NOAA FISHERIES

Oceanic Whitetip Shark
(*Carcharhinus longimanus*)

Endangered Species Act (ESA) Draft Recovery Plan

January 2023

OCEANIC WHITETIP SHARK
(*Carcharhinus longimanus*)

DRAFT RECOVERY PLAN

PREFACE

The National Marine Fisheries Service (NMFS) has developed this Draft Recovery Plan for the oceanic whitetip shark (*Carcharhinus longimanus*) pursuant to the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.), and in accordance with our mission to recover and conserve protected species. Draft recovery plans are subject to public review, and comments received during the review period are considered during preparation of the final plan. Supplemental scientific assessments and supporting information for this Draft Recovery Plan are available on the NMFS oceanic whitetip shark species profile page. The supplemental information (e.g., Recovery Status Review for the oceanic whitetip shark) is accessible for informational purposes but is not subject to formal public review.

The ESA establishes policies and procedures for identifying, listing, and protecting species of fish, wildlife, and plants that are endangered or threatened with extinction. The purposes of the ESA include, "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species." The definition of "conserve" and "conservation" under the ESA is "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary." In other words, conservation of the species generally culminates in the endpoint of its recovery. The ESA definition of "species" includes "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." The oceanic whitetip shark was listed as threatened on January 30, 2018 (83 FR 4153). A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Therefore, a threatened species is one that is likely to become in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

To help identify and guide recovery needs for listed species, section 4(f) of the ESA directs the Secretary to develop and implement recovery plans for listed species. A recovery plan must incorporate, to the maximum extent practicable, the following: (1) a description of site-specific management actions necessary for the conservation and survival of the species; (2) objective, measurable criteria that, when met, will allow the species to be removed from the endangered and threatened species list; and (3) estimates of the time and cost required to achieve the plan's goals. See 16 U.S.C. 1533(f)(1)(B)(i)-(iii). This Draft Recovery Plan specifically addresses the recovery planning requirements of the ESA for the oceanic whitetip shark. It presents a recovery strategy based on the biological and ecological needs of the species, current threats, and existing conservation measures, all of which affect its long-term viability.

DISCLAIMER

Recovery plans delineate such reasonable actions as may be necessary, based upon the best scientific and commercial data available, for the conservation and survival of listed species. We publish these plans that we sometimes prepare with the assistance of recovery teams, contractors, state agencies, and others. Recovery plans represent the position of NMFS, and do not necessarily represent the views, official positions, or approval of any individuals or other agencies involved in the plan formulation; they represent the official position of NMFS only after the Assistant Administrator has signed the final plan. Recovery plans are guidance and planning documents only. Identification of an action to be implemented by any public or private party does not create a legal obligation beyond any existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any federal agency obligate or pay funds in any single fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. § 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions.

LITERATURE CITATION SHOULD READ AS FOLLOWS:

National Marine Fisheries Service. 2023. Draft Recovery Plan for the Oceanic Whitetip Shark (*Carcharhinus longimanus*). NMFS, Office of Protected Resources. Silver Spring, Md. 62 pages.

Download a digital copy of this recovery plan from the NMFS oceanic whitetip shark profile page.

All NMFS recovery plans can be downloaded from the NMFS publications web page.

GUIDE TO THE PLAN

This Draft Recovery Plan is one part of a three-part format in which recovery planning components for the oceanic whitetip shark are divided into three separate documents. The first document, the Recovery Status Review (NMFS 2023a), provides detailed information on the oceanic whitetip shark's biology, ecology, status and threats, and conservation efforts to date, which has typically been included in the background section of a species' recovery plan. Highlights of the Recovery Status Review are summarized in the Introduction of this Draft Recovery Plan for the benefit of the reader, but readers can consult the Recovery Status Review if they seek additional information. The second document, this Draft Recovery Plan, focuses on the statutory components of a recovery plan, as required under the ESA to the maximum extent practicable: (1) a description of site-specific management actions necessary for the conservation and survival of the species (hereafter referred to as recovery actions); (2) objective, measurable criteria that, when met, will allow the species to be removed from the endangered and threatened species list (hereafter referred to as recovery criteria); and (3) estimates of the time and cost to achieve the plan's goals. Site-specific recovery actions in this Draft Recovery Plan are described at a high level and are strategic in nature. More in-depth, stepped-down activities that address the site-specific recovery actions for the oceanic whitetip shark can be found in a third stand-alone document, the Draft Recovery Implementation Strategy (NMFS 2023b). The Draft Recovery Implementation Strategy is a flexible, operational document separate from the Draft Recovery Plan that provides specific, prioritized activities necessary to fully implement recovery actions in the plan, while affording us the ability to modify these activities efficiently to reflect changes in the information available and progress towards recovery. All documents used to inform this recovery plan, including the Recovery Status Review and the Draft Recovery Implementation Strategy, are available on the NMFS oceanic whitetip shark species profile web site.

ACKNOWLEDGEMENTS

NMFS gratefully acknowledges the contributions of the numerous individuals in developing the Draft Recovery Plan for the Oceanic Whitetip Shark.

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EXECUTIVE SUMMARY

We listed the oceanic whitetip shark (*Carcharhinus longimanus*) as a threatened species under the ESA on January 30, 2018 (83 FR 4153) after considering the best scientific and commercial data available. Section 4(f) of the ESA states that a recovery plan must, to the maximum extent practicable, incorporate or include the following: (1) a description of site-specific management actions necessary for the conservation and survival of the species; (2) objective, measurable criteria that, when met, will allow the species to be removed from the endangered and threatened species list; and (3) estimates of the time and cost to carry out the measures needed to achieve the plan's goals. This Draft Recovery Plan addresses the recovery planning requirements of the ESA for the oceanic whitetip shark. It presents a recovery strategy based on the biological and ecological needs of the species, current threats, and existing conservation measures, all of which affect its long-term viability.

Species Status: The oceanic whitetip shark is a globally distributed, pelagic species of shark that is highly migratory, has low-moderate productivity, and relatively low reproductive rates. While the current population size is unknown, the best available information indicates the oceanic whitetip shark has experienced significant declines in abundance throughout its range over at least the last several decades due to overutilization in commercial fisheries resulting in excessive fishing mortality. It is also unknown whether global population abundance has continued to decline, has stabilized, or has recently increased. Primary threats to the oceanic whitetip shark are incidental bycatch in commercial fisheries, particularly longlines, purse seines, and gillnets; international trade of oceanic whitetip shark fins; and inadequate regulatory mechanisms to address these threats.

Recovery Strategy: The overall strategy to recover the oceanic whitetip shark is to reduce fishing mortality through a two-pronged approach: 1) reducing the frequency of fishing interactions, and 2) increasing survivorship before, during, and after the interactions with fishing gear occur. Given that the oceanic whitetip shark's range is largely outside of U.S. jurisdiction, the recovery strategy includes international cooperation through Regional Fisheries Management Organizations (RFMOs) and other international partners. We divided the global oceanic whitetip shark population into four management units (MUs) based on the boundaries established by the four convention areas of the major tuna RFMOs that are responsible for managing tuna fisheries and pelagic sharks such as the oceanic whitetip shark. The threat level from fisheries within these RFMOs varies, RFMOs manage these fisheries differently, and measures regarding oceanic whitetip sharks could change in the future. Therefore, delineating the global population of oceanic whitetip sharks into these four MUs will facilitate adaptive recovery strategies relevant to their respective regions.

Recovery Objectives: The three recovery objectives for the oceanic whitetip shark are to:

1) Ensure the oceanic whitetip shark maintains resiliency and geographic representation, and is a functional component of the ecosystem, by increasing overall abundance to achieve viable populations in all ocean basins;
2) Increase oceanic whitetip shark resiliency by managing or eliminating significant anthropogenic threats; and
3) Ensure the continued viability of the oceanic whitetip shark through development and effective implementation of regulatory mechanisms for the long-term protection of the species.

Recovery Criteria: In the absence of historical abundance data, we developed demographic recovery criteria based on modeling methods that are used to determine the sustainability of commercially exploited species. We developed four alternative demographic recovery criteria that can be used to determine when a stable and sustainable population size has been reached, depending on the level of available data. We also developed six threats-based recovery criteria that indicate the threats to the species are reduced, managed, or eliminated such that they are not contributing to the species being in danger of extinction within the foreseeable future. These criteria reflect the highest level of specificity that is feasible, or practicable, on the basis of the information available, including the lack of historical abundance data. To delist the oceanic whitetip shark, the demographic-based recovery criterion (met in one of four possible ways) and six threats-based recovery criteria should be met. However, it is possible that delisting could occur without meeting all of the recovery criteria if the best available information indicates the oceanic whitetip shark no longer meets the definition of an endangered species or a threatened species.

Objective	Delisting Criteria
1. Ensure the oceanic whitetip shark maintains resiliency and geographic representation, and is a functional component of the ecosystem, by increasing overall abundance to achieve viable populations in all ocean basins	1a) Formal stock assessment - The ratio of the current spawning biomass (SB) (i.e., the number of adult females in the current exploited population) in a given year to the unfished spawning biomass (SB0, i.e., the number of adult females in the population subject only to natural mortality) is at least 0.30 ($SB_{current}/SB_0$=0.30) in three of four management units representing all ocean basins (Atlantic Ocean, Indian Ocean, and at least one Pacific Ocean MU; see discussion in section 3.2 below) and on average demonstrates an increasing trend for 20 years (i.e., 2 generation lengths). This ratio would be determined using a formal stock assessment that incorporates estimates, where applicable, of life history, relative abundance, catch, and discard mortality analogous to that produced by Tremblay-Boyer et al. (2019) for the Western and Central Pacific Ocean. In this case, the unfished spawning biomass (SB_0) was calculated from the estimated recruitments via the Beverton-Holt stock recruitment relationship.

Objective	Delisting Criteria
	OR b) <u>Data-limited assessment</u> - The ratio of predicted total current stock biomass relative to unfished conditions (relative biomass), or predicted current spawning stock fecundity relative to unfished conditions (relative spawning stock fecundity) is at least 0.30 ($SB_{current}/SB_0=0.3$) in three of four management units representing all ocean basins (Atlantic Ocean, Indian Ocean, and at least one Pacific Ocean MU) and on average demonstrates an increasing trend for 20 years (i.e., 2 generation lengths). This ratio could be determined using an Age-Structured Catch-Free Model (e.g., Porch et al. 2006; Cortés et al. 2006), Incidental Catch Model (e.g., Caswell et al. 1998) or similar modeling approach that does not utilize catch as an input variable. OR c) Based on a spawning per recruit-based reference point as a proxy for status (e.g. Brooks et al. 2009), a ratio of spawner per recruit of 0.50 has been achieved in three of four management units representing all ocean basins (Atlantic Ocean, Indian Ocean, and at least one Pacific Ocean MU) and over 20 years. OR d) The annual rate of population change is found to be increasing at a rate of a minimum of 12% in three of four management units representing all ocean basins (Atlantic Ocean, Indian Ocean, and at least one Pacific Ocean MU) and over 20 years. This can be determined by using population count or relative abundance index data within a Bayesian state-space model (e.g., Just Another Red List Assessment [JARA]; Sherley et al. 2019).
2. Increase oceanic whitetip shark resiliency by managing or eliminating significant anthropogenic threats.	***Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*** No threats have been identified under Factor A; therefore, this recovery plan does not include recovery criteria for this factor. ***Factor B: Overutilization for Commercial, Recreational, Scientific,***

Objective	Delisting Criteria
	or Educational Purposes 2. $F_{current}$ (i.e., the current level of total fishing mortality (at-vessel + post-release mortality)) [is less than] < F_{limit} (i.e., the fishing mortality rate that corresponds to the maximum level of mortality that can occur that may drive the population to low levels in the long-term) over a period of 2 generations (~20 years). 3. Trade management mechanisms are in place to monitor and limit, as necessary, the level of fins in international trade, and a systematic review shows that the volume of fins in trade is not placing the species in danger of extinction within the foreseeable future throughout all or a significant portion of its range. ***Factor C: Disease or Predation*** No threats have been identified under Factor C; therefore, this recovery plan does not include recovery criteria for this factor. ***Factor E: Other Natural or Manmade Factors*** No threats have been identified under Factor E; therefore, this recovery plan does not include recovery criteria for this factor.
3. Ensure the continued viability of the oceanic whitetip shark through development and effective implementation of regulatory mechanisms for the long-term protection of the species.	***Factor D: Inadequacy of Existing Regulatory Mechanisms*** 4. U.S. Federal, state, and territorial laws are developed and/or maintained, implemented, and enforced to prevent finning of oceanic whitetip sharks and prevent retention of the species in commercial fisheries. Such laws include, but are not limited to, the Shark Conservation Act and Shark Finning Prohibition Act. 5. All nations identified as having significant catch, bycatch, and trade of oceanic whitetip shark (as identified by the respective RFMOs, their compliance committees, the Food and Agricultural Organization of the United Nations [FAO], and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) have acceded to international and multilateral agreements and enacted national legislation or equivalent regulatory measures to implement management measures specified under the agreements. 6. Measures prohibiting retention and finning of oceanic whitetip sharks are maintained by all RFMOs and Parties are implementing these measures adequately as measured by landings data and country reports to RFMOs. This can be

Objective	Delisting Criteria
	verified by each of the compliance committees in the respective RFMOs. 7. Within an individual country's EEZ not subject to RFMO retention prohibitions, laws are developed and/or maintained, implemented, and enforced to prevent finning of oceanic whitetip sharks and prevent retention of the species in commercial fisheries.

Recovery Program: We identified nine recovery actions that are necessary to recover the oceanic whitetip shark, as well as two other actions that are not necessary for recovery, but would facilitate monitoring for other potential stressors and planning for post-delisting.

Recovery Actions

Population Dynamics

1. Improve knowledge and understanding of oceanic whitetip shark population status, abundance trends, and genetic structure.
2. Improve knowledge and understanding of oceanic whitetip shark distribution, movement, and habitat use.
3. Improve knowledge and understanding of the demographics and life history of oceanic whitetip sharks.

