NOAA FISHERIES

Main Hawaiian Islands Insular False Killer Whale (*Pseudorca crassidens*) Distinct Population Segment

Final Endangered Species Act (ESA) Recovery Plan

October 2021

NOAA FISHERIES | PACIFIC ISLANDS REGIONAL OFFICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Final ESA Recovery Plan

for the

Main Hawaiian Islands Insular False Killer Whale

(*Pseudorca crassidens*)

Distinct Population Segment

Prepared by:

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Approved: ____

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Date: 10/28/21

PREFACE

We, NOAA Fisheries, have developed this Final Recovery Plan for the main Hawaiian Islands insular false killer whale (MHI IFKW) (*Pseudorca crassidens*) distinct population segment (DPS) 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. 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 Recovery Plan are available on our NOAA Fisheries false killer whale species profile web site. The supplemental information 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 are "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 equates with 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 MHI IFKW was determined to be a DPS and listed as endangered on November 28, 2012 (77 FR 70915). An "endangered species" is defined as "any species which is in danger of extinction 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 include the following: (1) a description of site-specific management actions necessary to conserve 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 funding required to achieve the plan's goals.

This Recovery Plan specifically addresses the planning requirements of the ESA for the MHI IFKW DPS. It also presents an updated threats analysis and a recovery strategy based on the biological and ecological needs of the DPS, current threats, and existing conservation measures, all of which affect its long-term viability.

DISCLAIMER

Endangered Species Act 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 NOAA Fisheries, and do not necessarily represent the views, official positions, or approval of any individuals or other agencies involved in the plan formulation; although they represent the official position of NOAA Fisheries only after the Assistant Administrator has signed them. 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 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:

NOAA Fisheries. 2021. Final Endangered Species Act Recovery Plan for the Main Hawaiian Islands Insular False Killer Whale (*Pseudorca crassidens*) Distinct Population Segment. October 2021. NOAA Fisheries, Pacific Islands Regional Office, Honolulu, HI 96818. 69 pages.

Download a digital copy of this recovery plan from the Conservation and Management tab of our NOAA Fisheries false killer whale species profile web site, specifically at https://www.fisheries.noaa.gov/species/false-killer-whale#conservation-management.

Obtain hard copies of this Final Recovery Plan from the following:

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All NOAA Fisheries recovery plans can be downloaded from the NOAA Fisheries recovery of species under the ESA website.

GUIDE TO THE PLAN

This Recovery Plan represents a new recovery planning approach developed by the U.S. Fish and Wildlife Service and recently accepted by NOAA Fisheries as an optional approach to traditional recovery plans. For this format, recovery planning components for the MHI IFKW DPS are divided into three separate documents. The first document, the Recovery Status Review (NOAA Fisheries 2021a), provides all the detailed information on the MHI IFKWs' biology, ecology, status and threats, and conservation efforts to date, which have 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 Recovery Plan for the benefit of the reader.

The second document, this Recovery Plan, focuses on the statutory requirements of the ESA. It includes (1) a description of site-specific management actions necessary to conserve 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 funding required to achieve the plan's goals. Recovery actions in the Recovery Plan are described at a higher-level and are more strategic.

More in-depth, stepped-down activities that address the site-specific recovery actions for the MHI IFKW can be found in a third stand-alone document, the Recovery Implementation Strategy (NOAA Fisheries 2021b). The Recovery Implementation Strategy is a flexible, operational document separate from the 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 in real time 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 Recovery Implementation Strategy, are available on the NOAA Fisheries false killer whale species profile web site.

Finally, we provide some biological and ecological information that is true for false killer whale populations generally (either globally or within the Hawaiian Archipelago) and some information that applies only to the MHI IFKW. Therefore, we wish to distinguish between the endangered MHI IFKW and other non-listed populations or stocks of false killer whales. In this document, the term "species" generally refers to the taxonomic (or global) species of false killer whales, *Pseudorca crassidens*, and the term "DPS" or "MHI IFKW" refers specially to the MHI IFKW DPS, the ESA-listed entity.

ACKNOWLEDGEMENTS

NOAA Fisheries gratefully acknowledges the contributions of the numerous individuals in developing the *Final Endangered Species Act Recovery Plan for the Main Hawaiian Islands Insular False Killer Whale* (Pseudorca crassidens) *Distinct Population Segment*.

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Finally, we gratefully acknowledge the participants of the MHI IFKW recovery planning workshop held in October 2016. We invited experts from a range of relevant disciplines to this workshop to provide informed and creative input into recovery planning for the MHI IFKW, including development of the MHI IFKW Recovery Planning Workshop Summary (see the workshop summary for a list of workshop participants). The workshop summary (NOAA Fisheries 2017) along with the recovery outline (NOAA Fisheries 2016) were used as the foundation for developing this recovery plan.

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LIST OF TERMS, ABBREVIATIONS, AND ACRONYMS

The following is a list of terms, abbreviations, and acronyms used throughout the Recovery Plan.

ACOE	Army Corps of Engineers
BOEM	Bureau of Ocean Energy Management
CCH	City and County of Honolulu
CEC	Chemicals of Emerging Concern
CI	Confidence Interval
CI	Conservation International
CRC	Cascadia Research Collective
DDT	Dichlorodiphenyltrichloroethane
Delisting	Removal from the list of Endangered and Threatened Wildlife and Plants
DLNR-DAR	Department of Land and Natural Resources–Division of Aquatic Resources' Protected Species Program
DNA	Deoxyribonucleic acid
DOH	Department of Health
DMONs	Digital acoustic monitors
Downlisting	Considered for reclassification from endangered to threatened under the ESA
DPS	Distinct Population Segment
EARs	Ecological Acoustic Recorders
EM	Electronic Monitoring
ENSO	El Niño-Southern Oscillation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAD	Fish Aggregating Device
FHA	Federal Highways Administration
FR	Federal Register
FKWTRP	False Killer Whale Take Reduction Plan
FKWTRT	False Killer Whale Take Reduction Team
FY	Fiscal Year
GPS	Global Positioning System
HARPs	High-frequency Acoustic Recording Packages
HFACT	Hawaiʻi Fishermen's Alliance for Conservation and Tradition
HIMB	Hawaiʻi Institute of Marine Biology
HLA	Hawaiʻi Longline Association
HPU	Hawaiʻi Pacific University
ITP	Incidental Take Permit
km^2	Square Kilometers
MHI IFKW	Main Hawaiian Islands Insular False Killer Whale
mi^2	Square Miles
MMPA	Marine Mammal Protection Act
Ne	Effective population size
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service

NOAA	National Oceanic and Atmospheric Administration
NWHI	Northwestern Hawaiian Islands
ONMS	Office of National Marine Sanctuaries
PacIOOS	Pacific Islands Ocean Observing System
PBDE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
PDO	Pacific Decadal Oscillation
PICCC	Pacific Islands Climate Change Cooperative
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
POP	Persistent Organic Pollutant
PWF	Pacific Whale Foundation
SE	Standard Error
SPLASH	Structure of Populations, Levels of Abundance, and Status of Humpback Whales
SWFSC	Southwest Fisheries Science Center
UAS	Unmanned Aerial System
UH	University of Hawaiʻi at Manoa
US	United States
USCG	United States Coast Guard
VMS	Vessel Monitoring System
WPRFMC	Western Pacific Regional Fishery Management Council

