend entirely on pinnipeds based on existing scientific information. The Petition acknowledges that in white sharks' migration offshore to the SOFA they could be feeding on other species, such as squid or swordfish (Domeier 2012c; Domeier and Nasby-Lucas 2008). Also, a new study using stable isotope analysis of white shark vertebrae found evidence that some adult white sharks do not depend on pinnipeds at all (Kim *et al*. 2012), and therefore may not utilize or depend on pinniped aggregation sites.

Mating Compatibility: Success in reproduction for adult white sharks may depend on the availability of mates. The Petition points to studies which found sex ratios in aggregation areas to be skewed in favor of males, with twice as many males observed as females (Sosa-Nishizaki *et al*. 2012; Domeier and Nasby-Lucas 2006; Anderson *et al*. 2011; Chapple *et al*. 2011), although about thirty percent of white sharks observed in one study were actually of unknown sex (Chapple *et al*. 2011). The Petition also cites observations at aggregations areas where males were observed to return every year, while females seem to return every other year as support for the idea that white sharks' gestation period is between 12 and 22 months (Wilson and Patyten 2008; Domeier 2012a); thus, females would be

available for mating only every other year (Domeier 2012a). As described in the section above on abundance, not all tagged/identified individuals return each year to the two aggregation sites, and new adult individuals appeared during the study period that were not tagged or identified previously. There is also uncertainty as to whether all sharks in the NEP population actually visit either of these areas at all. Very little is known about shark breeding behavior.

Human Disturbance: Although not expressly discussed in the Petition, the Department notes that disturbance at aggregation areas could also be a factor in survival and reproduction. The Department is aware of several companies which operate shark cage diving tours to Guadalupe Island and Gulf of the Farallones National Marine Sanctuary. Such tourism may affect shark feeding or behavior, although both areas have strict controls on types of activities and equipment to minimize harm to the sharks and alteration of their natural behaviors. It is possible this tourism activity could also amount to "take" under either the state or federal definition, but the Department was unable to undertake a full examination of this issue in time for this report.

h. Degree and Immediacy of Threat

To discuss the degree and immediacy of the threats, the Petition relies primarily on studies and documents related to the life history and biology, commercial fisheries interaction, physical oceanography, non-fishing human interactions with the NEP white shark population (such as pollution), and various NEP and global population estimates and trends of white sharks and sharks as a group. These studies include, but are not limited to "Historic Fishery Interactions with White Sharks in the Southern California Bight" (Lowe *et al*. 2012), "Use of Photo Identification to Describe a White Shark Aggregation at Guadalupe Island, Mexico" (Nasby-Lucas 2012), and "Heavy Metals, Trace Elements, and Organochlorine Contaminants in Muscle and Liver Tissue of Juvenile White Sharks, *Carcharodon carcharias*, from the Southern California Bight" (Mull *et al*. 2012).

Based on these scientific studies, the Petition discusses the following threats to white sharks:

Threats to Habitat: The Petition cites scientific information regarding the threats to white shark habitat off the coast of California, although these threats may or may not be imminent. The habitat threats listed in the Petition include documented pollutant discharge into the waters of the SCB, reduction in prey species such as pinnipeds and fishes through exploitation, and the acidification of the ocean due to absorption of carbon dioxide from the atmosphere.

The Petition states that a range of pollutants have been documented as being discharged into the SCB, resulting in the degradation of habitat necessary for survival. Historical discharges of organochlorides into the SCB have resulted in

elevated levels of these pollutants in prey species (Blasius and Goodmanlowe 2008). This is likely a factor in the markedly high levels of these pollutants documented in juvenile white sharks, as cited in the Petition (Mull *et al*. 2012). The effects of these increased levels of pollutants on white sharks is unknown at this time, however it is reasonable to conclude that pollutant discharge may have a deleterious effect on white sharks and their prey.

Historical overexploitation of pinnipeds has been cited in the Petition as a limiting factor to the growth of white shark populations. Furthermore, incidental catch of pinnipeds in commercial gill net fisheries has also been identified as a potential threat. The Department disagrees because although pinniped population levels were certainly depressed historically, protections for these species have resulted in dramatically increasing population levels over the last thirty years or more. The long term effects of the historical depletion of these prey species on the NEP white shark population is difficult to ascertain, although they likely once were a limiting factor. However, at least for adults, there appears to be little immediate threat due to depletion of prey species as a result of stable and increasing pinniped populations.

Ocean acidification is listed as a threat to white sharks in the Petition. Studies referenced in the Petition conclude that nearshore regions will experience under-saturation in the top 60 meters within the next 30 years (Feely *et al*. 2008; Gruber *et al*. 2012). Furthermore, it is stated that levels of acidity are rapidly increasing and will be outside of the normal range in the near future. While ocean acidification may be a threat to white sharks as well as other marine species, the severity of the effect this phenomenon will have on white shark and its habitat is uncertain. While studies document the negative effects ocean acidification may have on some marine species, further study is needed to evaluate how this phenomenon has affected and will affect white sharks and the NEP ecosystem as a whole. At this time, the degree and immediacy of this threat is uncertain.