Fisheries Interactions

4. Reduce fisheries bycatch and mortality of oceanic whitetip sharks by determining and addressing the frequency of capture and severity of fishing interactions in commercial, artisanal, and recreational fisheries.
5. Reduce fisheries bycatch and mortality of oceanic whitetip sharks in international fisheries and trade through enhanced international coordination and collaboration with relevant international organizations, such as RFMOs.

International Trade

6. Determine the effects of the international shark fin trade on oceanic whitetip shark populations in all management units, and take management actions to reduce, and/or eliminate if necessary, the amount of oceanic whitetip shark fins in trade.

Monitoring and Reporting

7. Improve species-specific monitoring and reporting of oceanic whitetip sharks in commercial and artisanal fisheries by RFMOs and individual countries to provide a better understanding of the effects of illegal, unreported, and unregulated (IUU) fishing, improve estimates of catch and discards, and measure progress towards recovery.

Regulatory Mechanisms and Enforcement

8. Reduce fishing mortality of oceanic whitetip sharks through effective development, implementation, and enforcement of international and domestic measures, such as legislation and regulations.

Outreach and Education

9. Develop and implement outreach and education strategies and programs to increase public and stakeholder (including fishermen) awareness on the status and recovery needs of the oceanic whitetip shark.

Other Actions

Other Stressors

10. Identify, evaluate, and minimize any other stressors that may be impeding recovery of oceanic whitetip sharks.

Post-delisting Monitoring Plan

11. Develop a post-delisting monitoring plan to ensure management of oceanic whitetip sharks continues to be sustainable post-delisting.

Estimated Time and Cost of Recovery: Based on life history characteristics and generation time of the species, we estimate it will take approximately 62 years for the oceanic whitetip shark to recover, if all recovery actions are implemented. We estimate a total cost of $110,035,000 to implement all of the recovery actions identified in the recovery plan.

LIST OF ACRONYMS

CI	Confidence interval
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CPUE	Catch per unit effort
EEZ	Exclusive Economic Zone
EPO	Eastern Pacific Ocean
ESA	Endangered Species Act
EM	Electronic monitoring
FAD	Fish aggregating device
FAO	Food and Agricultural Organization of the United Nations
FR	Federal Register
FTE	Full-time equivalent
FY	Fiscal Year
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IUCN	International Union for the Conservation of Nature
IUU	Illegal, unreported, and unregulated
ISSF	International Seafood Sustainability Foundation
JARA	Just Another Red List Assessment
MOU	Memorandum of Understanding
MSY	Maximum sustainable yield
MU	Management Unit
NDF	Non-detriment finding
NGO	Non-governmental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
RFMO	Regional Fisheries Management Organization
SB	Spawning biomass
SPAW	Protocol for Specially Protected Areas and Wildlife
SPR	Spawning potential ratio
TBD	To be determined
TL	Total length
UNEP	United Nations Environment Programme
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean

1. Introduction

1.1 ESA Listing of the Oceanic Whitetip Shark

On January 30, 2018, after considering the best available scientific and commercial information, we listed the oceanic whitetip shark (*Carcharhinus longimanus*) as a threatened species throughout its range (83 FR 4153). The final rule became effective on March 1, 2018.

Figure 1. *Oceanic Whitetip Shark*

The oceanic whitetip shark is a highly migratory, pelagic species of shark that is distributed in tropical and subtropical waters globally. Like many other shark species, the oceanic whitetip shark is relatively long-lived, with low-moderate productivity and low reproductive rates. Although the species is currently thought to consist of a single population, some population structuring is evident, particularly between the Atlantic and Indo-Pacific (Ruck 2016; Camargo et al. 2016). Once considered incredibly abundant and common, the oceanic whitetip shark has experienced significant population declines throughout its range due largely to bycatch in commercial fisheries and opportunistic trade of the species' fins in international markets.

1.2 Threats to the Species' Viability and Other Stressors

The 2017 Status Review Report (Young et al. 2017) and the 2018 final listing rule (83 FR 4153) identified and assessed the factors contributing to the decline of the oceanic whitetip shark. The Recovery Status Review (NMFS 2023a) presents an updated threats assessment that incorporates new information that has become available since the 2018 listing rule about potential emerging stressors and the scope and severity of existing threats, as well as modifications to better inform the recovery planning process. For example, in the final rule we assessed the threat of overutilization as the culmination of bycatch-related mortality and the fin trade globally, which also includes illegal, unreported, and unregulated (IUU) fishing and illegal trade. In the Recovery Status Review, we re-assessed the threat of overutilization by individually analyzing each major fishery by ocean basin and gear type so that we could develop more targeted recovery actions and activities. The purpose of the threats assessment is to identify, evaluate, and rank the stressors to the oceanic whitetip shark in order to understand which stressors are contributing to the species' decline and thus are considered threats to the species that should be addressed in the recovery plan.

Table 1 below presents a summary of the threats assessment from the Recovery Status Review. We assessed the threats/stressors for each region within the species' range (Atlantic, Eastern Pacific, Western and Central Pacific, and Indian Ocean). We identify those regions as Management Units[1] (MUs) in this Recovery Plan (see section 3.2 below for detailed explanation and rationale for identifying these MUs). We prioritized threats that are most urgent and significant for the recovery of the species according to the following criteria: 1) the frequency with which the threat/stressor occurs, 2) the severity of the threat/stressor, 3) the geographic extent of the threat/stressor, 4) the trend of the threat/stressor, and 5) the certainty that the threat/stressor is affecting the species. To determine the overall risk presented by each threat/stressor to the species within each respective MU, the factors described above were evaluated together to determine an overall "risk" score based on the following scale: low, low to moderate, moderate, moderate to high, high. See Box 1 below for definitions of the terms used in the threats assessment. More detailed methodology is presented in the Recovery Status Review.

As used in this recovery plan, a threat is any stressor, natural or human-related, that impedes recovery or contributes to the oceanic whitetip shark's extinction risk. Stressors ranked as high, moderate-to-high, or moderate risk were considered to be an important source of risk to the species that must be addressed in order for the species to recover, and thus are considered to be threats for the purposes of this recovery plan. Stressors identified as low or low-moderate risk are not currently known to be impeding recovery, and thus are not considered to be threats that need to be reduced or eliminated to achieve recovery, but should be investigated further to better understand how they may be acting on the species and whether they may become threats in the future. If NMFS determines that other

[1] Management units are a tool that can be used in recovery plans to address differing threats, management authority, and/or population viability across geographic areas requiring tailored management programs.

stressors are impeding recovery, the recovery plan will be updated to address and mitigate newly identified threats.

Based on the assessment presented in the Recovery Status Review and summarized in Table 1 below, the threats to the oceanic whitetip shark are generally as follows:

- Incidental bycatch in commercial fisheries, particularly longlines, purse seines and gillnets
- International trade of oceanic whitetip shark fins
- Inadequate regulatory mechanisms to address bycatch and trade

Based on the assessment presented in the Recovery Status Review and summarized in Table 1 below, the following stressors are not considered threats to the species currently, but should be monitored to determine whether they may become threats to the oceanic whitetip shark in the future:

- Climate change
- Pollutants and toxins
- Emerging stressors (e.g., aquaculture, tourism)

Box 1. Definitions of parameters used in Table 1: Assessment of Threats to the Oceanic Whitetip Shark
Major Effect: Effect(s) of the stressor on a specific aspect of life history or behavior of the oceanic whitetip shark. *Frequency*: The occurrence and regularity of the stressor over time ● Common: high occurrence ● Uncommon: moderate occurrence ● Rare: infrequent or hypothetical events *Severity*: The effect the stressor has on individuals of the species ● High: causes direct mortality (including high probability of combined at-vessel and post-release mortality for fisheries threats); and/or a high number of sublethal impacts that result in loss of productivity and fitness. ● Moderate: causes moderate probability of direct mortality and/or a moderate number of sublethal impacts that result in decreased productivity and fitness. ● Low: does not cause direct mortality and has a negligible impact on productivity and fitness. *Geographic extent*: The spatial extent of the threat within the management unit ● Range-wide: stressor occurs throughout all or the vast majority of the distribution ● Localized: stressor exists primarily in a portion of the range *Trend*: The change in extent, frequency, or severity of a stressor over time ● Increasing

- Stable
- Decreasing
- Unknown

Certainty: The amount of evidence that the stressor threat affects the species in a management unit

- High: direct evidence or multiple lines of indirect evidence
- Moderate: indirect, limited, or unclear evidence
- Low: little or no evidence

Overall risk ranking: The factors described above were evaluated together qualitatively to determine an overall "risk" level for each threat within each management unit.

- low risk
- low to moderate risk
- moderate risk
- moderate to high risk
- high risk

Table 1. Oceanic Whitetip Shark Threats Assessment Summary Table. The table below summarizes the threats and stressors acting on the oceanic whitetip shark, organized by management unit. Where there is insufficient detailed information on a threat/stressor at the management-unit scale, the threat/stressor was assessed for the species range-wide. It should be noted that this is a qualitative assessment and structured decision-making exercise based on best professional judgment to help organize and prioritize recovery actions and activities.

Threat or Stressor[2]	Major Effect	Frequency	Severity	Geographic extent	Trend	Certainty	Overall risk ranking
ATLANTIC OCEAN MANAGEMENT UNIT							
Commercial fisheries bycatch: purse seine	Injury/ Mortality	Uncommon	High	Localized	Unknown	Low	Low-moderate
Commercial fisheries bycatch: longline	Injury/ Mortality	Common	High-moderate	Rangewide	Stable to Decreasing	Moderate	Moderate-high
Artisanal fisheries	Injury/ Mortality	Uncommon	High	Localized	Unknown	Moderate	Low-moderate

[2] The assessment of fishing threats (all gears) also incorporates impacts of IUU fishing on the oceanic whitetip shark.

Threat or Stressor[2]	Major Effect	Frequency	Severity	Geographic extent	Trend	Certainty	Overall risk ranking
Illegal retention	Mortality	Uncommon	High	Rangewide	Unknown	Moderate	Low-moderate
Inadequacy of fisheries regulations	Injury/ Mortality	Common	Moderate	Rangewide	Decreasing	Moderate	Moderate
EASTERN PACIFIC MANAGEMENT UNIT							
Commercial fisheries bycatch: purse seine	Injury/ Mortality	Common	High	Rangewide	Increasing-stable	High	Moderate-high
Commercial fisheries bycatch: longline	Injury/ Mortality	Common	High	Rangewide	Unknown	Low	Moderate-high
Artisanal fisheries	Injury/ Mortality	Rare	High	Localized	Unknown	Low	Low
Illegal retention	Mortality	Common	High	Rangewide	Unknown	Moderate	Moderate
Inadequacy of fisheries regulations	Injury/ Mortality	Common	Moderate	Rangewide	Decreasing	Moderate	Moderate
WESTERN AND CENTRAL PACIFIC MANAGEMENT UNIT							
Commercial fisheries bycatch: purse seine	Injury/ Mortality	Uncommon	High	Rangewide	Decreasing	High	Moderate-high
Commercial fisheries bycatch: longline	Injury/ Mortality	Common	High	Rangewide	Decreasing	High	High
Artisanal fisheries	Injury/ Mortality	Uncommon	High	Localized	Unknown	Low	Moderate
Illegal retention	Mortality	Common	High	Rangewide	Decreasing	Moderate	Moderate

Threat or Stressor[2]	Major Effect	Frequency	Severity	Geographic extent	Trend	Certainty	Overall risk ranking
Inadequacy of fisheries regulations	Injury/ Mortality	Common	Moderate	Rangewide	Decreasing	Moderate	Moderate
INDIAN OCEAN MANAGEMENT UNIT							
Commercial fisheries bycatch: purse seine	Injury/ Mortality	Common	High	Rangewide	Unknown*	Moderate	Moderate-high
Commercial fisheries bycatch: longline	Injury/ Mortality	Common	High	Rangewide	Increasing	Moderate	Moderate-high
Commercial fisheries bycatch: gillnet	Injury/ Mortality	Common	High	Rangewide	Increasing	Moderate	High
Artisanal fisheries	Injury/ Mortality	Common	High	Localized	Increasing	Moderate	High
Illegal retention	Mortality	Common	High	Rangewide	Increasing	Moderate	High
Inadequacy of existing regulatory mechanisms	Mortality	Common	High	Rangewide	Stable	Moderate	Moderate-high
OTHER THREATS OR STRESSORS (APPLIES TO GLOBAL POPULATION)							
Climate change	Fitness, Productivity, Reproduction	n/a	Moderate	Rangewide	Increasing	Low	Low-moderate
Pollution and toxins	Fitness, Productivity, Reproduction	n/a	Unknown	Rangewide	Unknown	Low	Low
Illegal fin trade	Mortality	Common	High	Localized	Stable	Moderate	Moderate-high

Threat or Stressor[2]	Major Effect	Frequency	Severity	Geographic extent	Trend	Certainty	Overall risk ranking
Inadequacy of fin trade regulations	Mortality	Common	High	Localized	Stable	Moderate	Moderate-high
Emerging stressors (e.g., aquaculture, tourism)	Fitness, Productivity, Reproduction	Rare	Unknown	Localized	Unknown	Low	Low

2. Recovery Strategy

As also described in the Recovery Status Review, the oceanic whitetip shark is a globally distributed, pelagic species of shark that is highly migratory, has low-moderate productivity, and relatively low reproductive rates. While the current population size is unknown, the best available information indicates the oceanic whitetip shark has experienced significant declines in abundance throughout its range over at least the last several decades due to excessive fishing mortality. It is difficult to assess the global population status of the oceanic whitetip shark because stock assessments to date have only been conducted for the Western and Central Pacific stock. Therefore, it is unknown whether its global population abundance has continued to decline, has stabilized, or has recently increased. Regardless of recent trends, the oceanic whitetip shark's large population decline is a cause for concern due to ongoing susceptibility to threats acting on the species.

Of the identified threats to the oceanic whitetip shark, those we identified as being of high or moderate-to-high relative concern are (as they appear in Table 1) as follows: incidental bycatch in commercial fisheries, particularly longlines, purse seines and gillnets; international trade of oceanic whitetip shark fins; and inadequate regulatory mechanisms (management) to address these threats. There are several other stressors that are of lesser concern but may work synergistically to cause negative effects to oceanic whitetip sharks (e.g., effects of climate change, pollutants).