EXECUTIVE SUMMARY

On November 28, 2012, after considering the best scientific and commercial data available, we published a final rule to list the MHI IFKW as an endangered DPS under the ESA (77 FR 70915). Following the 2018 designation of critical habitat (83 FR 35062), we began recovery planning efforts for the MHI IFKW DPS. This Final Recovery Plan reflects the updated threats analysis for the MHI IFKW available in the 2021 Recovery Status Review (NOAA Fisheries 2021a). The most significant threats to the MHI IFKW are, in no particular order, (1) small population size; (2) incidental take (hooking or entanglement) in non-longline commercial and recreational fisheries (e.g., troll, handline, kaka line, and shortline); and (3) inadequate regulatory mechanisms for non-longline commercial and recreational fisheries, including inadequate management and reporting requirements. We have identified 16 other threats, including competition with various fisheries, environmental contaminants, short- and long-term effects from climate change, anthropogenic noise, intentional harm, marine debris ingestion, and oil spills, as well as cumulative and synergistic effects, among others (see Table 1–1).

The MHI IFKW is a small and reproductively isolated DPS with a range that surrounds the main Hawaiian Islands (see Figure 1–1 and Figure 1–2). The most recent abundance estimate was 167 animals within the surveyed area in 2015 (Bradford et al. 2018). For reasons unclear, the population has likely declined until at least the early 2000s. Because of changes in survey design and effort, it is unknown whether the abundance of MHI IFKWs has continued to decline, has recently stabilized, or has recently increased (Bradford et al. 2018). Considering the small population size, life history characteristics, and the threats affecting this DPS, the strategy of this recovery plan is to do the following:

1. Increase the population size through management actions that increase survival and decrease mortality due to known threats
2. Address threats from fisheries, including incidental take and competition with fisheries for prey
3. Protect, maintain, and enhance habitat by identifying and minimizing environmental contaminants, biotoxins, anthropogenic noise, and the effects of climate change, and planning for other rare threats such as oil spills
4. Ensure that other regulatory mechanisms such as state and federal laws and a post-delisting monitoring plan are in place to successfully manage threats and ensure that the population remains stable or increases after it is delisted
5. Continue research and monitoring to understand secondary threats and how they interact; based on the results, improve our ability to address multiple threats acting concurrently with feasible and effective management actions

By implementing this strategy through recovery actions and activities, the surviving individuals will be identified, social clusters studied, and the status and trends of this DPS will be monitored and managed.

The overall goal of this recovery plan is to recover the MHI IFKW, allowing ultimately for its removal from the Federal List of Endangered and Threatened Wildlife. The interim goal is to reclassify the MHI IFKW from endangered to threatened status.

We identified the following demographic- and threats-based recovery objectives and criteria for MHI IFKWs (Table 0–1) as they relate to the ESA section 4(a)(1) factors (see Box 1–1). To downlist the MHI IFKW DPS from endangered to threatened, the 3 demographic-based and 17 threats-based reclassification criteria should be satisfied. To delist the MHI IFKW DPS, the 3 demographic-based and 13 threats-based delisting criteria should be satisfied. Barring new information that indicates otherwise, meeting all the recovery criteria would indicate that the MHI IFKW should be delisted due to recovery; however, it is possible that delisting could occur without meeting all of the recovery criteria, if the best available information indicates that the MHI IFKW no longer meets the definition of endangered or threatened. Equally, even if all criteria are met, the MHI IFKW may not be reclassified or delisted if it still meets the definition of threatened or endangered. See Part 3 Section B: Recovery Objectives and Criteria for details on how the criteria were developed.

Table 0–1: Demographic- and Threats-based Recovery Objectives and Criteria Summary

DEMOGRAPHIC- AND THREATS-BASED RECOVERY OBJECTIVES AND CRITERIA SUMMARY		
Objective:	***Reclassification Criteria:***	***Delisting Criteria*:**
Objective 1: Ensure productivity and social connectedness of the MHI IFKW DPS (trend, abundance, and social clusters) have met or exceed target levels.	A. *Productivity:* An increasing average annual population trend is greater than or equal to 2% over one generation (25 years), and there are, at a minimum, 248 individuals; and B. *Abundance:* The consistency and frequency (e.g., occurring at least every 5 to 10 years) of abundance surveys are sufficient to detect changes in population size or trend; and C. *Social connectedness:* There are at least 3 social clusters, and no more than 50% of the population exists within a single social cluster.	A. *Productivity:* The population is, on average, stable or increasing over at least two generations (50 years), and there are, at a minimum, 406 individuals; and B. *Abundance:* The consistency and frequency (e.g., occurring at least every 5 to 10 years) of abundance surveys are sufficient to detect changes in population size or trend; and C. *Social connectedness:* There are at least 3 social clusters, and no more than 50% of the population exists within a single social cluster.
Objective 2: Address threats from fisheries including incidental take and competition with fisheries for prey.	A. The same as delisting criteria (reclassification criteria are optional). B. The same as delisting criteria (reclassification criteria are optional). C. The same as delisting criteria (reclassification criteria are optional). D. The same as delisting criteria (reclassification criteria are optional).	A. *Incidental take in non-longline commercial and recreational fisheries:* There is sufficient evidence that incidental take caused by hooking or entanglement in non-longline commercial and recreational fisheries, as evidenced by known interactions as well as dorsal fin injuries and mouthline injuries, is not impeding the attainment of demographic criteria for MHI IFKWs. B. *Incidental take in commercial longline fisheries:* There is sufficient evidence that incidental take caused by hooking or entanglement in commercial longline fisheries is not impeding the attainment of demographic criteria of MHI IFKWs. C. *Inadequate management and reporting of non-longline commercial and recreational fisheries:* Reporting requirements of non-longline commercial and recreational fisheries are implemented and deemed complete and accurate in order to better assess the rate and type of interactions occurring with MHI IFKWs. D. *Competition with fisheries for prey*: Sufficient prey are available to, at a minimum, not limit the attainment of demographic criteria, and competition with fisheries (commercial and recreational) is not a factor impeding the viability of MHI IFKWs.
Objective 3: Address threats from environmental contaminants & biotoxins.	A. The same as delisting criteria (reclassification criteria are optional). B. The same as delisting criteria (reclassification criteria are optional).	A. *Environmental contaminants:* There is sufficient evidence to indicate that contaminant levels in the marine environment (i.e., POPs, PCBs, DDTs, PBDEs, heavy metals, CECs) are not impeding the viability of MHI IFKWs. B. *Naturally occurring biotoxins*: There is sufficient evidence to indicate that health effects caused by naturally occurring environmental biotoxins (e.g., ciguatoxin, algal toxins) are not impeding the viability of MHI IFKWs or their prey.
Objective 4: Address threats from anthropogenic noise.	A. The same as delisting criteria (reclassification criteria are optional).	A. *Anthropogenic noise:* Management actions sufficiently address the effects of anthropogenic ocean noise (e.g., vessel traffic, sonar, alternative energy development) on MHI IFKWs and their habitat such that it is not adversely affecting and/or reducing their ability to successfully travel, communicate, and forage, and is not causing population-level effects.
Objective 5: Better understand the effects of	A. The same as delisting criteria (reclassification criteria are optional).	A. *Climate change*: There is sufficient evidence to indicate that short- and long-term effects from climate change-related threats (e.g., ocean warming, low productivity zones, and ocean acidification) are not impeding the viability of MHI IFKWs.