In conclusion, habitat degradation through pollutant discharge, overexploitation of prey species, and ocean acidification may pose a reasonable threat to habitat necessary for the survival of white sharks. Although these threats exist, the degree and immediacy of threats is uncertain, and further study is needed to assess the level of risk.

Regulations Which Reduce Degree and Immediacy of Threats: The Petition states that the regulatory mechanisms of California fisheries do not offer sufficient protections to the NEP white shark population. While white sharks have a special protected status within the Fish and Game Code, most specifically under Sections 5517 and 8599, the Petition considers the exemptions on take given to commercial fisheries and research to be potentially unlimited and therefore not able to adequately protect the NEP population. Section 5517 allows for white shark take with a Department-issued scientific collecting permit (SCP), and Section 8599 allows for incidental take by gill or roundhaul nets, and for the

sale of live white sharks taken in this manner for scientific or educational display purposes (which also requires an SCP). The Petition states that take from gill net fisheries is contributing to the decline of the NEP white shark population and is the primary threat to white shark populations of the NEP.

The Petition states that historically, the NEP white shark population was in danger due to directed commercial and recreational fishing pressure coupled with high juvenile bycatch in non-target fisheries in the SCB, thus prompting Assembly Bill 522 (1993) which led to the enactment of Section 8599. The Petition states that due to written requests from the California Gillnetters Association, white sharks taken in gill nets are exempt from this bill. The Legislative Counsel Digest, Section 1(e) states, “An insignificant level of incidental take of white sharks presently occurs in several net fisheries.” (Hauser 1993) By enacting the exemption for incidental take in the bill, the Legislature deemed it desirable to collect more information on white sharks prompting an allowance for permitted scientific collecting (Hauser 1993; Heneman and Glazer 1996).

However, The Petition views the situation differently, finding the level of incidental take to be significant, and concludes that these exemptions ultimately allow unrestricted incidental take of young-of-the-year and juvenile white shark to continue, thus impacting the population.

The Petition states that the drift and set gill net fisheries account for up to 81 percent of white shark take within California. But while Section 8599 allows for incidental take and landing of live white sharks for scientific and education purposes, the existing regulations governing gill net fisheries are in fact very restrictive. All California gill net fisheries are limited by a series of area closures. Gill nets have been prohibited in waters less than 60 fathoms north of Point Arguello since the enactment of an emergency closure in 2000. This closure became permanent in 2002, effectively limiting gill net use to southern California. Gill net use is banned in several fishing districts in the Southern California Bight, including the Marine Resources Protection Zone (See Fish & Game Code, § 8610.2-4). This zone prohibits gill net use within 1 nautical mile or 70 fathoms, whichever is less, around the Channel Islands and within 3 nautical miles of shore south of Point Arguello. These expansive area closures for set gill net likely limit potential interactions with juvenile white sharks which are present in the nearshore coastal habitat. Additionally, the Petition states that gill nets may be used year round, however, in addition to area closures, there are also seasonal closures, gear constraints, and other restrictions on the methods of take that apply for most sectors of the nearshore gill net fisheries (see Table 1 for detailed information).

The offshore large-mesh drift gill net fishery targeting pelagic sharks and swordfish is also subject to very restrictive seasonal and area closures (see Table 1 for detailed closure information). Depending on the time and location,

large-mesh drift gill net use may be prohibited 6 to 75 nautical miles from shore. Additionally, large-mesh drift gill net use is prohibited in the offshore area from Point Reyes to Southeast Farallon Island to Pillar Point and within 12 nautical miles of mainland shore north of a line extending west from Point Arguello (Fish & Game Code, § 8575.5).

The Petition concludes that California protections are insufficient due to legally allowed incidental take. The Petition states that the continued incidental capture and mortality of even small numbers of white sharks in U.S. waters, particularly off California, can have a large impact on the local population and cites in support a study off the Farallon Islands in which the removal of four adult white sharks from the area in 1982 resulted in significantly fewer sightings of shark attacks on pinnipeds than expected from 1983 to 1985 (Pyle *et al.*1996). The 1982 example in the Farallones does not, however, readily apply to the sharks captured incidentally to any of the California gill net fisheries. The Department notes that most, if not all, of the white sharks caught by gill net are young-of-the-year or juveniles according to catch statistics and observations. Gill net interactions with adult sharks have not been specifically observed and documented, and it is speculated that such interactions would just leave large holes where they broke through the gear. (Heneman and Glazer 1996) Since the two population estimates cited by the Petition do not include young-of-the-year and juvenile sharks, there is no estimate for the total NEP population including all age classes. Therefore, while the full extent of take, harm and mortality by the gill net fisheries on the total population warrants further analysis and investigation, the Department finds that take in gill net fisheries has already been minimized to some extent.

Within the United States, federal and state regulations protecting white sharks vary. Currently, the retention of white sharks in U.S. Federal waters in the Pacific Ocean is prohibited under the Highly Migratory Species Fishery Management Plan. In Oregon, state law requires that all white sharks must be released immediately if caught (ODFW 2012). Washington and Hawaii do not have specific fisheries regulations for white shark. However, since 2010, Hawaii, Washington, Oregon and California have all passed statutes making it unlawful to possess, sell, offer for sale, trade, or distribute shark fins (Hawaii Revised Statues §188-40.5; Revised Code Of Washington 77.15.770; Oregon Revised Statues §509.160; California Fish and Game Code § 2021). In January 2011 President Barack Obama signed the Shark Conservation Act into federal law. This prohibits any vessel from carrying shark fins without the corresponding number and weight of carcasses, and all sharks must be brought to port with their fins attached. These regulations may provide additional protection for white sharks.