Because the most significant threat to, and largest source of mortality of, the oceanic whitetip shark is bycatch (including at-vessel and post-release mortality) in commercial fisheries throughout its range, the overall strategy of this Recovery Plan is to reduce fishing mortality through a two-pronged approach: reducing the frequency of fishing interactions and increasing survivorship before, during, and after the interactions with fishing gear occur.

The oceanic whitetip shark is globally distributed, occurring in the waters of over 50 countries, and subject to threats from foreign fishing fleets (Young and Carlson 2020; NMFS 2023a). Because the oceanic whitetip shark's range is largely outside of U.S. jurisdiction, and regulations have been enacted to reduce the impacts of all domestic fisheries on this species, one of the major components of this strategy focuses on strategic international cooperation. As a pelagic species that occurs mostly offshore, it is managed on the high seas across its global range by four major tuna-focused Regional Fisheries Management Organizations (RFMOs). Therefore, international cooperation to reduce bycatch can be best achieved by coordinating and collaborating with RFMOs and their Cooperating Parties. In addition, collaboration with other partners such as academic institutions, non-governmental organizations (NGOs), and various industries and communities will be critical in developing and implementing the recovery strategy outlined herein.

Effective recovery action implementation for highly migratory species relies on successful collaboration with domestic and international partners, building upon existing management, research and conservation efforts.

3. Recovery Goals, Objectives, and Criteria

The following section describes the goals, objectives, and criteria of this recovery plan, which set standards for determining when sufficient recovery progress has been made such that the species no longer needs the protections of the ESA and can be delisted. These standards refer to the definitions of endangered and threatened under section 3 of the ESA: "endangered" means a species is in danger of extinction throughout all or a significant portion of its range, whereas "threatened" means that a species is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

For the purposes of recovery planning, the recovery goal is to address and ameliorate threats responsible for the species' decline in order to ultimately achieve recovery and, therefore, delisting of the species (NMFS 2020). Recovery objectives describe the conditions necessary for achieving the recovery goal. They are identified in terms of demographic parameters, reduction or elimination of threats to the species (the five ESA section 4(a)(1) factors), and any other particular vulnerability or biological needs inherent to the species. Recovery criteria are established for each recovery objective (NMFS 2020). Recovery criteria are subject to revision based on new information and insights.

3.1 Goal

The ultimate goal of this recovery program is to increase oceanic whitetip shark viability across its range, such that the species can achieve recovery and be removed from the List of Endangered and Threatened Wildlife under the ESA (i.e., delist).

3.2 Management Units

Management units (MUs) are a tool that can be used in recovery plans to address differing threats, management authority, and/or population viability across geographic areas requiring tailored management programs. For purposes of this Recovery Plan, we identify four oceanic whitetip shark MUs:

1) Atlantic Ocean;
2) Eastern Pacific Ocean (EPO);
3) Western and Central Pacific Ocean (WCPO); and
4) Indian Ocean.

Figure 2 below shows the delineation of these MUs based on the boundaries established by the four convention areas of the major tuna RFMOs that are responsible for managing tuna fisheries and pelagic sharks such as the oceanic whitetip shark. The four MUs have been identified based on differences in key life history characteristics, population status, magnitude of threats, and management needs across the range of the species as described below.

Oceanic whitetip sharks exhibit life-history traits and population parameters that differ between the Atlantic Ocean and Pacific Ocean. In the Atlantic Ocean, oceanic whitetip sharks reach sexual maturity at approximately 6-7 years and 180-190 cm total length (TL) (both sexes) (Seki et al. 1998; Lessa et al. 1999), while in the North Pacific Ocean, sharks mature later at ages of 8.5-8.8 years for females and 6.8-8.9 years for males (Joung et al. 2016). Oceanic whitetip sharks also grow slower in the Pacific Ocean.

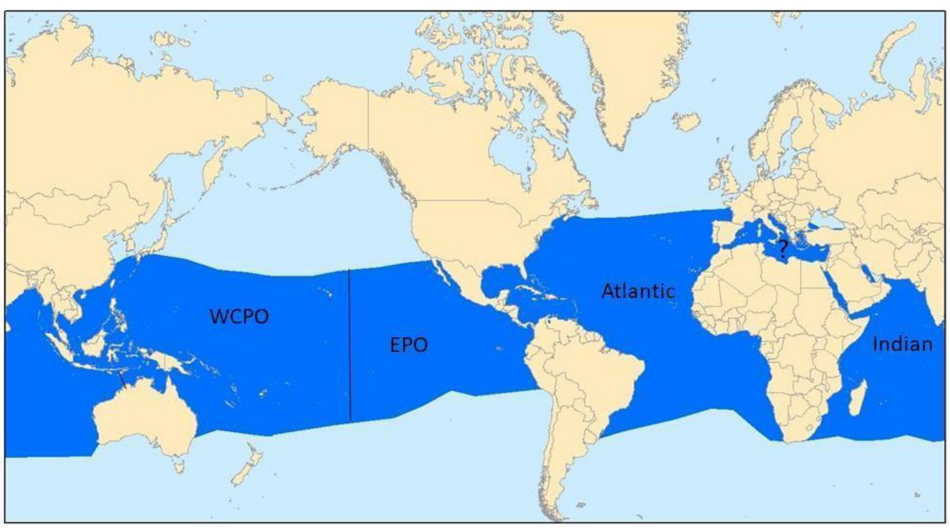

Figure 2. *Global range of the oceanic whitetip shark with Management Unit boundaries based on tuna-RFMO convention areas. (Source: Modified from Young and Carlson 2020)*

While the reproductive cycle is thought to be biennial for both ocean basins, recent unpublished data obtained via ultrasonography of pregnant females over multiple years suggests that—at least for a proportion of the population in the Atlantic Ocean—reproduction may be annual (James Gelsleichter, University of North Florida, unpublished data). These life history traits, when applied to demographic models, indicate varying levels of productivity that directly affect this species' ability to recover. While little life history information exists from the Indian Ocean, based on similarities in oceanographic conditions that affect life history characteristics, we considered the life history of oceanic whitetip sharks in the Indian Ocean to be more similar to the life history of those in the Pacific Ocean.

Oceanic whitetip sharks are managed differently by four separate tuna RFMOs: the International Commission for the Conservation of Atlantic Tunas (ICCAT; Atlantic Ocean), Inter-American Tropical Tuna Commission (IATTC; Eastern Pacific Ocean), the Western and Central Pacific Fisheries Commission (WCPFC; Western and Central Pacific Ocean); and the Indian Ocean Tuna Commission (IOTC; Indian Ocean).

Oceanic whitetip sharks in the Atlantic Ocean are managed by ICCAT. In this portion of the range, there is no stock assessment available, but evidence suggests that relative abundance is stable in the Northwest Atlantic and possibly declining in the South Atlantic (Young et al. 2017; Young and Carlson 2020). Additionally, the magnitude of the threat in the Atlantic appears to be lower than in other areas of the species' range. Interactions in pelagic longline gear and landings of the species are lower in the Atlantic than in the EPO and WCPO. At-vessel mortality rates in pelagic longline fisheries also appear to be lower than in any other ocean basin (24% at-vessel mortality based on U.S. pelagic longline fleet). Additionally, some core areas of the species' habitat in the U.S. and Bahamian exclusive economic zones (EEZs) are protected from pelagic longline fishing (Young and Carlson 2020). ICCAT was also the first RFMO to implement a no-retention measure for oceanic whitetip sharks in 2011. This measure prohibits the retention, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of oceanic whitetip sharks caught in association with ICCAT fisheries.

The WCPO, managed by the WCPFC, is the only region for which a formal stock assessment (Tremblay-Boyer et al. 2019) exists for the oceanic whitetip shark. The stock assessment concluded that the stock of oceanic whitetip shark is overfished and experiencing overfishing, with significant population declines of up to 95% since 1995. As historical declines occurred prior to 1995, and fishing effort and mortality is higher in this region, the status of oceanic whitetip sharks in this MU is likely worse than in other regions. Because of its poor conservation status, the WCPFC implemented a no-retention measure in its region for oceanic whitetip sharks in 2013, and updated safe handling guidelines and gear restrictions aimed at reducing post-capture mortality of these and other shark species in 2019. In 2022, the WCPFC passed a significant gear-related conservation measure for sharks, which bans the use of both wire-leaders and shark lines to reduce fishing mortality, particularly of oceanic whitetip and silky sharks.

In the EPO, which is managed by the IATTC, there is no formal stock assessment available for the oceanic whitetip shark; however, nominal catches from the tuna purse seine fishery from 1992-2015 suggest significant population declines similar to the WCPO of up to 95% (Young et al. 2017; Young and Carlson 2020). There are little data regarding the impact of the longline fishery on this species in the EPO, but based on information detailed in section 4.2.1 (Fisheries Interactions and Mortality) of the Recovery Status Review (NMFS 2023a), longline fishing mortality is likely not as significant in this MU as in the WCPO. However, information suggests that oceanic whitetip sharks have been impacted by the purse seine fishery in this region, with bycatch comprising mostly juveniles. The IATTC also implemented a no-retention measure in its region for oceanic whitetip sharks in 2013 that prohibits retaining onboard, transhipping, landing, storing, selling, or offering for sale any part or whole carcass of oceanic whitetip sharks in the fisheries managed by the IATTC. Resolution C-16-05 also requires safe handling protocols for sharks caught in purse seine fisheries.

In the Indian Ocean, which is managed by the IOTC, there is no stock assessment available for the oceanic whitetip shark; however, the best available information indicates there have been potentially significant population declines. The scope and magnitude of threats in this region are potentially higher than some other regions due to higher at-vessel mortality rates in pelagic longlines and wider use and impacts of gillnets, though this is uncertain. Fishing effort, harvest, and shark landings are also higher in the Indian Ocean than any other region (Pacoureau et al. 2021). Although the IOTC implemented a no-retention measure in its region for oceanic whitetip sharks in 2013, artisanal fisheries (within the EEZ of Contracting Parties and for domestic consumption) are exempt from the measure, and likely interact with the same stock as the pelagic fisheries. As a result, several countries are still reporting landings of the species (Rice 2016).

All these RFMOs have taken steps to protect the oceanic whitetip shark by implementing measures prohibiting retention of the species, improving data reporting, and expanding research (Young and Carlson 2020). However, the threat level from fisheries within these RFMOs varies (e.g., at-vessel mortality is significantly higher in longlines in the Indian Ocean vs. other regions), RFMOs manage these fisheries differently, and measures regarding oceanic whitetip sharks could change in the future. Therefore, delineating the global population of oceanic whitetip sharks into these four MUs will facilitate adaptive recovery strategies relevant to their respective regions.

In order for the oceanic whitetip shark to be considered recovered under the ESA, three of four MUs must have met the recovery criteria outlined in section 3.3 below. These three MUs must represent all ocean basins (Atlantic, Pacific, and Indian). Although the Pacific Ocean is divided into two MUs, only one Pacific Ocean MU needs to have met the recovery criteria (in addition to the Atlantic and Indian Ocean MUs) for the following reasons:

1. The boundary line between the IATTC and WCPFC (representing the Eastern Pacific and Western and Central Pacific populations of oceanic whitetip shark, respectively) is biologically arbitrary and based on international treaties and management needs.

2. Nominal catches in the IATTC purse seine fishery and the formal stock assessment of WCPFC show similar levels of decline over the same time period, indicating a hypothetical single population.
3. The best available genetic information indicates a mixed population across the Pacific.
4. Oceanic whitetip sharks are capable of making long-distance migrations of several thousand km and in the process are likely to cross over the boundary line between the WCPFC and IATTC.
5. Catch records from both RFMOs show individual sharks near the boundary line.

As such, we conclude that oceanic whitetip sharks from the WCPO likely mix with oceanic whitetip sharks of the EPO, and if one management unit shows indications of progress toward meeting the recovery criteria, it is likely that the entire population across the Pacific Ocean basin is making similar progress toward meeting the recovery criteria. Therefore, only one of the Pacific Ocean MUs needs to meet the recovery criteria described in section 3.3 (in addition to the Atlantic and Indian Ocean management units), for the oceanic whitetip shark to be considered for delisting.

3.3 Objectives and Criteria

The recovery goal is subdivided into discrete component objectives that, collectively, describe the conditions necessary to achieve recovery. We identified three recovery objectives for the oceanic whitetip shark that address demographic concerns and threats abatement. They are outlined below along with their associated recovery criteria.

The three objectives for the oceanic whitetip shark are to:

1) Ensure the oceanic whitetip shark maintains resiliency and geographic representation, and is a functional component of the ecosystem, by increasing overall abundance to achieve viable populations in all ocean basins;
2) Increase oceanic whitetip shark resiliency by managing or eliminating significant anthropogenic threats; and
3) Ensure the continued viability of the oceanic whitetip shark through development and effective implementation of regulatory mechanisms for the long-term protection of the species.

A prerequisite to achieving these objectives is obtaining sufficient data to determine whether they have been met. As a result, many of the recovery actions in section 4.1 below focus on research and data collection.

There are two types of recovery criteria: 1) demographic criteria that reflect the population and life history parameters that indicate the species is no longer threatened or endangered, and 2) threats-based criteria that indicate the threats to the species are sufficiently reduced, managed, or eliminated. The demographic criteria include specific targets to support the objectives of species' viability (e.g., abundance, productivity, spatial distribution, and diversity). Threats-based criteria identify when threats have been minimized such that they are not contributing to the species being in danger of extinction within the foreseeable future throughout all or a significant portion of its range. Information we will assess to determine whether the threats-based criteria have been met will include how the species has responded to minimization measures, as measured by the demographic recovery criteria or reflected in the published literature, technical memoranda, population monitoring results, and other credible sources.

To delist the oceanic whitetip shark, the demographic-based recovery criterion and all of the threats-based recovery criteria discussed in sections 3.3.1 and 3.3.2 should be met. However, it is possible that delisting could occur without meeting all of the recovery criteria if the best available information indicates the oceanic whitetip shark no longer meets the definition of an endangered species or threatened species.