DEMOGRAPHIC- AND THREATS-BASED RECOVERY OBJECTIVES AND CRITERIA SUMMARY		
Objective:	***Reclassification Criteria:***	***Delisting Criteria*:**
climate change and manage accordingly.	B. The same as delisting criteria (reclassification criteria are optional).	B. *<u>Disease vectors</u>:* There is sufficient evidence to indicate that effects from climate change are not increasing the widespread presence of disease vectors and thus impeding the viability of MHI IFKWs.
Objective 6: Ensure regulatory mechanisms, including state & federal management and post-delisting monitoring, are in place prior to delisting.	A. No reclassification criteria. B. No reclassification criteria.	A. *<u>State and federal management</u>:* Regulatory mechanisms other than the ESA are in place to successfully manage threats and ensure that the MHI IFKW population remains stable or increases after it is delisted. B. *<u>Post-delisting monitoring</u>*: A post-delisting monitoring plan is in place.
Objective 7: Ensure that secondary threats and synergies among threats are not limiting recovery of the population.	A. *<u>Marine debris ingestion</u>:* There is sufficient evidence that ingestion of marine debris is not causing population-level effects by impeding the viability of MHI IFKWs. B. *<u>Intentional harm</u>:* There is sufficient evidence to indicate that illegal and intentional harming or deterring of MHI IFKWs via shooting, stabbing, explosives, or chemicals to avoid losing catch or bait is not occurring or, if occurring, is not causing population-level effects by impeding the viability of MHI IFKWs. C. *<u>Oil spills</u>:* Oil and hazardous substance spill prevention and response plans are in place and effectively address protections for MHI IFKWs. D. *<u>Predation</u>:* There is sufficient evidence that predation from killer whales, tiger sharks, or other predators is not causing population-level effects by impeding the viability of MHI IFKWs. E. *<u>Interactions with aquaculture facilities and other marine structures</u>:* There is sufficient evidence that interactions with aquaculture facilities and other marine structures (e.g., wave arrays, wind farms, solar farms) are not causing population-level effects by impeding the viability of MHI IFKWs. F. *<u>Vessel strikes</u>:* There is sufficient evidence that vessel strikes are not causing population-level effects by impeding the viability of MHI IFKWs. G. *<u>Whale/dolphin watching and other ecotours</u>:* There is sufficient evidence that commercial and recreational whale/dolphin or other ecotours are not causing population-level effects by impeding the viability of MHI IFKWs. H. *<u>Competition with marine species</u>:* There is sufficient evidence that competition for prey with marlin, sharks, and other top predators is not causing population-level effects by impeding the viability of MHI IFKWs.	A. *<u>Secondary threats</u>:* There is sufficient evidence that each of the secondary threats (Criteria A–H of Objective 7) independently is not causing population-level effects by impeding the viability of MHI IFKWs. B. *<u>Cumulative and synergistic effects</u>:* There is sufficient evidence that cumulative and synergistic effects among all of the threats are well understood and are not causing population-level effects by impeding the viability of MHI IFKWs.

We have organized recovery actions into seven categories: 1) population dynamics; 2) non-longline commercial and recreational fisheries; 3) environmental contaminants and biotoxins; 4) anthropogenic noise; 5) climate change; 6) secondary threats and synergies; and 7) other actions. Recovery actions include research, management, monitoring, and outreach/education components. These efforts will provide a comprehensive approach to addressing MHI IFKW recovery.

We initially project at least a 50-year timeframe to achieve recovery and subsequent delisting of the MHI IFKW. This assumes an increasing average annual population trend that is consistent with what is seen in other similar cetacean species (i.e., greater than or equal to 2% over two generations) and assumes high resource investment into implementation of recovery actions and activities. If resource investment into recovery is low to moderate or if the average annual population trend is not increasing at the predicted rate, then this timeframe may need to be revised. We estimate the earliest possible time scenario of at least 25 years based on the current reclassification criteria.

We estimate the total cost of recovery over a minimum of 50 years to be at least $347,966,000.

Part 1. INTRODUCTION

A. Summary of ESA Listing and Regulatory Actions of the Main Hawaiian Islands Insular False Killer Whale

On November 28, 2012, we, NOAA Fisheries, listed the MHI IFKW as an endangered DPS under the ESA (77 FR 70915). This final rule became effective on December 28, 2012.

In September 2016, we released a recovery outline. The recovery outline has served as an interim guidance document to direct recovery efforts, including recovery planning, for the MHI IFKW until a final recovery plan was developed and approved.

In October 2016, we held a 4-day workshop to gather information and perspectives on how to recover the MHI IFKW DPS. Over 40 experts from a range of relevant disciplines participated in the workshop. Feedback was used to update the threats to MHI IFKWs and develop a workshop summary (NOAA Fisheries 2017). We used the collective information as the foundation upon which to develop our three recovery planning documents: the Recovery Status Review, this Final Recovery Plan, and the Recovery Implementation Strategy.

On July 24, 2018, we designated critical habitat for the MHI IFKW (83 FR 35062). The total area of designation includes 45,504 km^2 (17,569 mi^2) of marine habitat in waters from 45 meters to 3,200 meters in depth surrounding the main Hawaiian Islands (from Niʻihau to Hawaiʻi). The physical and biological features essential to the conservation of MHI IFKWs include the following:

- Adequate space for movement and use within shelf and slope habitat
- Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth
- Waters free of pollutants of a type and amount harmful to MHI IFKWs
- Sound levels that would not significantly impair false killer whales' use or occupancy

In 2019, we revised the Recovery Priority Number of the MHI IFKW to 1C (out of 11). A Recovery Priority Number of 1C indicates that the DPS experiences a high demographic risk; major threats are well understood; the U.S. has jurisdiction and authority for management or protective actions to address major threats; there is high certainty that management or protective actions will be effective; and the DPS is in conflict with economic activity (84 FR 18243; NMFS 2019).

B. Current Status of the Main Hawaiian Islands Insular False Killer Whale

There are three populations or stocks of false killer whales in the Hawaiian Islands: the Northwestern Hawaiian Islands population, the pelagic population, and the main Hawaiian Islands insular population or MHI IFKW (see Figure 1–1 and Figure 1–2).