Outside of the United States, protections for white sharks also vary. In Mexico, catch and retention of white sharks, and the landing of shark fins without carcasses has been banned since 2006 (Lack and Sant 2011), although

incidental capture continues to occur (Galván-Magaña *et al*. 2010; Santana-Morales *et al*. 2012). In Canada, there are no specific regulations to protect white sharks, but a ban on shark finning may provide some protection (Department of Fisheries and Oceans Canada 2007). In international waters, white sharks are protected under the Convention on International Trade in Endangered Species (CITES) Appendix II, and other international agreements, including the Convention on Migratory Species (Appendix I and II) and the United Nations Convention on the Law of the Sea. However, the Petitioners conclude these protections are insufficient given continued trade in white shark products due to poaching and variable enforcement of regulations (CITES 2004; Clarke 2004; Shivji *et al*. 2005; Clarke *et al*. 2006; Galván-Magaña *et al*. 2010; Jorgensen *et al.* 2010; Viegas 2011).

Overall, the Petition presents adequate information that threats exist, and it is reasonable to further infer that these threats could pose immediate and significant impacts to the population. However, further analysis is needed to evaluate both degree and immediacy of these threats. California's existing regulations governing white shark take and fishery operations for drift and set gill net fisheries are very restrictive and likely have reduced the degree and immediacy of threats from fishing significantly. Further analysis of take via scientific collecting permits and by catch accounting is needed to more fully understand direct human impacts to the NEP population from fisheries, scientific research, and recreational/tourism activities. Activities governed by other state or federal agencies, or by other nations have not been evaluated as part of this evaluation.

Overexploitation: The Petition states that the greatest threat to the NEP white shark population is direct and incidental take from commercial fisheries. Various records (vessel logbook records, landing receipts, etc.) dated from 1936 to 2009 are cited in the Petition and document 300 white shark captures from the combined gill net fisheries. These records require additional validation and scrutiny for potential duplicates and misinterpreted or incorrect landing codes. Department records of some shark species were aggregated and not differentiated to species before 1979. Of available landing records, there is a possibility of duplication between landing receipt records and scientific collecting permit (SCP) annual reports, as some sharks that were tagged and released alive from commercial fishing vessels according to SCP reports have also been found listed on landing receipts from fishermen and recorded in the state database as dead. Resolution of such disposition information was not possible in time for this report.

The Petition further cites federal observer data, and gill net vessel logbooks furnished by the Department. Observer coverage (the percentage of gill net sets witnessed and recorded by onboard federal observers) within both gill net fisheries is considered inadequate according to the Petition. The Petition states that average coverage from 1990 to 2006 was 8.7 percent and in recent years as

low as 5 percent or less. Another analysis of observer data indicates coverage of 21 percent from July 1990 to 2008, documenting 8 white shark captures (Lowe *et al.* 2012). These estimates appear to be made from different sectors of the gill net fishery and aggregates of all gill net types. Observer coverage as reported by the California Set and Drift Gill Net Observer Program for the 2010 season was 4.7 percent for nearshore large-mesh set gill net (targeting CA halibut), 12.5 percent for nearshore small-mesh set and drift gill net (targeting white sea bass) and 13 percent for offshore large-mesh drift gill net (targeting swordfish and thresher shark). Observer coverage in 2011 was 8 percent, 3.3 percent, and 19.5 percent respectively. The Department agrees that additional observer coverage could improve precision in estimates of the take of white sharks in gill net fisheries. Also, improved logbook compliance and changes to logbook forms that would specifically require fishermen to furnish information on white shark interactions may improve information on gill net fishery interactions.

The Petition cites 111 white sharks taken in Mexican gill net and seine fisheries from 1999 to 2010 as another significant source of fishing pressure on the population. This is a concern, even though there are significant differences in the regulations and fishery practices (gear and record keeping) between Mexico and California. The NEP population of white sharks crosses the United States-Mexico border, and the fisheries practices of one country must be considered in context with the other.

As mentioned previously, California has enacted protections for white sharks and prohibits take of this species (see Table 4 for detailed regulatory information). The Petition cites cases of illegal fishing and sales of white shark teeth, jaws, and fins for the curio trade worldwide (CITES 2004), but there are no known recorded cases of illegal trade in white shark parts in California (Hartman pers. comm.). Both state and federal law recognize the CITES treaty and prohibit trade of these products.

Contaminants: The Petition includes discussion of the degree and immediacy of threats due to other natural or anthropogenic factors to white sharks. The Petition cites information from Mull *et al*. related to contamination in muscle and liver tissues of juvenile white sharks from the SCB, as well as studies on pelagic fish near Hawaii and studies of other elasmobranch species in Baja California. In general, the Petition states that high levels of PCB, DDT, and mercury found in body tissues suggest white sharks could be facing physiological impairments and reduced fitness from such contaminants.