3.3.1 Demographic Objectives and Criteria

Objective 1: Ensure the oceanic whitetip shark maintains resiliency and geographic representation, and is a functional component of the ecosystem, by increasing overall abundance to achieve viable populations in all ocean basins.

Delisting Criteria

1. Abundance and population growth
    a. Formal stock assessment - The ratio of the current spawning biomass (SB) (i.e., the number of adult females in the current exploited population) in a given year to the unfished spawning biomass (SB_0, i.e., the number of adult females in the population subject only to natural mortality) is at least 0.30 ($SB_{current}/SB_0=0.30$) in 3 of 4 management units representing all ocean basins (Atlantic, Indian, and at least one Pacific Ocean MU; see discussion in section 3.2 above) and on average demonstrates an increasing trend for 20 years (i.e., 2 generation lengths). This ratio would be determined using a formal stock assessment that incorporates estimates, where applicable, of life history, relative abundance, catch, and discard mortality analogous to that produced by Tremblay-Boyer et al. (2019) for the Western and Central Pacific Ocean. In this case, the unfished spawning biomass (SB_0) was calculated from the estimated recruitments via the Beverton-Holt stock recruitment relationship.

        OR

    b. Data-limited assessment - The ratio of predicted total current stock biomass relative to unfished conditions (relative biomass), or predicted current spawning stock fecundity relative to unfished conditions (relative spawning stock fecundity) is at least 0.30 ($SB_{current}/SB_0=0.3$) in 3 of 4 management units representing all ocean basins (Atlantic, Indian, and at least one Pacific Ocean MU) and on average demonstrates an increasing trend for 20 years (i.e., 2 generation lengths). This ratio could be determined using an Age-Structured Catch-Free Model (e.g., Porch et al. 2006; Cortés et al. 2006), Incidental Catch Model (e.g., Caswell et al. 1998) or similar modeling approach that does not utilize catch as an input variable.

OR

In the absence of any type of stock assessment, or when an assessment has a high level of uncertainty, the oceanic whitetip shark will have met the demographic recovery criteria when:

c. Based on a spawning per recruit-based reference point as a proxy for status (e.g. Brooks et al. 2009), a ratio of spawner per recruit of 0.50 has been achieved in 3 of 4 management units representing all ocean basins (Atlantic, Indian, and at least one Pacific Ocean MU) and over 20 years (i.e., 2 generation lengths).

OR

d. The annual rate of population change is found to be increasing at a rate of a minimum of 12% in 3 of 4 management units representing all ocean basins (Atlantic, Indian, and at least one Pacific Ocean MU) and over 20 years (i.e., 2 generation lengths). This can be determined by using population count or relative abundance index data within a Bayesian state-space model (e.g., Just Another Red List Assessment [JARA]; Sherley et al. 2019).

Justification (1a and 1b)

A formal stock assessment that incorporates estimates of life history, relative abundance, catch, and discard mortality is a quantitative and reliable methodology for determining the status of commercially exploited shark species. Under this methodology, a population decrease (i.e., a worsening in population status) is linked to a lower value for SB/SB_0. Conversely, a population increase (i.e., an improvement in population status) is linked to a higher value for SB/SB_0. As the retention and landing of oceanic whitetip sharks is now prohibited in all major tuna-RFMOs, there is an increased likelihood that catch may no longer be reported. In fisheries where there is a high degree of uncertainty in reported catches, or catches are not reported at all, stock assessment models that rely on catch data may not be appropriate. Without accurate knowledge of the magnitude of total catches and discards, it is not possible to estimate absolute abundance levels for the population. There are several alternative modeling methods appropriate to these situations that could be used to evaluate the status of the oceanic whitetip shark and determine when the species has recovered. With such high uncertainty in the series of reported catch and discards, the catch-free methodology has been found to be an appropriate method for determining stock status. This model was initially developed by Porch et al. (2006) for use in a goliath grouper assessment for which only life history information and relative abundance (catch per unit effort [CPUE]) indices were available. The model has also been successfully applied to dusky shark (Cortes et al. 2006; SEDAR 2016). Similar modeling approaches, such as the Incidental Catch Model, have been previously applied to assess the capacity of bycatch species to withstand removals. There are examples for cetaceans (Caswell et al. 1998; Dans et al. 2003), basking shark (Campana et al. 2008), white shark (Bowlby and Gibson 2020) and porbeagle (ICCAT 2020).

In 1995, the population of oceanic whitetip shark in the WCPO was estimated to be at about 35% of unfished spawning biomass. In establishing a level of depletion relative to the recovery of the oceanic whitetip shark, we examined the inflection point of population growth curves for the species. Inflection points in animal population growth curves (expressed as a fraction of equilibrium population levels, i.e., carrying capacity) are correlated with the rates of increase a population can grow per generation. The inflection point declines with increasing rates of population growth. This apparent unifying principle of population dynamics is independent of phenomena related to body size since the rate of population growth is not correlated with body size. Species as diverse as whales and bacteria appear to conform to the pattern. Cortés (2008) estimated the position of the inflection point for the oceanic whitetip shark in the Atlantic and Pacific Oceans was close to 0.5 of carrying capacity (K). Assuming K is close to B_o, (i.e., unfished biomass) and the fact that the life history data used in those calculations resulted in the intrinsic rate of population increase (i.e., Rmax), suggests any population size above $0.5B_o$ would be viable. Population sizes below $0.5B_0$ may also be viable as the position of the inflection point corresponds to the proportional value of B_0 where the net increase in population size is maximized (i.e., the MSY), in this case $0.5B_0$. However, for elasmobranchs in general, $0.3B_0$ is thought to be a reasonable Limit Reference Point (see Clarke and Hoyle 2014), so any value above $0.3B_0$ would still be indicative of a sustainable population size (even if it does not produce MSY).

In addition to reaching a minimum of 30% unfished biomass, we determined an appropriate timeframe over which the oceanic whitetip shark must demonstrate, on average, an increasing population trend by examining the life history of the species. Generation time, which is defined as the time it takes, on average, for a sexually mature female oceanic whitetip shark to be replaced by offspring with the same reproductive capacity, is estimated to be around 10-11 years (Smith et al. 2008; Cortés 2019). We selected 20 years (~2 generation lengths) as an appropriate timeframe over which the population biomass needs to maintain an increasing trend, on average, because it is biologically based (approximately two generations) and reasonably expected to encompass environmental and fisheries-based stochastic events that may affect the population over that extended timeframe. Taking the average trend over a 20-year timeframe is necessary to account for natural variability and stochastic events, such that year-to-year fluctuations in abundance do not reset the 20-year timeframe. For a long-lived species with relatively low productivity, the longer the population biomass shows an increasing trend at the recovered level (minimum 30% of unfished levels), the more confident we can be that the species as a whole will be stable and resilient to stochastic events in the future.

Justification (1c and 1d)

When stock status is difficult to estimate or deemed unreliable, a proxy is often employed. Common proxies are based on productivity such as a percentage of spawning potential ratio (SPR) or average biomass level, although sometimes proxies based on the rates of fishing mortality or some combination of these may be used. SPR is the ratio between the number of spawners (or eggs) produced over a recruit's lifetime (given fishing mortality, F) divided by the number of spawners produced without fishing; as such, it measures the proportional reduction in total potential productivity attributable to fishing. The appropriate SPR level as a proxy for recruitment-overfishing was taken by derivations from Brooks et al. (2009). They determined that very long-lived, slow-maturing species like oceanic whitetip sharks would require much higher levels of SPR. For example, it has been suggested that several large species of coastal sharks may have recruitment steepness in the range of 0.2-0.4 (SEDAR 2006). For those species, an SPR of at least 0.6 would be required. As a validation of the methodology proposed by Brooks et al. (2009), results from 11 other species of sharks that were assessed using formal stock assessment approaches were compared with analytically predicted spawner depletions and results consistently matched the results from the stock assessments (Brooks et al. 2009). As SPR is species-specific, Cortés (2019) determined SPR for oceanic whitetip sharks was 0.47 (mean; with 95% CL=0.31-0.71 for the Atlantic) and 0.43 (mean; with 95% CL=0.26-0.72 for the Pacific). Thus, an SPR of about 0.5 may be more appropriate for oceanic whitetip sharks, which are fairly productive compared to other species estimated by Brooks et al. (2009).

When reliable indices of abundance are available, Bayesian state-space models offer a powerful and flexible framework to model variable population trends. Bayesian state-space models have properties that could help improve the objectivity of population assessments. First, the posterior probabilities provide an intuitive way to express uncertainty around rates of population change (Sherley et al. 2018). Second, missing values can be estimated automatically, providing a robust and transparent way of dealing with time series of differing lengths and quality, and of forecasting future population trajectories (Kindsvater et al. 2018). Third, it is simple to combine the posterior probabilities for regional population trends (and their uncertainty) to determine an overall management unit reduction rate. Bayesian state-space models have been used to assess extinction risk under the ESA (Boyd et al. 2017). One potential tool, JARA (https://github.com/henningwinker/; Winker & Sherley 2019), was used in the International Union for the Conservation of Nature (IUCN) red list assessment of 13 pelagic and coastal-pelagic sharks. JARA determined the global abundance of oceanic sharks and rays has declined by 71% since 1970 (Pacoureau et al. 2021). JARA determines the percentage change in the population from the calculated posteriors of the estimated population time series and estimates the overall observed and projected (± 95% confidence interval (CI)) population trajectory over a time threshold. The annual rate of population change, on average, of 12% is similar to the intrinsic rate of population increase (Rmax) estimated for oceanic whitetip sharks (Cortés 2019). This trend would need to be maintained, on average, over 20 years.

3.3.2 Threats-based Objectives and Criteria

Objective 2: Increase oceanic whitetip shark resiliency by managing or eliminating significant anthropogenic threats.

We organized the threats-based recovery criteria according to the five ESA section 4(a)(1) factors that are considered when determining whether a species is endangered or threatened, and also when reclassifying or delisting any listed species:

A. The present or threatened destruction, modification or curtailment of its habitat or range;
B. Overutilization for commercial, recreational, scientific, or educational purposes;
C. Disease or predation;
D. Inadequacy of existing regulatory mechanisms; or
E. Other natural or manmade factors affecting its continued existence.

In addition to meeting the demographic recovery criterion in section 3.3.1, the following threats-based recovery criteria must be met in order to delist the oceanic whitetip shark:

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Destruction, modification, or curtailment of habitat or range was not an important factor in the decline of the species historically and is not believed to limit recovery of the population at this time. Recent information suggests that climate change effects (e.g., ocean warming) may negatively affect oceanic whitetip sharks via shifts in vertical and horizontal movements and distribution due to physiological intolerance to warming temperatures, as well as shifts in primary prey distribution. However, there is not yet enough information available about the oceanic whitetip shark's sensitivity to climate factors and its capacity to adapt to changes in those factors, including changes in prey distribution and abundance, to conclude that climate change is a threat to the oceanic whitetip shark at this time. Therefore, no threats have been identified under Factor A, and this recovery plan does not include recovery criteria under Factor A.

As discussed in section 1.2, climate change is a stressor that should be monitored. An action is included in the recovery program to better understand the effects other stressors may have on the oceanic whitetip shark.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Bycatch

2. $F_{current}$ (i.e., the current level of total fishing mortality (at-vessel + post-release mortality)) < F_{limit} (i.e., the fishing mortality rate that corresponds to the maximum level of mortality that can occur that may drive the population to low levels in the long-term) over a period of 2 generations (~20 years).

Justification

Fishing mortality-based (F-based) reference points can be derived analytically using life history information. This approach assumes that reference points are a function of life history parameters, specifically that F-based reference points are related to the intrinsic rate of population increase (r_{max}) and natural mortality rate (M). Since the natural mortality rate is used in the computation of the intrinsic rate of population increase, only relationships between F and r_{max} would be used to define three reference points:

> $F_{msy} = r_{max} /2$, where F_{msy} is the fishing mortality rate that results in maximum sustainable yield (MSY), which corresponds to a population size that can be harvested sustainably and still grow.
>
> $F_{lim} = 0.75\ r_{max}$, where F_{lim} is the fishing mortality rate that corresponds to the maximum level of mortality that can occur that may drive the population to low levels in the long term, but not necessarily extinction.
>
> $F_{crash} = r_{max}$, where F_{crash} is the minimum unsustainable fishing mortality rate that theoretically will lead to population extinction in the long-term.

Once the F-based reference points are derived, an estimate of the current level of fish mortality ($F_{current}$) will be derived to compare them. In the absence of a formal stock assessment, $F_{current}$ can be obtained using area-based methods (as used in the Sustainability Assessment for Fishing Effects (SAFE) approach, e.g., Zhou and Griffiths 2008; Zhou et al. 2009), catch-based methods (catch curves), length-based methods, or other independent estimates of fishing mortality (e.g., from conventional or electronic tagging).

A level of risk can then be established based on the current level of total fishing mortality relative to the F-based reference points. For a management unit to be considered to have met this recovery criteria, the current level of total fishing mortality should be between the fishing mortality rate that results in maximum sustainable yield and the fishing mortality rate that results in the maximum level of mortality that could drive the population to low levels. This means that while fishing mortality is still occurring, the level of mortality and associated risk would be low enough that the population would still be able to grow over the long-term (and eventually meet the demographic criterion described in section 3.3.1 Demographic Objectives and Criteria). This level of fishing mortality would fall in between the low and medium "risk" categories as shown below in Figure 3. Uncertainty can be incorporated into the calculation of r_{max} (Cortés 2019) and comparing the independently derived estimate of the current level of fishing mortality to the F-based reference point at each iteration (Figure 3).