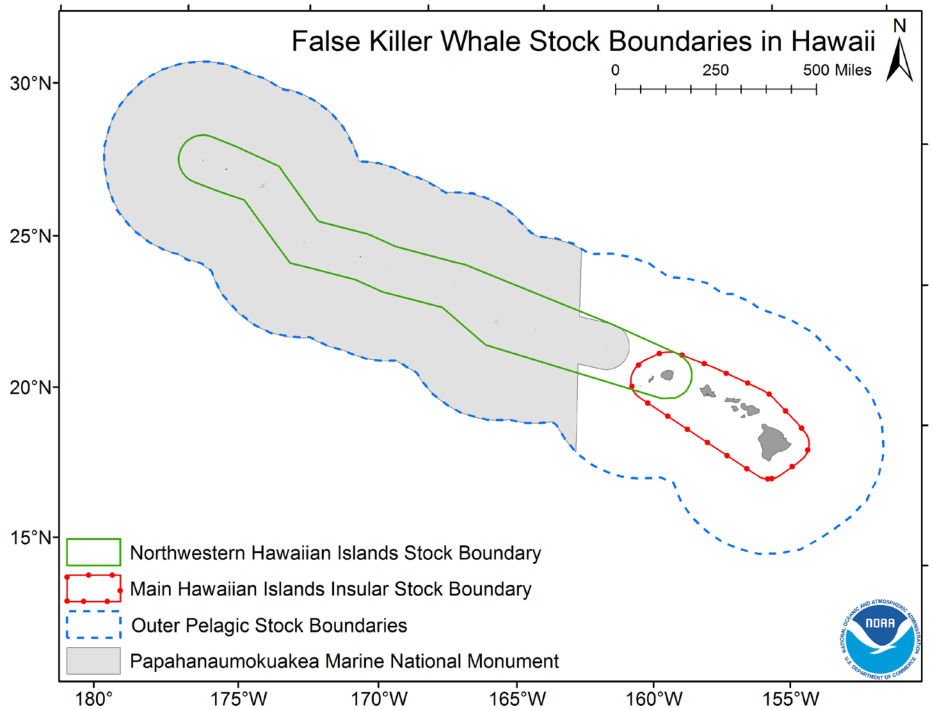

Figure 1–1. False killer whale population boundaries in Hawaiʻi (Source: NOAA Fisheries unpublished 2021 (modified from Bradford et al. (2015, 2020)).

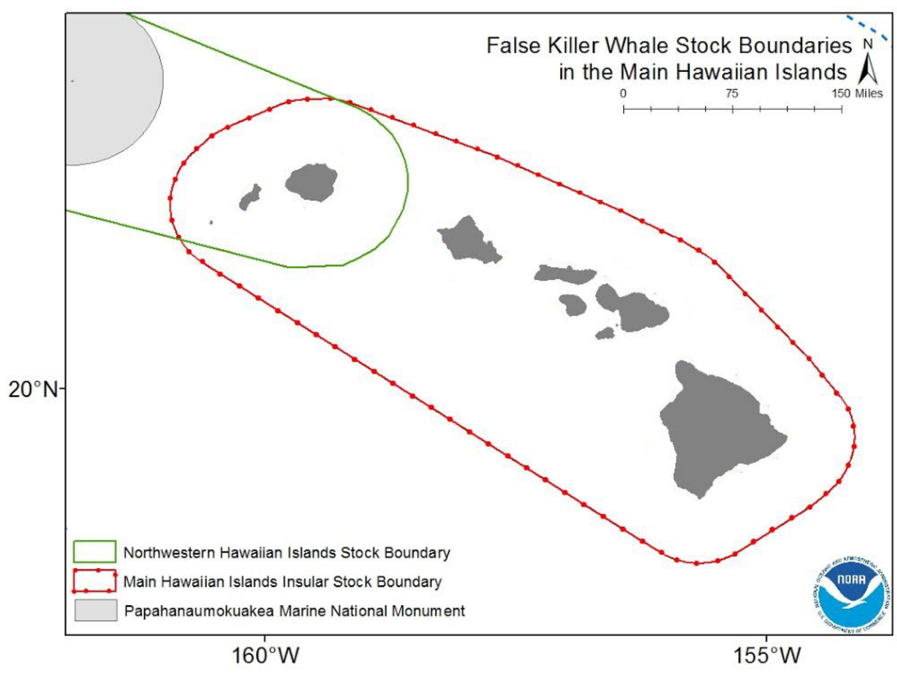

Figure 1–2. Close up view of false killer whale population boundaries in Hawaiʻi, focusing on the MHI IFKW (represented by the red dotted line) (Source: NOAA Fisheries unpublished 2021 (modified from Bradford et al. (2015, 2020)).

The MHI IFKW is a unique, island-associated population with a range that surrounds the main Hawaiian Islands. The most recent abundance estimate was 167 (SE=23; 95% CI=128–218) animals within the surveyed area in 2015 (Bradford et al. 2018) and is based on encounter data from dedicated and opportunistic surveys for MHI IFKWs from 2000 to 2015 to generate annual mark-recapture estimates of abundance over the survey period. Annual estimates over the 16-year survey period ranged from 144 to 187 animals within the surveyed area in that year (Bradford et al. 2018). This estimate is similar to multi-year aggregated estimates previously reported (Oleson et al. 2010). Aerial survey sightings from 1989 to 2003 suggest that the abundance of MHI IFKWs has declined until at least the early 2000s for unclear reasons. Because of changes in survey design and effort, it is unknown whether the abundance of MHI IFKWs has continued to decline, has recently stabilized, or has recently increased (Bradford et al. 2018).

The main threats to the MHI IFKW are small population size; incidental take (hooking or entanglement) in non-longline commercial and recreational fisheries, e.g., troll, handline, kaka line, shortline; and inadequate regulatory mechanisms (management and reporting) for non-longline commercial and recreational fisheries. (Commercial longline fisheries have little overlap (~5.4%), comparatively speaking, with the range of the MHI IFKW due to a longline fishing prohibited area around the main Hawaiian Islands.) Other threats such as reduced prey size and biomass, contaminants, effects from climate change, and noise, among others, may also play a role.

C. List of Threats to the DPS' Viability

In this section, we present an assessment of threats identified as affecting or potentially affecting the status of the MHI IFKW DPS. This table of threats is taken from the Recovery Status Review (NOAA Fisheries 2021a) and is based on the table in the 2010 Status Review Report (Oleson et al. 2010) and the 2012 final listing rule for the MHI IFKW DPS (77 FR 70915) with some modifications. For instance, the final rule to list the MHI IFKW originally described 29 historical, current, and future threats to the DPS, whereas in the updated threats analysis, we repackaged the original 29 threats into 19 threats (a 20th threat, live capture for aquaria, is considered an historical threat). We clarified the way we described and grouped the threats, and re-analyzed the threats from a recovery perspective, i.e., relative to each other (as opposed to high, medium, and low, which reflected how they might affect the status of the DPS for listing). We will update the threats assessment portion of the Recovery Status Review as we learn more about how threats continue to act on the DPS, both individually and synergistically.

Threats to the DPS are described here with a variety of parameters:

- Major effects, e.g., compromised health, reduced foraging success, injury or mortality, etc.
- Extent (the portion of the range over which the threat exists)
- Frequency (occurrence/regularity of the threat over time)
- Severity (magnitude or intensity of the threat)
- Trend (change in extent, frequency, or severity of the threat over time)
- Relative concern (overall perception of how the threat affects recovery relative to the other threats)
- Evidence of the threat acting on the population (confidence in the available information upon which our assessment is based)

Box 1–1, below, defines the various parameters used in Table 1–1: Current and/or Future Threats to MHI IFKWs.