The Petition accurately represents current scientific knowledge that predatory sharks are particularly vulnerable to accumulation of contaminants due to their high trophic level on the food web, long life spans, and large lipid-rich livers. A study on trophic structures in pelagic ecosystems concluded that the Cesium-Potassium (Cs/K) ratio, shown to be a useful indicator of the biomagnification potential of food webs, in pelagic organisms from the eastern Pacific Ocean

clearly increases with an increase in trophic level (Mearns *et al.* 1981). The Petition states that high levels of PCB, DDT, and methyl mercury could cause impairments and reduced fitness (Mull *et al.* 2012), however this same study states that little is known of baseline contaminant loads in elasmobranchs. Studies have shown support for the Petition's conclusion that DDT and PCB are foreign chemicals and that concentrations increase with trophic levels, yet higher concentrations of methyl mercury are normally found in higher trophic level organisms and are of an organic form (Young *et al.* 1980). It has also been found that chlorinated hydrocarbon concentrations deviate from expected values, and depend on exposure to a source and trophic position (Schafer *et al.* 1981). In conclusion white sharks along the California coast are at risk for high levels of contamination, due to a long life span and predatory nature. More research is needed to understand the true effects and risks of this contamination.

It is noted in the Petition that juvenile white sharks of the SCB are more likely to be exposed to contaminants due to their proximity to urban areas along the coastline associated with legacy contamination. While historically high levels of contaminated runoff have been noted in the past, studies have shown, overall, there has been a 70 percent reduction in contaminant inputs to the SCB coastal waters since the 1970s, despite urbanization and population growth (Schiff *et al.* 2000).

The Department agrees with the Petition's conclusion that high concentrations of contaminants may be contributing to physiological impairments and reduced fitness of white sharks, however further investigation into contaminant levels and effects are needed to determine the significance of the impacts.

i. Impact of Existing Management Efforts

To discuss the impact of existing management efforts, the Petition relies primarily on studies describing regulations specific to white shark in the state of California, nationally and internationally, including but not limited to the following: "More Rare Than Dangerous: A Case Study of White Shark Conservation in California" (Heneman and Glazer 1996) from the book Great White Sharks: The Biology of *Carcharodon carcharias*, and "Consideration of Proposals for Amendment of Appendices I and II" (CITES) at CoP13, Thirteenth meeting of the Conference of the Parties in Bangkok, Thailand (Australia and Madagascar 2004).

In 1994, white sharks received special protected status in the state of California by the addition of Sections 5517 and 8599 to the Fish and Game Code. Section 5517 prohibits the take of white sharks, except by special permit from the Department. Section 8599 prohibits commercial take of white sharks except for permitted scientific and educational purposes through an SCP. Section 8599 does allow for incidental take by roundhaul or gill nets, and any sharks landed live may be sold for scientific or live display purposes, although an SCP is required for this purpose.

Though the Petition recognizes the enactment of these regulations, it states that they provide inadequate protections to white shark in the state of California. In addition the Petition states that current regulations restricting the use of gill nets in state and federal waters along the California coast provide insufficient protection for this species.

The following describes specific regulations and their associated implementation that show the extent of protections afforded to white sharks in the waters off California.

Scientific Collection Permits: There are currently 11 Department issued SCPs that authorize take of white sharks. Current permit holders, depending on the terms of the permit, are allowed to possess (live or dead), tag and release, and salvage white sharks. Three permit holders are allowed to sacrifice specimens. The conditions of each permit are proposed by the applicant and then evaluated by Department staff. If approved, permit holders must submit an accurate record of their activities. Based on reports (2007-2011) submitted by permittees, 107 white sharks were tagged and released live, 6 white sharks were retained for live display and none were sacrificed. It is unclear from these reports how many of the individuals were taken incidental to regular commercial fishing activities compared with how many were taken by SCP permittees conducting targeted fishing activities on white sharks only for the purpose of tagging and releasing them.

Nearshore Gill Net Fishery Management[1]: The nearshore gill net fishery uses three different gear configurations to target white sea bass and California halibut.

- Small-mesh set gill net – target white sea bass; 6 inch mesh size; anchored
- Large-mesh set gill net – target CA halibut; 8.5-14 inch mesh; anchored
- Small-mesh drift gill net – target yellowtail and barracuda; 3.5-6 inch mesh; not anchored; limit of 10 white sea bass per trip

A general gill net permit is required for all three of these nearshore gill net gear configurations. For the 2011-12 license years, there are 147 general gill net permit holders with approximately 42 active participants. Between 1985 and

[1] Gill nets are strings of vertical net walls. They can be placed anywhere in the water column from near the surface to the bottom, and are either anchored to the bottom (set gill net) or left drifting, free or connected with the vessel (drift gill net). Fish are caught when they become entangled (gilled) in the net. The nets are held vertical and at the desired depth by floats on the upper line (headrope) and, in general, weights on the ground-line (footrope). These nets are usually strung together in a line or 'fleet' of nets. In modern fisheries the gill net is retrieved from the water using a net hauler or power block. Fish are removed from the gill net as it is pulled from the water and then folded on the deck or wound onto a drum. Gill nets are used to target fish species throughout the water column all over the world. (FAO 2012)

2000, the nearshore gill net fishery faced several restrictions, reducing the allowable area off California to fish with this type of gear.