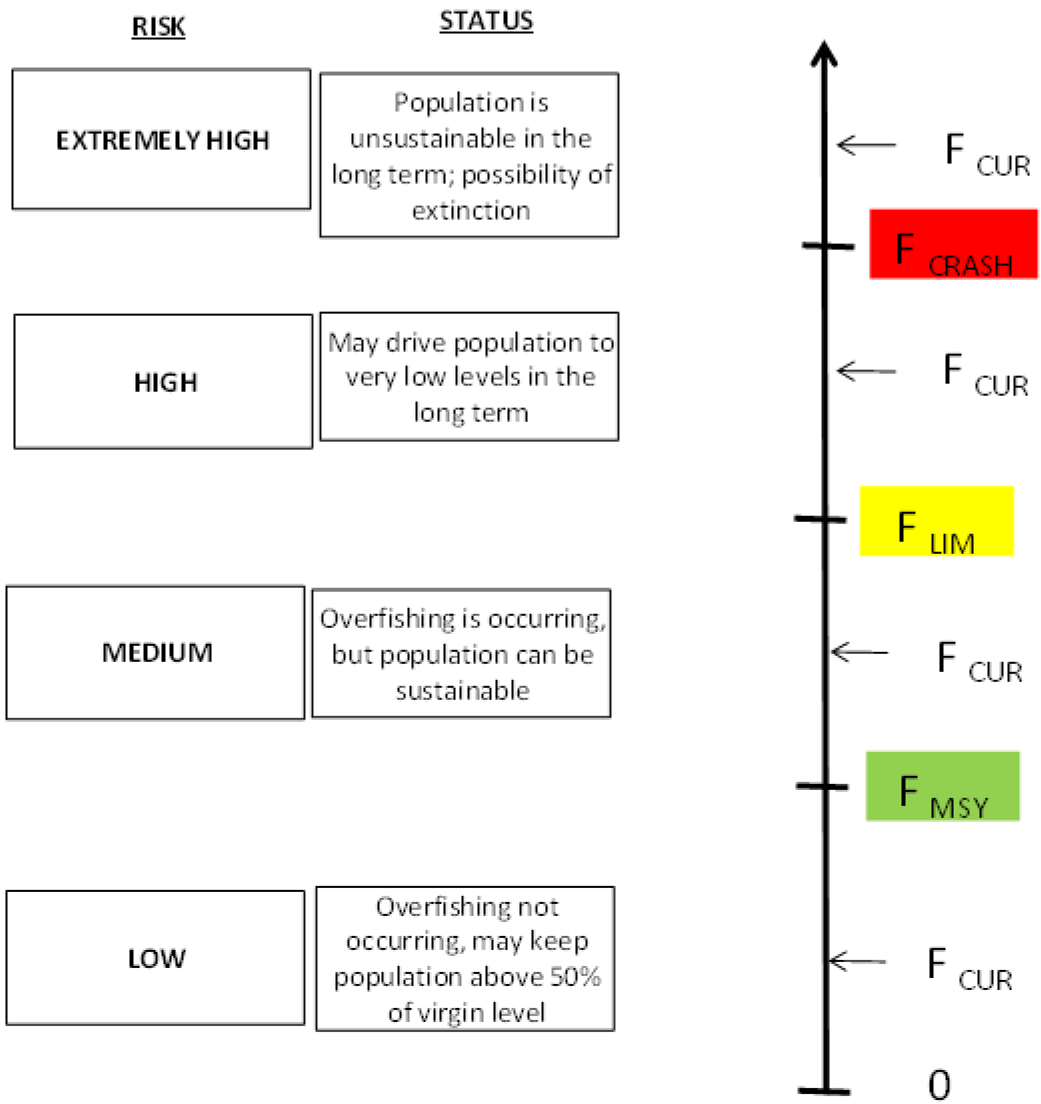

***Figure 3**. Graphical representation of F-based reference points and risk levels modified by Cortés (2019) from Table 1 in Zhou et al. (2011).*

In determining an appropriate timeframe for this criterion to be met, we examined the life history of the oceanic whitetip shark. Generation time, which is defined as the time it takes, on average, for a sexually mature female oceanic whitetip shark to be replaced by offspring with the same spawning capacity, is estimated to be around 10–11 years (Smith et al. 2008; Cortés 2020). As a long-lived species that matures relatively late, has relatively slow growth rates and low to moderate productivity, it would likely take more than one generation time to ensure that the level of fishing mortality is lower than what is required to keep the population at or above 50% of its unfished level. Therefore, we selected 20 years as an appropriate timeframe for this criterion because it is biologically based (approximately 2 generations) and reasonably expected to encompass environmental and fisheries-based stochastic events that may affect the population in the future. For a long-lived species with relatively low productivity, this timeframe would ensure that the threats have been reduced to an adequate level that ensures the species as a whole to maintain stability at the recovered level and resilience to stochastic events.

International Trade

4. Trade management mechanisms are in place to monitor and limit, as necessary, the level of fins in international trade, and a systematic review shows that the volume of fins in trade is not placing the species in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

Justification:

The international shark fin trade was identified as a significant threat to the oceanic whitetip shark (Young et al. 2017; NMFS 2023a). Although the oceanic whitetip shark is generally not a targeted species, it is a preferred species for opportunistic retention because its large fins obtain a high price per kg in the Asian fin market (Convention on International Trade in Endangered Species of Wild Fauna and Flora [CITES] 2013). The high value of oceanic whitetip shark fins creates an incentive for opportunistic retention and finning of oceanic whitetip sharks when caught, and thus represents the main economic driver of mortality of this species in commercial fisheries throughout its global range.

We included a management mechanism in this criterion because determining whether the volume of trade is placing the species in danger of extinction within the foreseeable future will require a trade tracking and monitoring system to be in place that will allow collection of data on imports and/or exports and setting and monitoring of quotas, as necessary. A systematic review, as referenced in this criterion, means a review of the best available data, such as import/export permits (e.g., CITES permits), enforcement and seizure data, and molecular identification or other techniques, that can be used to analyze the volume of oceanic whitetip shark fins in international trade in the context of the overall population status of the species.

It is not practicable to develop a more objective and measurable criterion at this time because we lack reliable information on historical and current levels of trade in oceanic whitetip shark fins, and techniques used to estimate levels of fins in trade are influenced by multiple, complex factors. For example, review of CITES export permits can provide some indication of the level of trade being authorized, but does not indicate the volume of fins that are actually harvested and cannot fully account for levels of illegal or unreported trade. Molecular identification techniques can be used to identify the presence of oceanic whitetip shark fins in major markets and provide an estimate of the total quantity of fins in trade; however, these techniques are subject to sampling error. In addition, changes in reporting levels, compliance with export permit requirements (e.g., CITES requirements), and enforcement will influence estimates of the volume of fins in trade, but may not necessarily reflect a change in the actual level of threat to the species. For example, increased enforcement efforts may increase the detection rate for oceanic whitetip shark fins in trade, but an increased detection rate would not necessarily indicate that the total volume of fins in trade has increased. Therefore, other information, such as current and predicted future trends in the international shark fin trade, prices for oceanic whitetip shark fins, and species abundance will need to be considered when determining whether this criterion has been met.

Factor C: Disease or Predation

As described in the status review (Young et al. 2017) and more recent Recovery Status Review (NMFS 2023a), there is no information to indicate that disease or predation represents a threat to the oceanic whitetip shark. Neither of these factors were important in the decline of the species historically and they are not believed to limit recovery of the population at this time. Therefore, no threats have been identified under Factor C, and this recovery plan does not include recovery criteria under Factor C.

Objective 3: Ensure the continued viability of the oceanic whitetip shark through effective development and implementation of regulatory mechanisms for the long-term protection of the species.

Factor D: Inadequacy of Existing Regulatory Mechanisms

5. U.S. federal, state, and territorial laws are developed and/or maintained, implemented, and enforced to prevent finning of oceanic whitetip sharks and prevent retention of the species in commercial fisheries. Such laws include, but are not limited to, the Shark Conservation Act and Shark Finning Prohibition Act.
6. All nations identified by the respective RFMOs, their compliance committees, the Food and Agricultural Organization of the United Nations [FAO], and/or CITES as having significant catch, bycatch, and/or trade of oceanic whitetip shark have acceded to international and multilateral agreements and enacted national legislation or equivalent regulatory measures to implement management measures specified under the agreements.
7. Measures prohibiting retention and finning of oceanic whitetip sharks are maintained by all RFMOs, and Parties are implementing these measures adequately as measured by landings data and country reports to RFMOs. This can be verified by each of the compliance committees in the respective RFMOs.
8. Within an individual country's EEZ not subject to RFMO retention prohibitions, laws are developed and/or maintained, implemented, and enforced to prevent finning of oceanic whitetip sharks and prevent retention of the species in commercial fisheries.

Justification:

Inadequate regulatory mechanisms to control overutilization of oceanic whitetip sharks in commercial fisheries and international trade were identified as a significant threat to the species. Although regulations and management measures have been implemented to limit harvest and trade of the species both internationally and nationally, these measures were deemed only partially effective due to lack of compliance and variable enforcement across the species' range (Young et al. 2017). Therefore, ensuring adequate implementation of and compliance with these mechanisms will help reduce fisheries mortality and support the long-term sustainability and recovery of the species.

Factor E: Other Natural or Manmade Factors

As described in the status review (Young et al. 2017) and more recent Recovery Status Review (NMFS 2023a), there is very little information to indicate that other natural or manmade factors represent a threat to the oceanic whitetip shark. While oceanic whitetip sharks have been shown to accumulate extremely high concentrations of mercury, greater than most other shark species (Gelsleichter et al. 2020), the overall impact to the species from this and other toxins is still not known. Although acute mortality occurs usually at extremely high exposure levels, longer physiological effects could occur at lower levels, including neurobehavioral effects and reduction of reproductive fitness. For example, higher organochlorine concentrations in specific habitats of bonnethead shark (*Sphyrna tiburo*) in Florida were linked to higher rates of infertility for sharks captured in those areas. If such effects were to occur in oceanic whitetip sharks, it could negatively impact the growth and stability of the species. However, there is no evidence that pollutants and toxins are a threat currently acting on the species.

Potential emerging stressors such as aquaculture development and tourism may interact with and exacerbate existing threats to the oceanic whitetip shark. However, there is no evidence that these stressors are a threat currently acting on the species.

No additional factors were identified as contributing to the decline of the species historically or limiting recovery of the population at this time. Therefore, no threats were identified under Factor E, and this recovery plan does not include recovery criteria under Factor E.

As discussed in section 1.2, pollutants, toxins, and emerging stressors should be monitored. An action is included in the recovery program to better understand the effects other stressors may have on the oceanic whitetip shark.

4. Recovery Program

This section provides an outline of, and narrative for, research, management, monitoring, and outreach actions targeted at achieving the recovery criteria for the oceanic whitetip shark. We have organized these recovery actions into six main categories: 1) population dynamics; 2) fisheries interactions; 3) international trade; 4) monitoring and reporting; 5) regulatory mechanisms and enforcement; 6) outreach and education. These recovery actions will assist us in understanding and reducing threats, and restoring the oceanic whitetip shark to the point at which the species can be delisted. In addition, the recovery program includes other actions that are not necessary for recovery, but would facilitate monitoring for other potential stressors and planning for post-delisting.

Because of the global distribution of the oceanic whitetip shark and the international nature of commercial fisheries affecting the species, recovery will only occur by working collaboratively with others, including other federal and state agencies, academia, NGOs, RFMOs, and the international fishing community at large.

The Recovery Action Outline below lists the recovery actions in outline format. The Recovery Action Narrative describes the recovery actions in the outline in more detail, including the objective of the action, why it is important, and information regarding how it will be implemented and measured. These descriptions are intended to provide guidance to resource managers, commercial fishermen, researchers, other stakeholders, and the public. Parties with authority and/or responsibility to implement, or those who have expressed an interest in implementation of, a specific recovery action are identified in section 5. Recovery Action Implementation.

As previously mentioned, we have designed this Recovery Plan to provide the foundation for recovering the oceanic whitetip shark. It provides an overall road map for achieving the recovery goal, objectives, and criteria, and includes strategic, site-specific recovery actions and time and cost estimates for these recovery actions to the maximum extent practicable for this highly migratory species. Section 4(f) of the ESA does not define a particular level of specificity as being required for describing site-specific actions in a recovery plan. The descriptions we have included in the plan meet the statutory requirements as they include as much detail, including as regards the sites where recovery actions can be planned, as is practicable for a document of this type. The Recovery Implementation Strategy (NMFS 2023b), on the other hand, is a more dynamic document that steps-down the recovery actions into more specifically defined activities that implement and support the recovery actions. Unlike the Recovery Plan itself, which sets out the overarching path and is updated through a process that includes public notice and comment, the Recovery Implementation Strategy can more nimbly adapt over time based on the progress of recovery and the availability of new information, either as research is analyzed, literature is published, or when the status of the oceanic whitetip shark is reviewed. We elect to provide the additional level of specificity in the Recovery Implementation Strategy, to help further conservation of the species by providing as much transparency and information as possible to the public. Further, we note it would not be practicable to include such detail in the Recovery Plan itself given the rapid pace with which circumstances on the ground can change as to a range of issues, such as availability of funding, identification of emerging appropriate locations for projects, willingness of partners to implement actions, etc. Should the progress on activities in the Recovery Implementation Strategy indicate the recovery actions in the Recovery Plan should be revised, we will revise the Recovery Plan as appropriate and seek public comment on those revisions.

4.1 Recovery Action Outline

Recovery actions in this outline are not in order of priority. Unless otherwise indicated, the relevant "site" for each recovery action is located throughout each of the four management units, which cover the entire range of the oceanic whitetip shark as shown in Figure 2.

Recovery Actions

Population Dynamics

1. Improve knowledge and understanding of oceanic whitetip shark population status, abundance trends, and genetic structure.
2. Improve knowledge and understanding of oceanic whitetip shark distribution, movement, and habitat use.
3. Improve knowledge and understanding of the demographics and life history of oceanic whitetip sharks.

Fisheries Interactions

4. Reduce fisheries bycatch and mortality of oceanic whitetip sharks by determining and addressing the frequency of capture and severity of fishing interactions in commercial, artisanal, and recreational fisheries.
5. Reduce fisheries bycatch and mortality of oceanic whitetip sharks in international fisheries and trade through enhanced international coordination and collaboration with relevant international organizations, such as RFMOs.

International Trade

6. Determine effects of the international shark fin trade on oceanic whitetip shark populations in all management units, and take management actions to reduce, and/or eliminate if necessary, the amount of oceanic whitetip fins in trade.