Box 1–1. Definitions of Parameters Used in Table 1–1: Summary of Threats to MHI IFKWs.
Major Effect: Effect(s) of the threat on a specific aspect of life history or behavior of MHI IFKWs **Section 4(a)(1) Factor(s)**: In accordance with section 4(a)(1) of the ESA, a species is listed when it is determined to be endangered or threatened because of any one of the following factors: A. The present or threatened destruction, modification, or curtailment of habitat/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 These factors must also be evaluated when reclassifying or delisting any listed species. **Extent**: The portion of the range of the MHI IFKW over which the threat exists • *Range wide*: The threat occurs throughout all or most of the distribution of the MHI IFK. • *Localized*: The threat exists primarily in a portion of the range or may be present at low levels throughout the range but is greatest or most concentrated in one or more discrete areas **Frequency**: The occurrence/regularity of the threat over time • *Continuous*: The threat is relatively constant throughout the year • *Seasonal*: The threat is greatest during specific seasons but may occur at other times of the year • *Intermittent*: The threat may occur at intervals not associated with specific seasons • *Rare*: Infrequent or hypothetical events **Severity**: The magnitude or intensity of a threat across the range of the listed entity (because abundance is so low that loss of an individual could affect the status of the MHI IFKWs), described as *low*, *medium*, *high*, or *variable* **Trend**: The change in extent, frequency, or severity of a threat over time, described as *increasing*, *decreasing*, *stable*, or *unknown* **Relative Concern**: The overall perception of how a threat affects MHI IFKW recovery relative to the other threats, on an increasing scale of 1 to 5 **Evidence**: Level of available information upon which our assessment is based • *Clear*: There is direct evidence of the threat acting on MHI IFKWs, based either on observations or on other published or unpublished data • *Limited*: There is evidence of the threat occurring within the range of MHI IFKWs, though the extent of its direct or indirect effect on the population and trend is uncertain; alternatively, there is some evidence that the threat is occurring and negatively affecting MHI IFKWs • *Unclear*: There is evidence of a negative effect that may be caused by this threat, but it is indeterminable whether or to what extent this threat is the cause of the effect

To assist us in determining where and when to invest resources in ameliorating the most significant and urgent threats relative to others, we prioritized threats to the MHI IFKW relative to each other using a numeric scale of increasing severity of 1 through 5, as follows:

- 1 = Threat of relatively low concern either now or in the future
- 2 = Threat of relatively low to moderate concern either now or in the future
- 3 = Threat of relatively moderate concern either now or in the future
- 4 = Threat of relatively moderate to high concern either now or in the future
- 5 = Threat of relatively high concern either now or in the future

Table 1–1. Current and/or Future Threats to MHI IFKWs (listed in descending order of relative concern (i.e., the most significant threats are listed first).

Threat (Cause)	Major Effect	ESA Listing Factor(s)	Extent	Frequency	Severity	Trend	Relative Concern	Evidence
Incidental take (hooking or entanglement) in non-longline commercial and recreational fisheries (i.e., troll, handline, kaka line, shortline, etc.)	Injury/mortality	E	Range wide	Unknown	High	Increasing	5	Limited
Inadequate regulatory mechanisms (management and reporting) of non-longline commercial and recreational fisheries	Injury/mortality	D	Range wide	Continuous	High	Stable	5	Clear
Small population size	Limited genetic diversity, inbreeding depression, other Allee effects	E	Range wide	Continuous	High	Unknown *	5	Clear
Competition with non-longline commercial fisheries (i.e., troll, handline, kaka line, and shortline)	Reduced prey size and total prey biomass, reduced foraging success, reduced fitness (reproductive and/or survival)	A	Range wide	Continuous	Unknown / potentially high	Unknown	4	Unclear
Competition with recreational fisheries	Reduced prey size and total prey biomass, reduced foraging success, reduced fitness (reproductive and/or survival)	A	Range wide	Continuous	Unknown / potentially high	Unknown	4	Unclear
Environmental contaminants (e.g., PCBs, DDTs, PBDEs, heavy metals, CECs), and naturally occurring biotoxins (e.g., ciguatoxin, algal toxin)	Reduced prey quality and quantity, compromised health, reduced fitness, disease	A, C	Range wide	Continuous	Medium / high	Unknown	4	Clear

Threat (Cause)	Major Effect	ESA Listing Factor(s)	Extent	Frequency	Severity	Trend	Relative Concern	Evidence
Short and long-term climate change (ocean warming, low productivity zones, ocean acidification, and disease vectors (e.g., pathogens, fungi, worms, parasites))	Compromised health, reduced foraging success, reduced fitness (reproductive and/or survival)	A, C, E	Range wide	Continuous	Low / medium	Increasing	**3**	Limited
Anthropogenic noise (e.g., vessel traffic, sonar (military, oceanographic, fishing), alternative energy development)	Reduced communication, reduced foraging success, injury or mortality	A, E	Localized & range wide	Intermittent / continuous	Medium	Stable or increasing	**3**	Limited
Cumulative and synergistic effects	Chronic stress, reduced fitness (reproductive and/or survival) and resilience	A, C, D, E	Range wide	Continuous	Unknown / potentially high	Unknown	**3**	Unclear
Competition with commercial longline fisheries (i.e., deep-set and shallow-set)	Reduced prey size and total prey biomass, reduced foraging success, reduced fitness (reproductive and/or survival)	A	Range wide	Continuous	Unknown / potentially low	Stable	**2**	Unclear
Marine debris ingestion	Compromised health, reduced foraging success, mortality	E	Range wide	Intermittent	Low	Unknown	**2**	Limited
Intentional harm (e.g., shooting, poisoning, explosives)	Displacement, injury, mortality	E	Localized	Rare / Unknown	High	Unknown	**2**	Unclear
Oil spills	Compromised health, reduced fitness, reduced prey quality, mortality	A, E	Localized	Rare	Variable	Stable	**1**	Limited
Predation (killer whales, tiger sharks, etc.)	Injury or mortality	C	Range wide	Rare / Intermittent	Unknown / potentially high	Stable	**1**	Limited

Threat (Cause)	Major Effect	ESA Listing Factor(s)	Extent	Frequency	Severity	Trend	Relative Concern	Evidence
Incidental take (hooking or entanglement) in commercial longline fisheries (i.e., deep-set and shallow-set)	Behavior modification, injury, mortality	E	Localized	Rare	Low	Stable	**1**	Clear
Interactions with aquaculture facilities and other marine structures (e.g., wave arrays, wind farms, solar farms)	Behavior modification, injury, mortality	E	Localized	Rare	Low	Stable (potential future increase)	**1**	Limited
Vessel strikes	Injury or mortality	E	Range wide	Rare	Low	Stable / increasing	**1**	Limited
Whale/dolphin watching and other ecotours	Behavior modification, displacement, habitat degradation, injury, mortality	E	Localized	Intermittent	Low	Stable	**1**	Limited
Competition with marine species (marlin, sharks, etc.)	Reduced prey size and total prey biomass, reduced foraging success, reduced fitness (reproductive and/or survival)	E	Range wide	Continuous	Low	Unknown	**1**	Unclear
Live capture for aquaria (historic threat)	Reduced population size	B	N/A	N/A	N/A	N/A	0	Clear