The first area closure occurred in 1986, with a 25 fathoms closure from Franklin Point (San Mateo County) to Waddell Creek (Santa Cruz County), and a 15 fathoms closure from Waddell Creek to Yankee Point (Monterey County). During this time, gill nets were also prohibited in District 18, north of Point Sal (Santa Barbara County) in waters 15 fathoms or less. Additional closures were added between 1986 and 1991 (see Table 1 for closure details).

In 1994, the Marine Resources Protected Zone (MRPZ) was created, which prohibited gill net use within one nautical mile or 70 fathoms, whichever is less, around the Channel Islands and within three nautical miles of the mainland shore south of Point Arguello. The Petition states that all nearshore gill net fisheries are year-round. While this is true for the California halibut gill net fishery, it is not typically prosecuted during the fall and early winter when halibut are unavailable on the fishing grounds and the fishery would encounter more young-of-the-year white sharks in the SCB. The white seabass gill net fishery is closed annually from March 15 to June 15.

Offshore Large-mesh Drift Gill Net Fishery Management: The offshore drift gill net fishery targets swordfish and thresher sharks using nets with a mesh size greater than 14 inches. This fishery has its own set of seasonal and area closures that began in 1982. Between 1982 and 1989, several seasonal closures were enacted out to 200 nautical miles. Closures in 1982 and 1985 were enacted to protect marine mammals. The 1982 closure prohibited drift gill net use within 200 nautical miles of shore between February 1 and April 30. Regulations enacted in 1986 eliminated the drift gill net fishery for thresher sharks within 12 nautical miles of shore north of Point Arguello (Santa Barbara County), in areas around the Farallon Islands and near the mouth of San Francisco Bay. This also shortened the thresher shark season in all other areas to the period from May 1 to May 30. In 1988 federal observers were authorized for deployment on drift gill net vessels, and in 1989 the seasonal closures out to 200 nautical miles became permanent. Collectively these regulations severely limited effort and landings of the directed thresher shark fishery in California. Today, the large-mesh drift gill net fishery for swordfish and thresher sharks is federally managed under the HMS-FMP, although the state's rules remain in effect.

In 2001, the NOAA Fisheries created the Protected Resources Area Closures to protect Pacific leatherback turtles and later Pacific loggerhead turtles. This regulation (50 CFR 660.713) created the Pacific Leatherback Conservation Area (PLCA) off the coast of northern California. In the PLCA, the large-mesh drift gill net fishery is closed annually from August 15 to November 15. There is also a second PLCA for Loggerhead turtles, which closes the fishery off the coast of southern California from June 1 to August 31 during El Niño events. While not

mentioned in the Petition, these seasonal area closures likely reduce the chance of contact with white sharks by the large-mesh drift gill net fishery.

Between 1979 and 2011, the Department notes there are noticeable trends in white shark catch, which correlate with periods following significant regulation changes. Between 1981 and 2005, the number of sharks caught peaked in 1985 and then decreased as regulations steadily reduced the amount of fishing effort of the nearshore set gill net fishery. Lowe reports that young-of-the-year captures by the gill net fishery follow temporal trends in fishery effort (Lowe *et al*. 2012). In 1989 set gill net fishing effort reached its lowest level since 1979. Even with continued restrictions to the gill net fisheries, effort remained relatively stable through the next twenty years. Beginning in 2000, the reported capture of white sharks in gill net fisheries increased by 16 percent (Lowe *et al*. 2012). Almost all of these reported captures were of young-of-the-year and juvenile white sharks. The Department notes that this may indicate increased recruitment as it appears more young white sharks were present on the fishing grounds (Lowe *et al.* 2012). The Department further notes that increases in incidental catch would seem unlikely in the face of increased restrictions and regulation changes on gill net fisheries during this time period.

Table 1. Set Gill Net Fishery State Laws

Statute	Year	Description
FGC 8664.8a	1989	Gill nets shall not be used in ocean waters between a line extending 245 degrees magnetic from the most westerly point of the west point of the Point Reyes headlands in Marin County and the westerly extension of the California-Oregon boundary.
FGC §8625a, b, c	1989	a: 8.5 inches mesh required to take halibut, total net length allowed is 1,000-1,500 fathoms depending on location in Santa Barbara Co.
		b: Except as provided in subdivision c, not more than 1,500 fathoms of gill net or trammel net shall be fished in combination each day for California halibut from any vessel in ocean waters.
		c: Not more than 1,000 fathoms of gill net or trammel net shall be fished in combination each day for California halibut from any vessel in ocean waters between a line extending due west magnetic from Point Arguello (Santa Barbara County) and a line extending 172 degrees magnetic from Rincon Point (Santa Barbara County) to San Pedro Point at the east end of Santa Cruz Island (Santa Barbara County), then extending southwesterly 188 degrees magnetic from San Pedro Point on Santa Cruz Island.
FGC §8724	1989	Trammel nets must have a mesh size of at least 8.5 inches in Districts 10, 17, 18, and 19.
FGC §8610.2d(1), d(2), d(3)	1990	Marine Resource Protection Zone (MRPZ) created: d(1): waters less than 70 fathoms or within one mile (whichever is less) around the Channel Islands d(2): area within 3 nautical miles offshore of the mainland coast and any manmade breakwater between a line extending from Point Arguello to the Mexican border. d(3): waters less than 35 fathoms between a line running 18 degrees from Point Fermin and a line running 270 degrees from the south jetty of Newport harbor.
FGC 8610.3b	1994	Gillnet use prohibited in Marine Reserve Protected Zone
	2000	Emergency closure prohibiting set net use in waters 60 fathoms or less between Point Reyes (Marin Co) and Point Arguello (Santa Barbara Co)
CCR Title 14 §104.1	2002	Permanent closure of waters 60 fathoms or less between Point Reyes (Marin Co) and Point Arguello (Santa Barbara Co)