Monitoring and Reporting

7. Improve species-specific monitoring and reporting of oceanic whitetip sharks in commercial and artisanal fisheries by RFMOs and individual countries to provide a better understanding of the effects of IUU fishing, improve estimates of catch and discards, and measure progress towards recovery.

Regulatory Mechanisms and Enforcement

8. Reduce fishing mortality of oceanic whitetip sharks through effective development, implementation, and enforcement of international and domestic measures such as legislation and regulations.

Outreach and Education

9. Develop and implement outreach and education strategies and programs to increase public and stakeholder (including fishermen) awareness on the status and recovery needs of the oceanic whitetip shark.

Other Actions

Other Stressors

10. Identify, evaluate, and minimize any other stressors that may be impeding recovery of oceanic whitetip sharks.

Post-delisting Monitoring Plan

11. Develop a post-delisting monitoring plan to ensure continued sustainable fisheries management of oceanic whitetip sharks post-delisting.

4.2 Recovery Action Narrative

In this section, we provide a description for each recovery action identified above, including a rationale for why each action is necessary for the recovery of the oceanic whitetip shark as well as a general description of how these recovery actions will be implemented. The recovery actions discussed below will occur throughout each of the four management units, which cover the entire range of the oceanic whitetip shark.

Table 2 below provides a summary of the recovery program, linking the recovery actions to the threats identified as factors contributing to the threatened status of the oceanic whitetip shark.

Population Dynamics

1. **Improve knowledge and understanding of oceanic whitetip shark population status, abundance trends, and genetic structure.**

   Understanding the population status and abundance trends of the oceanic whitetip shark throughout its range is essential for assessing the conservation status of the species and measuring progress towards achieving recovery. Therefore, this recovery action is needed to monitor progress towards achieving the demographic recovery criterion (1a-1d). Information on population status, abundance trends, and genetic structure also provides a foundation for monitoring whether management interventions to mitigate threats are having the expected effect on the species. This recovery action is therefore also needed to monitor progress towards achieving the threats-based criteria for bycatch and trade under Factor B.

   Currently, stock assessments represent the most robust approach to determining the status of oceanic whitetip sharks. Stock assessments require information on catches (i.e., landings and discards), abundance, and life history (e.g., age, growth, maturity). To date, stock assessments only exist for the WCPO and include the period from 1995 to 2016 (Tremblay-Boyer et al. 2019). However, as retention of oceanic whitetip sharks is now prohibited in all major tuna-RFMOs, there is an increased likelihood that catches may become an unreliable source of data. Without accurate knowledge of the magnitude of total catches and discards, it is not possible to estimate absolute abundance levels for the population. Therefore, stock assessments or alternative methods of determining population status (see objectives and demographic criteria for delisting oceanic whitetip shark) will need to be developed and/or updated as new information on fisheries, abundance, and biology of the species require regular assessments. As such, activities under this recovery action should include developing and/or using alternative modeling methods appropriate to these situations to evaluate the status of the oceanic whitetip shark and measure recovery progress. Additionally, advocating for increased support of monitoring of commercial fisheries using either electronic monitoring (EM) and/or at-sea fisheries observers to improve the quality and quantity of data collected (e.g., landings and discards) to inform such research will be necessary. Increasing observer coverage to help achieve this is covered under recovery actions 5 and 7 below.

2. **Improve knowledge and understanding of oceanic whitetip shark distribution, movement, and habitat use.**

   Currently, the distribution and habitat use of oceanic whitetip sharks are not well understood. Studies using archival satellite tags suggest oceanic whitetip sharks are highly migratory with some evidence of philopatry (Howey-Jordan et al. 2013). However, most research on the movement patterns and migration paths of this species are limited spatially (e.g., almost all data on habitat use in the Atlantic MU are from the Bahamas) and have small sample sizes. Areas and habitats where oceanic whitetip sharks are consistently observed or captured are assumed to be important to the species for carrying out life history functions such as feeding, breeding, and pupping; areas used infrequently or for short periods may also serve important functions for the species that are not yet understood. More research is needed to rigorously and specifically define the environmental features that make an area important to oceanic whitetip sharks so these areas can be protected and/or managed adequately. Therefore, this recovery action is needed to monitor progress toward achieving the demographic recovery criterion (1a-1d), and to inform management and mitigation measures that will lead to achieving the threats-based recovery criteria related to bycatch (2) and trade (3) under Factor B. Physical, chemical, biological, fishery, and other relevant data should be collected or compiled to characterize features of important habitats. Habitat characterization also involves, among other things, descriptions of prey types, densities, and abundances, and of associated oceanographic and hydrographic features. As such, activities under this recovery action should include the development of a predictive framework for identifying oceanic whitetip shark habitat as a management tool for potentially reducing fishery interactions. Research and analyses to characterize oceanic whitetip shark habitat use may also inform evaluation of climate change effects. Additionally, advocating for increased support of monitoring of commercial fisheries using either electronic monitoring (EM) and/or at-sea fisheries observers to improve the quality and quantity of data collected (e.g., landings and discards) to inform such research will be necessary. Increasing observer coverage to help achieve this is covered under recovery actions 5 and 7 below.

3. **Improve knowledge and understanding of the demographics and life history of oceanic whitetip sharks.**

   It is important to obtain current and accurate information on life history parameters for the oceanic whitetip shark (e.g., age, growth, reproduction), as this information is used in population models to predict the productivity of the species and ensure current levels of fishing mortality are allowing the population to recover. Thus, this recovery action is necessary to measure progress toward achieving the demographic recovery criterion (1a-1d), as well as the threats-based criteria for bycatch (2) and trade (3) under Factor B. Current information suggests oceanic whitetip sharks exhibit life-history traits and population parameters (e.g., growth and productivity) that are generally intermediary among other shark species (Cortés 2016; Young and Carlson 2020). However, information is still lacking from some portions of its range and there is still uncertainty in some life history parameters (e.g., some females may give birth annually rather than biennially). Therefore, updating current life history information and determining whether life history parameters differ among MUs will be critical in determining population status and measuring recovery progress. As such, activities under this recovery action should focus on improving data collection and biological sampling of oceanic whitetip sharks in all MUs.

Fisheries Interactions

4. **Reduce fisheries bycatch and mortality of oceanic whitetip sharks by determining and addressing the frequency of capture and severity of fishing interactions in commercial, artisanal, and recreational fisheries.**

   The most significant threat to the oceanic whitetip shark is the combined at-vessel and post-release bycatch-related mortality in commercial fisheries across the species' global range (Young and Carlson 2020; Young et al. 2017). The oceanic whitetip shark interacts with pelagic longlines, purse seines, and gillnets frequently, and has experienced significant population declines as a result. Thus, this recovery action is aimed at directly mitigating oceanic whitetip shark interactions with fishing activities, and is necessary to achieve the demographic recovery criterion (1a-1d) and the threats-based criterion for bycatch (2). However, more information is needed to better understand factors that may affect the frequency with which oceanic whitetip sharks interact with these fisheries in order to implement measures that have the potential to reduce these interactions. This recovery action will also provide information needed to develop effective regulatory measures to address fisheries interactions, and is therefore needed to achieve recovery criteria 5, 7, and 8. Increasing the likelihood that the sharks will survive interactions that do occur, both at the vessel and after the sharks are released, is also key to reducing the overall threat of fishing on the species and eventually improving overall population numbers. Factors that affect levels of at-vessel and post-release mortality vary by gear type and may include the following: how (and for how long) the animals are handled, methods of release, soak time, and the quantity of trailing gear left on the animal after being cut loose. For example, Hutchinson and Bigelow (2021) determined that post-release survivorship in longline fisheries increased when less than one body-length of trailing gear (i.e., <0.5 m) remained on the animals. Therefore, activities under this recovery action will be aimed at determining and implementing methods to reduce overall interaction rates of oceanic whitetip sharks in commercial fisheries, as well as reducing mortality associated with capture, handling, and release of oceanic whitetip sharks in commercial fishing gear. This could include, for example, the potential use of time-area closures in areas used by oceanic whitetip sharks, various deterrent methods, research on best methods to increase at-vessel and post-release survivorship (e.g., gear configurations), and development and implementation of species and gear-specific safe handling and release guidelines.

   Oceanic whitetip sharks are also caught in artisanal and recreational fisheries, although the extent and scale of these fisheries and their impacts on the oceanic whitetip shark population is not well understood. This action would encompass activities aimed at evaluating the scope and scale of non-commercial fisheries in all four MUs.

5. **Reduce fisheries bycatch and mortality of oceanic whitetip sharks in international fisheries and trade through enhanced international coordination and collaboration with relevant international organizations, such as RFMOs.**

The oceanic whitetip shark is a globally distributed species of shark whose range is largely outside of U.S. jurisdiction and occurs in the waters of more than 50 countries (Rigby et al. 2019). As a pelagic species that occurs mostly offshore, it is also managed largely on the high seas across its global range by four major tuna-RFMOs. Additionally, across MUs, the top oceanic whitetip shark catching countries are foreign countries (Young et al. 2017). As such, improved coordination through the RFMOs is needed to enhance the implementation of, compliance with, and effectiveness of existing conservation and management measures for sharks in general, and oceanic whitetip sharks specifically, and to identify any new management measures needed to reduce the threat of fishing activities on the species. This recovery action is needed to achieve the demographic recovery criterion (1a-1d), as well as threats-based criteria for bycatch (2), trade (3), and inadequate regulatory mechanisms to address bycatch and trade (5, 6). While several activities under this recovery action will be specific to each MU, some activities will apply across all MUs. Activities include encouraging Parties to implement domestic regulations to comply with RFMO measures (especially retention prohibitions), increasing observer coverage to minimum requirements, and increasing data collection on oceanic whitetip sharks to better understand the impact of fishing on the species.

In addition to improved coordination through the relevant tuna-RFMOs, there are many other international organizations and mechanisms that focus on conservation and management of species, including sharks. Enhanced coordination between these organizations, specifically for oceanic whitetip sharks, will be beneficial for promoting and supporting recovery across international and regional jurisdictions. These include international agreements such as CITES, the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and its Sharks Memorandum of Understanding (CMS Sharks-MOU), as well as other mechanisms and projects (e.g., United Nations Environment Programme [UNEP] Protocol for Specially Protected Areas and Wildlife [SPAW], IUCN Shark Specialist Group, International Seafood Sustainability Foundation [ISSF], and others as appropriate). Activities under this recovery action should focus on continued engagement, enhanced coordination, and implementation of various management and research activities aimed at conserving oceanic whitetip sharks by reducing threats of overfishing and international trade of the species.

Because countries outside U.S. jurisdiction are the largest sources of oceanic whitetip shark mortality (Young et al. 2017), effective implementation of management actions to reduce the threat of overfishing to the oceanic whitetip shark throughout its range will require the participation of the international fishing community, as well as foreign government officials and other stakeholders. However, some countries whose fishing fleets interact with oceanic whitetip sharks may not have adequate institutional capacity and resources to properly implement fisheries regulations and/or monitoring and enforcement measures. They may also lack the resources to train fishers in safe handling and release methods, species identification, and data collection protocols. Therefore, this recovery action includes investing in capacity building programs in these key countries or regions, which will be critical for reducing the main threat of overfishing on the oceanic whitetip shark.

International Trade

6. **Determine the effects of the international shark fin trade on oceanic whitetip shark populations in all management units, and take management actions to reduce, and/or eliminate if necessary, the amount of oceanic whitetip shark fins in trade.**

   The international shark fin trade was identified as a significant economic driver for opportunistic and illegal retention of oceanic whitetip sharks because their large, distinctive fins obtain a high price in international markets (Young et al. 2017). In a 2006 study, Clarke et al. found that oceanic whitetip sharks represented nearly 2% of the Hong Kong fin market; this represents an estimated total annual catch of approximately 200,000–1,200,000 individuals (median ~700,000). In more recent studies, oceanic whitetip sharks still made up a substantial percentage of tested fins and fin trimmings in Hong Kong (Cardeñosa et al. 2018; Fields et al. 2018), indicating that the species is still very prevalent in the trade despite its conservation status and non-retention measures for the species in every major tuna-RFMO. However, very little information exists regarding the impact of trade on the species, including the current number of oceanic whitetip sharks traded each year or from which MU most oceanic whitetip sharks are sourced for the international market. Therefore, activities under this recovery action should focus on studies (including both economic/market surveys and genetics analyses) that will help determine the current scope of international trade of oceanic whitetip sharks, track trends over time, and identify the main populations or MUs from which most oceanic whitetip sharks are being taken. Based on results of this research, further engagement on management actions with the CITES Parties (such as advocating for strengthening non-detriment findings (NDFs) and/or a significant trade review) may be warranted. Additionally, understanding the magnitude of illegal trade and its origin will help us better understand which RFMOs need to take further management action to address IUU fishing of oceanic whitetip sharks based on their region of operation.

   This recovery action is needed to achieve the demographic recovery criterion (1a-1d) as well as threats-based criteria for trade (3) and inadequate regulatory mechanisms to address finning and trade (4, 5, 6, 7).

Monitoring and Reporting

7. **Improve species-specific monitoring and reporting of oceanic whitetip sharks in commercial and artisanal fisheries by RFMOs and individual countries to provide a better understanding of the effects of IUU fishing, improve estimates of catch and discards, and measure progress towards recovery.**

Adequate monitoring and reporting is crucial for determining reliable estimates of catch, discards, and disposition (i.e., whether an animal is released alive or dead, and if released alive at-vessel, whether the animal survived), and provides vital data needed in population assessments. Thus, this recovery action is needed to measure progress toward achieving the demographic recovery criterion (1a-1d) and the threats-based criteria related to bycatch (2) and trade (3). In addition, monitoring and reporting is important for determining the efficacy of existing RFMO measures, so this recovery action is needed to measure progress toward achieving recovery criteria for inadequate regulatory mechanisms to address bycatch, finning, and trade (5, 6, 7). Currently, all relevant tuna-RFMOs (ICCAT, IATTC, IOTC, and WCPFC) have prohibited retention of the oceanic whitetip shark in certain fisheries. Measures prohibiting retention of the oceanic whitetip shark, if adequately implemented and enforced, may reduce overall bycatch mortality because the species exhibits relatively high at-vessel survivorship compared to some shark species (Musyl et al. 2011; Hutchinson et al. 2021). However, monitoring and reporting of catches and discards is highly variable across the species' range, with some countries not reporting. As a result, accurately determining the efficacy of these measures may not be possible, which makes future management decisions and their outcomes uncertain. Moreover, a lack of data regarding the disposition (i.e., discarded dead, released alive and/or injured) of oceanic whitetip sharks in commercial fisheries will preclude the effective enforcement of RFMO conservation and management measures, particularly whether countries are adhering to retention prohibition measures.