**Thus far we do not have reliable trend information for the DPS so we cannot determine if the population is increasing (leading to a decreasing trend for this threat), decreasing (leading to an increasing trend for this threat), or stable.*

Part 2. RECOVERY STRATEGY

A. Key Facts and Assumption

As described in the Recovery Status Review, the MHI IFKW population is small and reproductively isolated. The most recent abundance estimate, from 2015, was 167 (SE=23; 95% CI=128–218) animals within the surveyed area, with annual estimates over a 16-year survey period from 2000 to 2015 ranging from 144 to 187 animals for the portion of the range surveyed in each year (Bradford et al. 2018). This estimate is similar to multi-year aggregated estimates previously reported (Oleson et al. 2010). The revised estimated effective population size is approximately 57.6 adults (95% CI=47.2–71.8) (Martien et al. 2019). The best available information indicates a decline in abundance over the few decades until the early 2000s (Oleson et al. 2010). The cause of decline was not evaluated. It is difficult to determine more recent trends in abundance of MHI IFKWs because of inter-annual variability in survey effort, so it is unknown whether the population abundance has continued to decline, has recently stabilized, or has recently increased (Bradford et al. 2018). Regardless of recent trend, the MHI IFKWs' small population size is a major cause for concern due to limited genetic diversity, inbreeding depression, other "Allee" effects (decline in individual fitness at low population size or density), and increased susceptibility of threats acting synergistically on the population.

Of the 19 current and future threats to the MHI IFKW, those we identified as having a high or moderate-to-high relative concern are (as they appear in Table 1–1) as follows: incidental take (hooking or entanglement) in non-longline commercial and recreational fisheries, inadequate regulatory mechanisms (management) of non-longline commercial and recreational fisheries (e.g., lack of reporting requirements and resultant management measures), small population size, competition with various fisheries, and environmental contaminants and biotoxins. There are numerous threats that are of lesser concern but may work synergistically to cause negative effects to MHI IFKWs.

Linkages between the ESA section 4(a)(1) causative factors (i.e., threats) and the observed abundance are poorly understood for the MHI IFKW. We assume that the decline in the abundance of MHI IFKWs likely resulted from several threats acting together or synergistically (Oleson et al. 2010, NOAA Fisheries 2021a).

B. Primary Foci of the Recovery Effort

Given the above key facts and assumption, the following are the primary foci for recovery of the MHI IFKW:

1. Increase the population size through management actions that increase survival and decrease mortality due to known threats
2. Address threats from fisheries, including incidental take and competition with fisheries for prey
3. Protect, maintain, and enhance habitat by identifying and minimizing environmental contaminants, biotoxins, anthropogenic noise, and the effects of climate change, and planning for other rare threats such as oil spills

4. Ensure that other regulatory mechanisms such as state and federal laws and a post-delisting monitoring plan are in place to successfully manage threats and ensure that the population remains stable or increases after it is delisted
5. Continue research and monitoring to understand secondary threats to the DPS and how they interact; based on the results, improve our ability to address multiple threats acting concurrently with feasible and effective management actions

We recognize that recovery will require a sustained effort over time that is adapted as new information becomes available, threats are mitigated, new threats arise, and the status of the MHI IFKW population changes. As such, we structured this plan to address known or potential threats necessary to curb population decline and/or stabilize/increase the population first (since the current trend is unknown), and to adapt future work to ensure continued population growth and recovery.

Part 3. RECOVERY GOALS, OBJECTIVES, AND CRITERIA

The following goals, objectives, and criteria set standards for determining when recovery progress has been made under the ESA to the point at which the species can be downlisted to threatened and, ultimately, to the point at which the species has recovered and can be delisted because listing is no longer warranted. These standards refer to the definitions of endangered and threatened under section 3 of the ESA: "endangered" means that 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*.

It is important to note that the criteria in recovery plans are subject to change based on new information and insights, and that the statutory process for making reclassification and delisting determinations is the five-factor analysis under ESA section 4(a)(1). However, the biological (demographic-based) criteria help inform when these factors are no longer significant (i.e., they are no longer impeding recovery).

A. Recovery Goals

The ultimate goal of this recovery program is to achieve the recovery of the MHI IFKW DPS to a level sufficient to warrant its removal from the List of Endangered and Threatened Wildlife under the ESA (i.e., to delist). The intermediate goal is to reclassify the MHI IFKW DPS from endangered to threatened (i.e., downlist).

B. Recovery Objectives and Criteria

The Recovery Goal is subdivided into discrete component objectives that, collectively, describe the conditions necessary to achieve recovery. We identified seven Recovery Objectives for the MHI IFKW that address demographic concerns and threats abatement. They are outlined below along with their associated Recovery Criteria.

Section 4(f)(1) of the ESA requires recovery plans to incorporate "objective, measurable criteria which, when met, would result in a determination…that the species be removed from the list" (16 U.S.C. § 1533(f)). This recovery plan contains both demographic-based criteria (associated with Objective 1) and threats-based criteria (associated with Objectives 2–7) for downlisting and delisting (summarized in Table 3–1). To downlist the MHI IFKW DPS from endangered to threatened, the 3 demographic-based and 17 threats-based reclassification criteria should be satisfied. To delist the MHI IFKW DPS, all 3 demographic-based and 13 threats-based delisting criteria should be satisfied. Barring new information that indicates otherwise, meeting all the recovery criteria would indicate that the MHI IFKW should be delisted due to recovery; however, it is possible that delisting could occur without meeting all of the recovery criteria, if the best available information indicates that the MHI IFKW no longer meets the definition of endangered or threatened. Equally, even if all criteria are met, the MHI IFKW may not be reclassified or delisted if it still meets the definition of threatened or endangered. In the latter, we would revise the recovery criteria and seek public comment. Either way, the criteria will guide when the MHI IFKW is ready to be delisted or reclassified, but we will conduct a status review to make the determination. Additionally, as we achieve progress in addressing threats, and as we gain a better understanding of how addressing these threats contributes to achieving the biological (demographic) criteria, we can better describe the extent to which these threats must be addressed to support a recovered MHI IFKW population.

Finally, we begin many of the reclassification and delisting criteria with the statement that "There is sufficient evidence to indicate…is not causing population-level effects by impeding the viability of MHI IFKWs." Although the "sufficient evidence" phrasing is somewhat innately subjective, it does require the Agency to use our best scientific judgement to make a conclusion—on whether each criterion has been met—once we have evaluated the objectively measured evidence to support the statement. For example, the threat of marine debris not causing population-level effects by impeding viability is measured by examination of stomach contents during necropsies to determine whether ingestion of marine debris led to the cause of death(s). Three of the six stranded MHI IFKWs to date had some form of marine debris in their stomach contents, though it was not established as the cause of death for these animals (NOAA Fisheries 2021a). However, if ingestion of marine debris is in fact the cause of death for more than a very small number of individuals (e.g., two MHI IFWKs at the current estimated population size of 167), then the viability of the population is likely being impeded. Therefore, using our best scientific judgement, the Agency would likely determine there is sufficient evidence to conclude that this criterion has not been met (in this hypothetical example). Another example is the threat of predation from marine predators not causing population-level effects by impeding viability measured by evidence that the number of predators in an area is not artificially increased due to human activities (e.g., an increase in the number and frequency of tiger shark sightings at offshore aquaculture facilities). There is no specific number per se to indicate what constitutes "an increase in the number and frequency of tiger shark sightings." However, an increase of a notable amount (e.g., from regular sightings of 2 tiger sharks to 10 sharks regularly sighted at an aquaculture facility), coupled with the spatial and temporal overlap of tiger sharks and MHI IFKWs in the area, and/or evidence of predation from tiger sharks on MHI IFKWs, would, arguably, lead the Agency to use our best scientific judgement to likely determine there is sufficient evidence to conclude this criterion has not been met (in this particular hypothetical example).