Table 2. Nearshore Drift Gill Net State Laws

Statute	Year	Description
FGC §8623 c, d	1957, amended 1988	c: 3.5 inch minimum mesh to take yellowtail and barracuda d: Gill nets with 6 inch mesh may be used to take white seabass; however, during the period June 16 to March 14, not more than 20 percent by number of a load of fish may be white seabass 28 inches or more in total length, up to a maximum of 10 white seabass per load, if taken in gill or trammel nets with mesh from 3.5 to 6 inch

Table 3. Offshore Drift Gill Net State Laws

Statute	Year	Description
FGC §8573a	1982, amended 2007	From 6/1-11/15 shark or swordfish gill nets shall not be in the water two hours after sunrise to two hours before the sunset east of the line from Santa Cruz Island to the California-Mexico border.
FGC §8575 b, c, d ,e , f	1982	Drift gill nets time closures b: 5/1-7/31 within 10 nautical miles of San Miguel Island to a line with Santa Rosa Island
		c: 5/1-7/31 within 10 nautical miles radius of the west end of San Nicolas Island
		d: 8/15-9/30 from Dana Point (Orange County) to Church Rock (Catalina Island) then direct line to Pt. La Jolla, then from mainland shore to Dana Point
		e: 8/15-9/30 6 nautical miles of the coastline on the northerly and easterly side of San Clemente Island to a line extending six nautical miles east magnetically from Pyramid Head
		f: 12/15-1/31 ocean waters within 25 nautical miles of the mainland coastline
FGC §8573b(1) , b(2), b(3), b(4),	1983	b(1): Total maximum length of shark or swordfish gill net shall not exceed 6,000 feet in float line length
		b(2): Gill net on the reel shall have float lines of adjacent panels tied together. No quick disconnect device may be used unless total maximum length of all gill nets does not exceed 6,000 feet
		b(3): Spare gill net aboard vessel shall not exceed 250 fathoms (1,500 feet)
		b(4): Torn panel should be removed from working net before replacement panel is attached to the working net.
FGC §8575.5	1986	DGN fishery was eliminated within 12 nautical miles of the coast north of Point Arguello and in certain areas in the Gulf of Farallones and near the mouth of San Francisco Bay; thresher season was reduced to 5/1-5/30

Statute	Year	Description
FGC §8576.5	1988	Pelvic fin retention on threshers required for sex determination by state; federal Marine Mammal Protection Act amended to require drift gill net vessels to display federal exemption permits, report marine mammal fatalities, and allow federal observers.
FGC §8576	1989	Lengthened 75 nautical miles closure to 5/1-8/14 and maintained the prohibition (200 nautical miles closure); CA, OR, and WA enact tri-state inter-jurisdictional fishery monitoring plan for threshers (Pacific Fisheries Management Council 1990)

Table 4. State Laws Specific to White Shark

Code	Year	Description
FGC §5517	1993	Makes unlawful to take any white shark except under permits issued pursuant to Section 1002 for scientific or educational purposes.
FGC §8599a, b, c	1993	a: Unlawful to take an white shark for commercial purposes, except under permits issued pursuant to Section 1002 for scientific or educational purposes or pursuant to subdivisions.
		c: White sharks may be taken incidentally by commercial fishing operations using set gill nets, drift gill nets, or round haul nets. Pelvic must be attached on carcass until after the white shark s brought ashore. If landed alive, may be sold for scientific or live display purposes.
		c: Any white shark killed or injured by any person in self-defense may not be landed.
FGC §8599.3	1993	Department shall cooperate with scientific institutions to facilitate data collection on white sharks taken incidentally by commercial fishing operations.
Section 28.06, Title 14, CCR	1994	Prohibits take in ocean sport fisheries except under an SCP

j. Suggestions for Future Management

In its suggestions for future management measures, the Petition relies primarily on a 2003 paper by J. Baum *et al.* in the journal Science, "Collapse and Conservation of Shark Populations in the Northwest Atlantic", which describes the decline of several large shark species on the east coast and suggests possible action to prevent further decline.