Regulatory Mechanisms and Enforcement

8. Reduce fishing mortality of oceanic whitetip sharks through effective development, implementation, and enforcement of international and domestic measures, such as legislation and regulations.

As described previously, measures prohibiting retention of oceanic whitetip sharks, if adequately implemented and enforced, can reduce the overall bycatch mortality of the species because it has relatively high at-vessel survivorship compared to other shark species (Musyl et al. 2011), and a large proportion of individuals caught incidentally and released alive may survive. Despite the adoption of no-retention measures by RFMOs, illegal retention of oceanic whitetip sharks taken as bycatch continues to occur, mainly driven by demand from the international shark fin trade. Therefore, activities under this recovery action should focus on tracking retention of the species over time, and identifying areas where further regulation and enforcement are needed to reduce retention. In addition, based on results of research activities in recovery action 4, regulatory measures other than retention bans, including measures to avoid interactions in the first place (such as time/area closures and deterrence measures) or measures that increase the survival of released sharks (such as best practices for fishing operations and circle hook requirements), could be implemented.

Retention of oceanic whitetip sharks has been prohibited in U.S. Atlantic commercial fisheries with pelagic longline gear onboard and on recreational vessels that possess tuna, swordfish, or billfish since 2011. Since these prohibitions were implemented, estimated commercial landings of the species declined from 1.1 mt in 2011 to 0.03 mt in 2013 (NMFS 2012, 2014), and there have been no reported commercial or recreational landings of the species since 2015 (NMFS 2021). However, oceanic whitetip sharks are occasionally still landed in this region as retention in other authorized gear types such as gillnets and bottom longlines is still permitted (NMFS 2012, 2014). Although reported legal retention of the species in U.S. Atlantic fisheries is low, retention in all U.S. Atlantic commercial fisheries should be prohibited. This would further facilitate the recovery of the species in this region, and show that we are taking all steps possible to further conserve the oceanic whitetip shark in domestic waters.

The international shark fin trade asserts significant pressure on the global oceanic whitetip shark population, with an estimated 1.2 million individuals killed and traded per year (Clarke et al. 2006). In 2016, NMFS implemented the 2011 Shark Conservation Act (see 50 CFR 600 Subpart N), which largely re-wrote the Shark Finning Prohibition Act of 2000. Under the final requirements, U.S. vessels are prohibited, with a limited exception, from removing fins from sharks while at sea, landing shark fins that are not naturally attached to the carcass, and landing a shark carcass that does not have all its fins naturally attached. Similarly, U.S. dealers are prohibited from possessing, purchasing, offering to sell, or selling fins or shark carcasses taken, transferred, landed, or possessed in violation of Shark Conservation Act. Since the implementation of these laws, U.S. exports of dried shark fins dropped substantially. For example, in 2004, 50.6 tons of fins were exported, but in 2013 the weight of fins exported dropped to 12 tons (NMFS 2018). This reduction in weight of fins exported is in contrast to the overall increasing price per kg of shark fin and suggests that existing regulations have likely been effective at discouraging fishing for sharks solely for the purpose of the fin trade. Therefore, continuing implementation of these domestic laws is an important recovery action to reduce the number of oceanic whitetip sharks taken for the shark fin trade. In addition, to complement recovery action 5, the United States should continue working through RFMOs and other international mechanisms such as CITES to encourage countries engaged in the fin trade to adopt, implement, and enforce regulatory measures to reduce the number of oceanic whitetip sharks killed for the shark fin trade. The United States should also work through other international mechanisms such as CITES to ensure that any trade occurring (legal or illegal) is not impeding recovery of the species.

This recovery action is needed to achieve the demographic recovery criterion (1a-1d) as well as threats-based criteria for bycatch (2), trade (3), and inadequate regulatory mechanisms to address finning and trade (4, 5, 6, 7).

Outreach and Education

9. **Develop and implement outreach and education strategies and programs to increase public and stakeholder (including fishermen) awareness on the status and recovery needs of the oceanic whitetip shark.**

Effective implementation of recovery actions to reduce bycatch-related mortality of oceanic whitetip sharks in commercial fisheries and ensure the long-term recovery of the species will require global cooperation and collaboration with fishermen and the public. A comprehensive outreach and education strategy that promotes a more positive image of oceanic whitetip sharks and the importance of conserving them could help facilitate positive shifts in perceptions, attitudes, and behaviors in both groups. Because public and stakeholder support is needed for implementation of mitigation measures as well as the development and implementation of regulatory mechanisms, this recovery action will support progress toward achieving all of the threats-based criteria (2, 3, 4, 5, 6, 7).

When aimed at fishermen, the strategy should address the impact of commercial fishing on the status of the species, and provide specific ways to reduce mortality associated with fisheries interactions. When aimed at building and maintaining public support for the conservation of oceanic whitetip sharks, the strategy may include community science efforts and general outreach and education on the status and importance of the species. Education and outreach is especially important to communities that are most likely to affect or be affected by the species. Increased public interest in conserving oceanic whitetip sharks can help build partnerships and funding for the implementation of recovery actions. In both cases, because the oceanic whitetip shark is globally distributed and occurs in numerous countries representing diverse communities, cultures, and customs, an effective outreach and education strategy should draw on respective cultural insights and take advantage of communication avenues already being used by relevant communities, including social media and other online resources. While NOAA should lead the development and dissemination of outreach, education and communication strategies and materials as outlined above, other countries and RFMOs should also engage in these efforts in collaboration with NGOs, academia, and the private sector.

Other Stressors

10. Identify, evaluate, and minimize any other stressors that may be impeding recovery of oceanic whitetip sharks.

There is no information at this time to indicate that other stressors are currently impeding recovery of the oceanic whitetip shark. However, there are very few data available on these stressors, and thus a high degree of uncertainty around the potential effects they may have on the oceanic whitetip shark population. Other stressors that currently pose a low or low-moderate risk to the species, such as climate change, pollutants, and toxins, should be monitored to ensure that they are not impeding the recovery of the species.

Effects of climate change were rated as a low-moderate risk to oceanic whitetip sharks. The species' broad distribution and ability to move to areas that suit their biological and ecological needs may buffer effects from climate change. However, there is very little information specific to the potential effects of climate change on oceanic whitetip sharks. Data from the Northwest Atlantic suggest the species may face metabolic challenges when coping with habitats close to its upper thermal limits and potential overheating (Andrejaczek et al. 2018). Changes in ocean temperature could also affect the overlap between the species' distribution and prey species and/or fishing gear. Overall, the potential effects from climate change on oceanic whitetip sharks are highly uncertain and more information is needed in order to accurately assess the risk that climate change poses to the species. Activities under this action could include research, vulnerability and risk assessments, and scenario planning, and should be focused initially on factors that have been identified as the most likely to affect the species, such as thermal tolerance ranges and changes in prey abundance and distribution.

Although studies have shown that environmental pollutants can accumulate and biomagnify in shark tissues, scientific studies have not yet demonstrated whether these pollutants and contaminants are having negative physiological effects on oceanic whitetip sharks. One study analyzed the pollutant composition of an amalgamated liver oil sample from an oceanic whitetip shark and silky and nurse sharks, and found very high levels of dioxins and dioxin-like polychlorinated biphenyls (PCBs) (Cruz-Nunez et al. 2009). However, threshold PCB concentrations at which detrimental effects may occur in cartilaginous fish are virtually unknown (Gelsleichter and Walker 2010). It is hypothesized that sharks can handle higher body burdens of anthropogenic toxins due to the large size of their livers (Storelli et al. 2003), or may even be able to limit their exposure by sensing and avoiding areas of high toxins (like during *Karenia brevis* red tide blooms) (Flewelling et al. 2010). Thus, pollutants and contaminants were rated as a low to moderate risk to oceanic whitetip sharks, but further information is needed in order to confirm the level of risk they pose to the viability of the species. In particular, a recent study reported toxic, non-essential metal mercury (Hg) concentrations in oceanic whitetip sharks were among the highest ever reported among four other pelagic shark species and correlated significantly with shark length (Gelsleichter et al. 2020). The authors concluded that Hg poses health risks to oceanic whitetip sharks and can include neurobehavioral effects and reduction of reproductive fitness, with the latter potentially affecting the ability of the species to recover. Therefore, activities under this action should focus on better understanding the potential physiological effects of pollutants such as mercury on the species' ability to recover.

Potential emerging stressors such as aquaculture development and tourism may interact with and exacerbate existing threats to the oceanic whitetip shark. One example is the operation of an aquaculture pen off the coast of Kona, Hawaii, which attracted oceanic whitetip sharks (and other fish/wildlife) in a similar way as fish aggregating devices (FADs) (Hutchinson, pers. comm. 2021). This aquaculture cage was also situated in prime fishing grounds, thereby increasing fishing interactions with oceanic whitetip sharks. While aquaculture and tourism were not evaluated or ranked as stressors in the original status review of the species (Young et al. 2017), they have the potential to act synergistically with other threats and possibly impede recovery progress. Therefore, this action should include monitoring and evaluating effects related to these non-fishing activities and implementing mitigation measures if necessary.

Post-delisting Monitoring Plan

11. Develop a post-delisting monitoring plan to ensure management of oceanic whitetip sharks continues to be sustainable post-delisting.

A post-delisting monitoring plan should be developed to ensure that the oceanic whitetip shark population status is appropriately monitored for at least five years post-delisting to ensure that removal of the protections of the ESA does not result in a return to threatened status.

Table 2. Summary of recovery program, linking threats to recovery actions.

Listing Factor	Threat	Recovery Criteria	Recovery Action Numbers
A	No threats identified	N/A	N/A
B	Fisheries bycatch (purse seine, longline, gillnet)	1, 2	1, 2, 3, 4, 5, 7, 8, 9
B	International fin trade	1, 3	1, 5, 6, 7, 8, 9
C	No threats identified	N/A	N/A
D	Inadequacy of fisheries regulations	1, 2, 4, 5, 6, 7	1, 2, 3, 4, 5, 7, 8, 9
D	Inadequacy of fin trade regulations	1, 3, 4, 5, 6, 7	1, 2, 3, 5, 6, 7, 8, 9
E	No threats identified	N/A	N/A

Listing Factors

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

5. Recovery Action Implementation

This chapter provides a detailed overview of the estimated time and costs for implementing this Recovery Plan and the overall time to recovery for the oceanic whitetip shark. Section 5.1 provides the rationale for the estimated amount of time it will take to recover the oceanic whitetip shark (i.e., 62 years). Section 5.2 provides an overview of the Implementation Schedule of this Recovery Plan, with a breakdown of the estimated costs for each recovery action.

5.1 Time to Recovery

To determine time to recovery, we examined the future population projections of Rice et al. (2021) which were based on the stock assessment of Tremblay-Boyer et al. (2019). At the terminal year of that assessment (2016), the ratio of the current population size to unfished biomass was estimated to be below 0.05 (SB/SB_0), and all model runs predict SB/SB_0 to be below 0.1. In constructing projection scenarios, Rice et al. (2021) developed "realistic levels of catch" to simulate increased adoption of the catch prohibition (CMM-2011-04; non-retention of the species, which became fully effective in 2013) over the years between the terminal year of the model (2016) and 2017-2020. Following the introduction of CMM-2011-04, estimated catches have declined (Tremblay and Neubauer 2019). In addition, onboard fisheries observer data indicates that this is due to increased discard rates in the longline and purse seine fisheries occurring over the last few years as the CMM was more widely adopted. Additionally, longline effort in the WCPO has declined in recent years, from a high of approximately 11 hundred million hooks to 8 hundred million hooks in 2017 (https://www.wcpfc.int/public-domain). Thus, catch estimates from 2017-2020 were estimated by reducing annual total catch using two levels representative of the average annual percent reduction from 2013-2014, 2014-2015, and 2015-2016 (10% and 20%) (Rice et al. 2021).

Rice et al. (2021) constructed various scenarios based on differences in growth, recruitment steepness, natural mortality, and levels of fishing mortality. The population was projected forward for 16 years (2 generations) to 2031 and overall was found to increase at a moderate pace over the projection period under the zero-catch scenario, as well as for many of the models under the projected status quo, 10% and 20% decrease catch scenarios. The average time to 50% of the 2016 biomass levels is approximately 10, 15, and 16 years for the 10% decline and 20% decline catch scenarios, respectively. Population projections under a 20% decline in catches for the years 2017-2020 show that in the majority of the simulations the population is increasing.

Using the projected rate of increase for the 10% and 20% reduction in catch scenarios, and assuming this rate will continue over time (beyond 2031) the population is expected to reach about 30% of unfished biomass by 2060. This level would be the initial signal that the population is recovering based on the fact that for elasmobranchs in general, $0.3B_0$ is a reasonable Limit Reference Point (see Clarke and Hoyle 2014), as a value above $0.3B_0$ would still be indicative of a sustainable population size (even if it does not produce MSY) (Cortés pers. comm. 2022). Before delisting can occur, the population must continue to demonstrate, on average, an increasing population trend for 2 generations (20 years). While this estimate was derived from projections assuming 10% and 20% declines in catches, these would be the most conservative, as oceanic whitetip sharks are prohibited from retention in all tuna RFMOs and catch should be zero. In addition, the data are applicable to the WCPO Management Unit where the population has declined by 95% and current information suggests the status of the species in this region is likely worse than any other area (Young and Carlson 2020). Therefore, these projections represent the most conservative estimates for determining when the species will recover.