Demographic-based Objective and Criteria

Objective 1. Ensure productivity and social connectedness of the MHI IFKW (trend, abundance, and social clusters) have met or exceeded target levels.

Reclassification Criteria:

A. **Productivity:** An increasing average annual population trend is greater than or equal to 2% over one generation (25 years), and there are, at a minimum, 248 individuals.

Justification: Given an estimated population size of 151 individuals (at the time of the status review in 2010 (Oleson et al. 2010) and when the MHI IFKW was listed in November 2012), and an estimated average annual growth of 2% (similar to what has been used for other cetacean populations that are small and have a low intrinsic growth rate (e.g., Southern Resident killer whale, Cook Inlet beluga whale)) over the next 25 years from 2010, the population should have about 248 animals in 2035. (The population should be closer to 274 animals if using the 2015 estimated abundance in the surveyed area of 167 individuals (Bradford et al. 2018) over a 25-year period ending in 2040; see Table 7–1**.**) We recognize there is variability around survey point estimates, and a single population point estimate may over- or under-estimate the true population size. Survey variance should be taken into consideration as the population size approaches 248 individuals to help ensure that consideration of downlisting is not based on anomalous conditions and accounts for the population trend over a full generation. The longer a population sustains a positive growth rate, the more confident we can be that the population is likely to continue to grow and become stable in the future and is therefore more resilient to stochastic events.

We selected a 25-year timeframe for population growth because it is biologically based (approximately one generation) and reasonably expected to encompass environmental variability affecting the population. Because a current population trend does not yet exist, our recovery criterion is based on a population size that increases at an acceptable average annual growth rate. Similar to killer whales, false killer whales have a low intrinsic growth rate (a consequence of late maturity and low birth rate). With plausible growth rates of less than 4% a year (Oleson et al. 2010), we chose an average annual growth rate of at least 2% over one full generation, or 25 years, which is a known acceptable rate of increase for a cetacean. This average annual growth rate must be met before the MHI IFKW can be considered for downlisting. This increase will guard against a steep decline or increased mortality and provide some indication that MHI IFKWs are resilient to stochastic events.

Finally, for long-term sustainability, a recovering population must show adequate population size and positive population growth over a timeframe long enough to encompass expected environmental variability. Historical population size of the MHI IFKW is unknown, so it is difficult to develop an absolute abundance number that can serve as a baseline. The Status Review Report estimated a plausible historical abundance with known caveats of 769 individuals (Oleson et al. 2010). Since the range of the MHI IFKW has been revised (Bradford et al. 2015) and is smaller than previously thought, using methods from Oleson et al. (2010) results in a revised plausible historical abundance estimate of 655 individuals. However, it is unknown if this revised plausible historical abundance estimate of 655 individuals is the best estimate of the carrying capacity of the MHI IFKW.

B. **Abundance:** The consistency and frequency (e.g., occurring at least every 5 to 10 years) of abundance surveys are sufficient to detect changes in population size or trend.

Justification: Inter-annual variability in survey effort can make it difficult to determine population size and trend, so the more frequent the surveys, the better we are able to assess the population trend to monitor whether the population has declined, has stabilized, or has increased. Ideally, abundance surveys should occur every few years but, at a minimum, at least every 5 to 10 years.

C. **Social connectedness:** There are at least 3 social clusters, and no more than 50% of the population exists within a single social cluster.

Justification: Social clusters are long-term associations of related individuals and are likely fairly stable over periods of years to decades, similar to killer whale "pods" (which are collections of individuals that spend >50% of their time together). Social groups seen in the field may include part of a cluster, all of a cluster, or individuals from multiple clusters. While more information is needed on cluster population structure (e.g., the number of social groups/clusters within the MHI IFKW DPS, which is currently identified at 5 (Mahaffy et al. 2017, Baird et al. 2019)), having a minimum of 3 clusters and no more than 50% of the MHI IFKW population within a single social cluster is meant to ensure maximum genetic diversity and resiliency in a DPS with a small population size and limited gene flow. However, note that in addition to considering the percent of the population within a social cluster, the number of juvenile and reproductive females should also be considered. This will help ensure that sex ratios are not biased towards males, which can lead to negative trajectories in population growth. (See section 2.3.2 Population Dynamics in the Recovery Status Review (NOAA Fisheries 2021a) about how research from Martien et al. (2019) indicates that 36–64% of mating involved individuals from the same social group or cluster.)

Delisting Criteria:

A. Productivity: The population is, on average, stable or increasing over at least two generations (50 years), and there are, at a minimum, 406 individuals.

Justification: This criterion adds an additional generation—for a total of two generations totaling at least 50 years—to an annual population trend averaging greater than or equal to 2%, while allowing for some variability. This is similar to what has been used for other cetacean populations that are small and have a low intrinsic growth rate (e.g., Southern Resident killer whale, Cook Inlet beluga whale). We selected two generations for population growth (i.e., one generation to meet the reclassification criterion and an additional generation to meet the delisting criterion) because it is a biologically-based time period that is expected to reasonably encompass environmental variability affecting the population over a longer time span. That is, population growth should take into account periods of good survival and periods of poor survival, and should get the species closer towards the revised plausible historical abundance of 655 individuals (NOAA Fisheries 2021a). Therefore, if beginning in 2010 (when the population was first estimated at 151 individuals (Oleson et al. 2010) and when the MHI IFKW was listed in November 2012), with 151 animals and an estimated average annual growth of 2% over the next 50 years (two generations), the population should have about 406 animals in 2060. (The population should be closer to 449 animals if using the 2015 estimated abundance in the surveyed area of 167 individuals (Bradford et al. 2018) over a 50-year period ending in 2065; see Table 7–1.) We recognize there is variability around survey point estimates, and a single population point estimate may over- or under-estimate the true population size. Survey variance should be taken into consideration as the population size approaches 406 individuals to help ensure that consideration of delisting is not based on anomalous conditions and accounts for the population trend over two full generations. The longer a population sustains a positive growth rate, the more confident we can be that the population is likely to continue to grow and become stable in the future and is therefore more resilient to stochastic events.

In the event the population reaches at least 406 individuals before two full generations (50 years), there must be evidence that the population has been stable or increasing for at least one full generation (25 years).

B. **Abundance:** The consistency and frequency (e.g., occurring at least every 5 to 10 years) of abundance surveys are sufficient to detect changes in population size or trend.