The Petition makes the following recommendations for management and research:

1. Protect white sharks as a threatened or endangered species under the California Endangered Species Act;
2. Set hard limits on the incidental capture of white sharks in California and U.S. fisheries; especially set and drift gillnet fisheries in the Southern California Bight, including increased observer coverage;
3. Create changes to existing fisheries management to reduce interactions of white sharks with commercial fisheries (gear modifications, soak time limits, time/area closures, and enforcement);
4. Create a recovery plan for white shark, including management efforts to reduce toxins in the habitat and mitigate impacts from ocean warming and acidification;
5. Increase coordination between state, federal and international governments to address fishery impacts in the NEP white shark's range;
6. Improve monitoring of population and abundance trends;
7. Increase understanding of genetics; and
8. Increase research on population size, movements, population dynamics, and other elements of white shark biology.

Some of these recommendations have already been identified or addressed in whole or in part by existing regulations, management plans and calls for research.

Related to point three, the Department and NOAA Fisheries have existing temporal and spatial closures in place for set and drift gill net fisheries, (see section H.4 – Degree and Immediacy of Threat – Regulations, section I - Impact of Existing Management Efforts, and Tables 1-3 & 5), that limit interactions with white sharks and other marine species.

As a first step to addressing point five mentioned in the Petition, the California statute allowing sale of incidentally caught white sharks for scientific and live display purposes (Fish & Game Code, § 8599) is in conflict with the federal Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species (HMS FMP), in which incidentally caught white sharks are a prohibited species and must be released immediately (50 CFR 660.711). State and federal agencies should make efforts to bring these regulations into conformance.

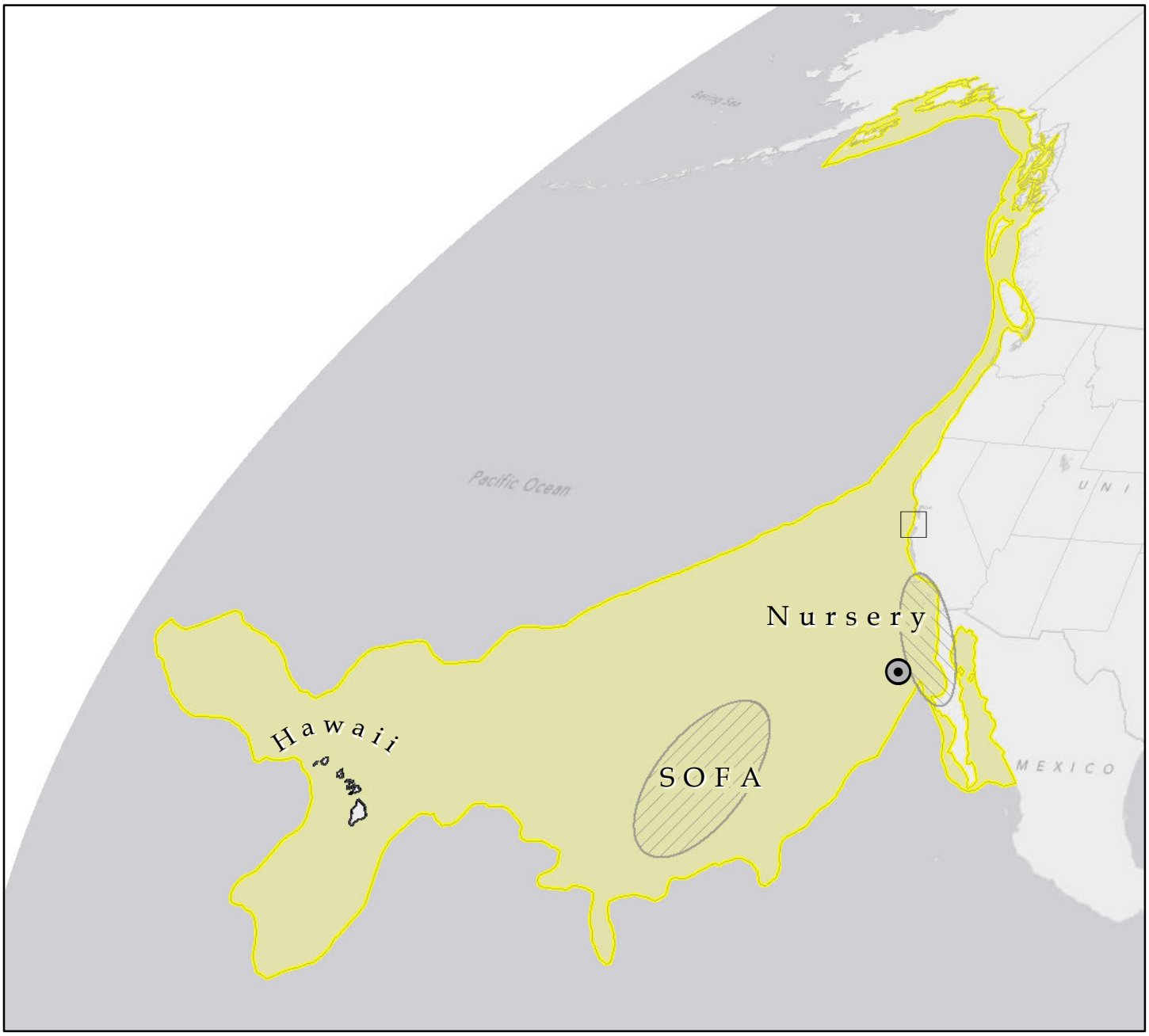
In an effort to increase coordination between state, federal and international regulations (point five), and since white sharks are cross-boundary animals and spend considerable portions of their life history in the international waters of the open ocean, California could support the Pacific Fishery Management Council (PFMC), recommending U.S. delegates to international regulatory bodies and Regional Fisheries Management Organizations (RFMO). Specifically, the US delegates to entities including the Inter-American Tropical Tuna Commission (IATTC) and the Western Central Pacific Fisheries Commission (WCPFC) could propose that their organizations adopt measures to make white sharks a prohibited species. Recommendations could be aimed at preventing or minimizing take or capture of NEP white sharks outside the U.S. Exclusive Economic Zone (EEZ).