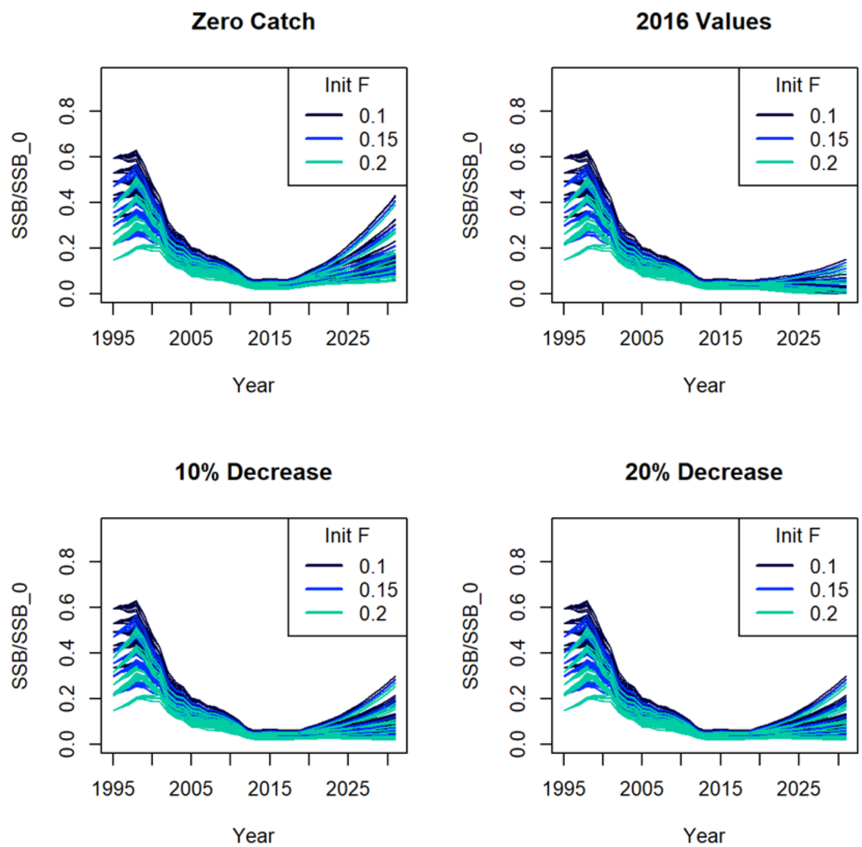

Figure 4. Forward projections for the WCPO population of oceanic whitetip shark based on a representative set of various uncertainties (Rice et al. 2021)

In estimating the overall time to recovery for the oceanic whitetip shark, we examined the life history of the species. Generation time, which is defined as the time it takes, on average, for a sexually mature female oceanic whitetip shark to be replaced by offspring with the same reproductive capacity, is estimated to be around 10-11 years (Smith et al. 2008; Cortés 2020). As described above in section 3.3.1 Demographic Objectives and Criteria, we selected 20 years (~2 generation lengths) as an appropriate timeframe for the population biomass and fishing mortality rates to have maintained a level demonstrating recovery because it is biologically based (approximately two generations) and reasonably expected to encompass environmental and fisheries-based stochastic events that may affect the population. For a long-lived species with relatively low productivity, the longer a population biomass shows an increase or stability at the recovered level (>30% of unfished levels), the more confident we can be that the species as a whole will be stable and resilient to stochastic events in the future. Therefore, given an estimated time to reach 30% of unfished biomass is ~2060 (42 years since time of listing), plus the time required for maintaining this level (2 generations of ~10 years) gives a total time to recovery of approximately 62 years.

5.2 Estimated Costs

The Implementation Schedule that follows (Table 3) outlines recovery actions and estimated time and costs to recover the oceanic whitetip shark, as set forth in this Recovery Plan. Although the estimated time to recovery for the oceanic whitetip shark is 62 years (as discussed in section 5.1 above), we estimated the cost of recovery based on 70 years to accommodate uncertainty in the estimated time to recovery. This schedule indicates the recovery action number, recovery action title, recovery action priority (Box 2), recovery objective, estimated costs for the first five fiscal years, estimated costs for the subsequent 65 fiscal years, the 70-year estimated total cost, and estimated duration or frequency of recovery actions. Parties with authority or responsibility to implement, or who expressed interest in implementing, a specific recovery action are also identified in the Implementation Schedule. The listing of a party in the Implementation Schedule does not imply that they are required to implement the recovery action(s) or secure funding for implementing the recovery action(s). In addition, site-specificity for all recovery actions are within each of the four management units that cover the range of the oceanic whitetip shark.

Other actions not required for recovery (actions 10 and 11) are not included in the estimated costs.

Box 2. Priority Assignments for Actions in the Recovery Plan[3]
Priority 1 Recovery Actions: These are the recovery actions and activities that must be taken to remove, reduce, or mitigate major threats and prevent extinction and often require urgent implementation. **Priority 2 Recovery Actions:** These are recovery actions and activities to remove, reduce, or mitigate major threats and prevent continued population decline or research needed to fill knowledge gaps, but their implementation is less urgent than Priority 1 actions. **Priority 3 Recovery Actions:** These are all recovery actions and activities that should be taken to remove, reduce, or mitigate any remaining, non-major threats and ensure the species can maintain an increasing or stable population to achieve delisting criteria, including research needed to fill knowledge gaps and monitoring to demonstrate achievement of demographic criteria. **Priority 4 Post-Delisting Actions:** These are actions and activities that are not linked to downlisting or delisting criteria and are not needed for ESA recovery, but are needed to facilitate post-delisting monitoring under ESA section 4(g), such as the development of a post-delisting monitoring plan that provides monitoring design (e.g., sampling error estimates).

[3] Endangered and Threatened Species Listing and Recovery Priority Guidelines (84 FR 18243, May 30, 2019)

Priority 0 Other Actions: These are actions and activities that are not needed for ESA recovery or post-delisting monitoring but that would advance broader goals beyond delisting. Other actions include, for example, other legislative mandates or social, economic, and ecological values. These actions are given a zero priority number because they do not fall within the priorities for delisting the species, yet the numeric value allows tracking these types of actions in the NMFS Recovery Action Database.

Table 3. Implementation Schedule.

Action #	Action Title / Additional Info	Priority #	Recov. Obj. #	Cost Estimates by FY (thousands of dollars)							Duration/ Frequency[1]	Potential Partners ±
				FY1	FY2	FY3	FY4	FY5	FY6+[2]	Total[3]		
POPULATION DYNAMICS												
1	Improve knowledge and understanding of oceanic whitetip shark population status, abundance trends, and genetic structure.	2	1	$1,595	$25	$775	$60	$750	$32,905	$36,110	Continuous	NOAA, RFMOs, Academia, NGOs, foreign govts, observer programs
	Costs include funding to conduct various scientific research projects and assessments (e.g., stock assessments, fishery-independent scientific surveys, genetic sampling and analyses). Costs would cover salary for hired researchers, associated research materials and equipment, vessel time and travel.											
2	Improve knowledge and understanding of oceanic whitetip shark distribution, movement, and habitat use.	2	1	$450	$20	$20	$20	$20	$4,560	$5,090	Ongoing	NOAA, Academia, RFMOs, NGOs, foreign govt scientific institutions
	Costs include satellite tags, field expenses, and salary for hired research scientist(s) to conduct tag data analysis and modeling studies.											

Action #	Action Title / Additional Info	Priority #	Recov. Obj. #	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[2]	Total[3]	Duration/ Frequency[1]	Potential Partners ±
3	Improve knowledge and understanding of the demographics and life history of oceanic whitetip sharks.	2	1	$95	$20	$20	$20	$20	$1,450	$1,625	Ongoing	NOAA, RFMOs, Academia, NGOs, foreign govt scientific institutions
	Costs include funding for biological sampling equipment and salary for a research scientist(s) to process samples, analyze data and produce reports/publications. Costs also include repeating life history studies every 10 years (~1 generation) to update information.											
TOTAL FOR POPULATION DYNAMICS				$2,140	$65	$815	$100	$790	$38,915	$42,825		
FISHERIES INTERACTIONS												
4	Reduce fisheries bycatch and mortality of oceanic whitetip sharks by determining and addressing the frequency of capture and severity of fishing interactions in commercial, artisanal, and recreational fisheries.	2	2	$1,135	$940	$875	$605	$530	$16,040	$20,125	Continuous/ not yet initiated	NOAA, Academia, RFMOs, NGOs, fishing industry and communities

Action #	Action Title	Priority #	Recov. Obj. #	Cost Estimates by FY (thousands of dollars)							Duration/ Frequency[1]	Potential Partners ±
	Additional Info			FY1	FY2	FY3	FY4	FY5	FY6+[2]	Total[3]		
	Costs include experimental research, development, and testing of deterrents, modified gear and gear configurations, and efficacy of time area closures as well as salary for hired scientific researchers. Costs also include safe handling/release training workshops for fishermen. Costs also include repeating experimental research studies and trainings periodically.											
5	Reduce fisheries bycatch and mortality of oceanic whitetip sharks in international fisheries and trade through enhanced international coordination and collaboration with relevant international organizations, such as RFMOs.	2	2	$1,090	$550	$550	$550	$550	$16,055	$19,345	Continuous/ not yet initiated	NOAA, U.S. State Dept., RFMOs, NGOs, CITES, CMS, IUCN Shark Specialist Group, ISSF, foreign govts, fishing industry and communities
	Costs include implementation of stakeholder and capacity building workshops in priority areas, increasing observer coverage (both physical observers and electronic monitoring [EM]) in international fisheries, as well as increased and focused engagement in international fora (RFMOs, CITES, CMS, etc.) on oceanic whitetip issues.											
TOTAL FOR FISHERIES INTERACTIONS				$2,225	$1,490	$1,425	$1,155	$1,080	$32,095	$39,470		
INTERNATIONAL TRADE												

Action #	Action Title / Additional Info	Priority #	Recov. Obj. #	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[2]	Total[3]	Duration/ Frequency[1]	Potential Partners ±
6	Determine the effects of the international shark fin trade on oceanic whitetip shark populations in all management units and take management actions to reduce, and/or eliminate if necessary, the amount of oceanic whitetip shark fins in trade.	2	2	$130	--	$130	--	$130	$4,420	$4,810	Ongoing	NMFS OLE, Academia, NGOs, RFMOs, CITES Secretariat & Parties
	Costs include implementation of market surveys and genetics research to elucidate prevalence of oceanic whitetip sharks in the international shark fin trade, track trends over time, and develop a strategy to reduce oceanic whitetip fins in trade.											
TOTAL FOR INTERNATIONAL TRADE				$130	--	$130	--	$130	$4,420	$4,810		
FISHERIES MONITORING AND REPORTING												

Action #	Action Title	Priority #	Recov. Obj. #	Cost Estimates by FY (thousands of dollars)							Duration/ Frequency[1]	Potential Partners ±
	Additional Info			FY1	FY2	FY3	FY4	FY5	FY6+[2]	Total[3]		
7	Improve species-specific monitoring and reporting of oceanic whitetip sharks in commercial and artisanal fisheries by RFMOs and individual countries to provide a better understanding of the effects of IUU fishing, improve estimates of catch and discards, and measure progress towards recovery.	3	3	$450	$125	TBD	TBD	TBD	TBD	$575 +	Ongoing	NOAA, NGOs, RFMOs, tech and fishing industries
	Costs include development and research of tools such as electronic monitoring and artificial intelligence to enhance fisheries monitoring and reporting capabilities. Costs also include funds to continue support and training of fisheries observers, domestically and internationally. Cost estimates for increasing observer coverage rate internationally could not be realistically determined at this time, but would be commensurate with meeting the minimum requirement of 5% as established by the RFMOs. Current cost per sea day in U.S. longline and purse seine fisheries is ~$1,500/sea day.											
TOTAL FOR FISHERIES MONITORING & REPORTING				$450	$125	TBD	TBD	TBD	TBD	$575+		

Action #	Action Title	Priority #	Recov. Obj. #	Cost Estimates by FY (thousands of dollars)							Duration/ Frequency[1]	Potential Partners ±
	Additional Info			FY1	FY2	FY3	FY4	FY5	FY6+[2]	Total[3]		
REGULATORY MECHANISMS & ENFORCEMENT												
8	Reduce fishing mortality of oceanic whitetip sharks through effective development, implementation and enforcement of international and domestic measures, such as legislation and regulations.	2	3	$150	$25	$25	$25	$25	$2,250	$2,500	Ongoing	NMFS OLE, U.S. State Department, Foreign govts, RFMOs, NGOs, CITES, CMS
	Most costs associated with this recovery action are included in the NMFS staff time costs at the bottom of this table, with additional travel costs included for NMFS staff to engage in international fora. Costs also include estimates for a research scientist to conduct compliance analyses of existing measures as well as support for trainings in shark fin ID to support enforcement of RFMO and trade regulations.											
TOTAL FOR REGULATORY MECHANISMS & ENFORCEMENT				$150	$25	$25	$25	$25	$2,250	$2,500		
OUTREACH AND EDUCATION												

Action #	Action Title / Additional Info	Priority #	Recov. Obj. #	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[2]	Total[3]	Duration/ Frequency[1]	Potential Partners ±
9	Develop and implement outreach and education strategies and programs to increase public and stakeholder (including fishermen) awareness on the status and recovery needs of the oceanic whitetip shark.	3	--	$255	$210	$140	$140	$55	$6,455	$7,255	Ongoing	NOAA Comms, Academia, NGOs, fishing industry and community
	Costs include development of outreach and education strategies for both the general public and stakeholders (e.g., fishermen), including socio-economic research, development of regional communication strategies, community and citizen science programs, social media campaigns, and educational signs near public access points to the marine environment in priority areas.											
TOTAL FOR OUTREACH & EDUCATION				$255	$210	$140	$140	$55	$6,455	$7,255		
TOTAL FOR NMFS STAFF TIME (2 ZP3/4 FTEs)				$250	$250	$250	$250	$250	11,250+	$12,500+		
GRAND TOTALS				$5,600	$2,165	$2,785	$1,670	$2,330	$95,485	$110,035	$110,035,000+	

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