Effort to address points five through eight in the Petition have been identified as research and management needs by the Department, the Pacific Fishery Management Council (PFMC), and white shark researchers. Research as outlined above and in the HMS FMP (pp. 97-98 & 100-101) should continue to further our understanding of white shark biology and management needs.

k. Detailed Distribution Map

The Petition included several maps, showing the general global range of white shark (Fergusson *et al.* 2009), a second map displaying adult movements of the NEP population from satellite tagging data (Jorgenson 2010), and a third map showing the distribution of fish camps with records of juveniles in the catch from Baja California (Santana-Morales *et al*. 2012). The Department produced an overview map as part of the Petition response covering range and general habitat of the NEP population of white shark.

Northeastern Pacific White Shark | Distribution and Focal Centers



Legend

- Central California Aggregation Sites
- Guadalupe Island
- White Shark Nursery
- Shared Offshore Foraging Area (SOFA)
- Geographic Range

Data Sources:
Chapple et al. (2011)
Jorgensen et al. (2010)
Domeier and Nasby-Lucas (2008)
Weng et al. (2007)
Klimley (1985)

Map Projection:
Winkel Tripel
Sphere
1:40,000,000 @ 8.5"x11"

October 29, 2012

4. Status of the Species

The Petition concludes that the white shark population of the NEP is in peril, white sharks are rare, and that protections are urgently needed. The Petition states that the white shark population off California is alarmingly low in size, and is genetically isolated from other global populations. Additionally, the Petition states there is an inherent extinction risk due to the likelihood that the NEP population is far below its minimum viable population size. The Petition acknowledges that the population is still in the process of being quantified but notes that direct and indirect human exploitation has likely resulted in a heavily depleted white shark population in the NEP and that populations in the NEP are considerably smaller than other regional populations worldwide using the same amount of coastal habitat.

The Petition states that white shark populations worldwide are in decline and, although population trends in the NEP are unknown, they are likely in decline. Following from cited population estimates for white shark in the NEP, the Petition concludes there is a substantial risk of extinction as the population is far below the minimum viable population (MVP) for most species.

The Department agrees that the life history parameters as an apex predator make this species naturally low in abundance. Additionally, due to its low abundance and life history characteristics, white shark populations are difficult to track and measure with a high degree of statistical confidence. The Department agrees that white sharks are vulnerable to incidental fishing pressure, habitat loss and alteration, and other natural and anthropogenic pressures due to a low rate of population increase and naturally low abundance as an apex predator.

The current status of the NEP white shark population is unknown. Despite recent advances, there are still large gaps in our understanding of the basic life history of white sharks such as age, growth and reproductive biology. Obtaining this knowledge may be slow due to the small population and restrictions imposed by important protections afforded to the species in recent decades. These factors limit samples to opportunistic interactions with commercial fisheries and non-lethal fishery-independent methods. However, the available literature focused on the NEP population of white sharks is much greater than what is available for other populations (e.g., the Australia/New Zealand population or the western South Africa population).

Although the overall status of the population is unknown, there are anecdotal indications that white shark populations off California in the NEP may actually be increasing as a result of increased fishery restrictions on gill net fisheries, and recovery of West Coast pinniped populations.

Incidental reported catch rates of young-of-the-year and juvenile white sharks have increased in southern California since the California nearshore gill net ban in 1994

and regulation of the offshore drift gill net fishery, despite a significant decrease in the overall gill net fishing effort since the mid-1990s. This suggests the white shark population off California may be increasing because of the reduced nearshore gill net fishing effort and white shark harvest protections in state and federal waters (Lowe *et al*. 2012). Recovery of other large nearshore-fish populations has also been documented as the result of nearshore gill net ban (Pondella and Allen 2008). This pattern of increasing white shark interactions is also reflected in progressive increases in white shark bite mortality on sea otters (Lowe *et al*. 2012; Mike Harris pers. comm.).

Although these patterns are of interest, and may indicate an increase in white shark abundance, further fishery independent research is needed to better assess and understand population dynamics and the status of NEP white shark populations off California.

5. Recommendation to the Commission

Pursuant to Section 2073.5 of the Fish and Game Code, the Department has evaluated the petition on its face and in relation to other relevant information the Department possesses or received. Pursuant to Section 2072.3 of the Fish and Game Code, to be accepted, a petition shall, at a minimum, include sufficient scientific information that the petitioned action may be warranted, and include information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and any other factors that the petitioner deems relevant.

In completing its petition evaluation, Department has determined there is sufficient scientific information to indicate that the petitioned action may be warranted, and recommends the petition be accepted and considered.

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