Justification: Inter-annual variability in survey effort can make it difficult to determine population size and trend, so the more frequent the surveys, the better we are able to assess the population trend to monitor whether the population has declined, has stabilized, or has increased. Ideally, abundance surveys should occur every few years but, at a minimum, at least every 5 to 10 years.

C. **Social connectedness:** There are at least 3 social clusters, and no more than 50% of the population exists within a single social cluster.

Justification: Social clusters are long-term associations of related individuals and are likely fairly stable over periods of years to decades, similar to killer whale "pods" (which are collections of individuals that spend >50% of their time together). Social groups seen in the field may include part of a cluster, all of a cluster, or individuals from multiple clusters. While more information is needed on cluster population structure (e.g., the number of social groups/clusters within the MHI IFKW DPS, which is currently identified at 5 (Mahaffy et al. 2017, Baird et al. 2019)), having a minimum of 3 clusters and no more than 50% of the MHI IFKW population within a single social cluster is meant to ensure maximum genetic diversity and resiliency in a DPS with a small population size and limited gene flow. However, note that in addition to considering the percent of the population within a social cluster, the number of juvenile and reproductive females should also be considered. This will help ensure that sex ratios are not biased towards males, which can lead to negative trajectories in population growth. (See section 2.3.2 Population Dynamics in the Recovery Status Review (NOAA Fisheries 2021a) about how research from Martien et al. (2019) indicates that 36–64% of mating involved individuals from the same social group or cluster.)

Threats-based Objectives and Criteria

Objective 2. Address threats from fisheries including incidental take and competition for prey.

Reclassification and Delisting Criteria (the same; reclassification criteria are optional):

A. **Incidental take in non-longline commercial and recreational fisheries (Factor E):** There is sufficient evidence that incidental take caused by hooking or entanglement in non-longline commercial and recreational fisheries, as evidenced by known interactions as well as dorsal fin injuries and mouthline injuries, is not impeding the attainment of demographic criteria for MHI IFKWs. This can be measured by data showing that the rate of new interactions/injuries is decreasing for both the population as well as for females since we know that adult females have more fishery-related injuries.

B. **Incidental take in commercial longline fisheries (Factor E):** There is sufficient evidence that incidental take caused by hooking or entanglement in commercial longline fisheries is not impeding the attainment of demographic criteria for MHI IFKWs. This can be measured by ensuring that incidental take in commercial longline fisheries continues to be regulated by the False Killer Whale Take Reduction Plan (FKWTRP) until such a time as when the Secretary of Commerce determines that the objectives of the FKWTRP have been met. Additionally, there is sufficient evidence that observed incidental take of MHI IFKWs in the commercial longline fisheries has remained low following implementation of the FKWTRP and is at or below the current 5-year estimate of mortality and serious injury of 0.03 (Carretta et al. 2020).

C. **Inadequate management and reporting of non-longline commercial and recreational fisheries (Factor D):** Reporting requirements of non-longline commercial and recreational fisheries are implemented and deemed complete and accurate in order to better assess the rate and type of interactions occurring with MHI IFKWs. The adequacy of the reporting can be measured by comparing data analyses from the reports with new photo evidence of dorsal fin and mouthline injuries to determine if the reported rate of new interactions/injuries comports with the visible rate.

D. **Competition with fisheries for prey (Factor A):** Sufficient prey are available to, at a minimum, not limit the attainment of demographic criteria, and competition with fisheries (commercial and recreational) is not a factor impeding the viability of MHI IFKWs. This can be measured in quantity (biomass), quality (size), and accessibility (availability) of prey species and/or body condition of the MHI IFKWs.

Justification: Addressing threats from fisheries, one of the most significant factors affecting MHI IFKWs, will likely improve another significant factor: its small population size. Addressing threats from fisheries includes mitigating incidental and unintentional hookings and entanglements—something that is injurious, if not deadly, to MHI IFKWs, and proportionally biased toward females. This reflects either the higher energy needs of females during lactation and/or the importance of prey sharing among females (Baird et al. 2014). With respect to effective population size (approximately 58 adults (Martien et al. 2019)), the loss of a reproductive female would have a much greater effect on the population than the loss of a male. Mitigating incidental hookings and entanglements will also benefit fishermen given that damaged, destroyed, or lost gear is costly in both time and money. Additionally, improving the management and reporting of all non-longline fisheries will aid in collecting several types of pertinent information required to accurately characterize both the fisheries (effort detail, catch, precise location, etc.) and the prevalence and severity of interactions with protected species, including the MHI IFKW. This will ultimately better inform fishery management actions to reduce interactions and benefit not only the species but also fishermen.

As for competition with fisheries for prey, catch reports should indicate that preferred prey stocks are healthy in both abundance and size, and photogrammetry—or aerial measurements of the length and girth—as well as tissue samples of MHI IFKWs indicate that individuals are adequately nourished and not experiencing starvation or other associated negative health effects. This determination of whether sufficient prey is available should take into consideration false killer whales' energetic requirements, accounting for variances due to age, sex, and reproductive status, and the specific prey available to MHI IFKWs. Reported estimates of daily consumption rates range from 2.9% to 14.2% of false killer whale body weight depending on size and sex (e.g., Sergeant 1969, Van Dyke and Ridgway 1977, Kastelein et al. 2000, Baird 2009). Additionally, approximately 2.6 to 3.5 million pounds of fish are consumed annually (based on the 2010 population estimate of 151 MHI IFKWs, depending on the whale population age structure used (see Oleson et al. 2010 for calculation method) (Brad Hanson, NOAA Fisheries Northwest Fisheries Science Center, pers. comm. 2017)). The annual quantity of fish consumed by MHI IFKWs is similar to the current annual retained catch in the commercial troll fishery (~4 million lbs) and is approximately 3 to 4 times greater than the annual catch in the commercial handline fishery (1 to 1.5 million lbs).

Objective 3: Address threats from environmental contaminants and biotoxins.

Reclassification and Delisting Criteria (the same; reclassification criteria are optional):

A. **Environmental contaminants (Factors A and C):** There is sufficient evidence to indicate that contaminant levels in the marine environment (i.e., POPs, PCBs, DDTs, PBDEs, heavy metals, and CECs) are not impeding the viability of MHI IFKWs. This can be measured in MHI IFKW tissues, prey species, proxy marine mammal species in the Hawaiian Archipelago, as well as in water samples. It can also be measured by determining if cause of death from a stranding is due to elevated environmental contaminants.

B. **Naturally occurring biotoxins (Factor C)**: There is sufficient evidence to indicate that health effects caused by naturally occurring environmental biotoxins (e.g., ciguatoxin, algal toxins) are not impeding the viability of MHI IFKWs or their prey. This can be measured by monitoring for detection of biotoxins in water samples, as well as monitoring for changes in health of prey species, and in changes to MHI IFKW reproduction and survival that are directly linked to biotoxins. It can also be measured by determining if cause of death from a stranding is due to biotoxins.

Justification*:* Addressing threats from environmental contaminants and biotoxins is important because of the deleterious biomagnification of these factors as they move up the food web to false killer whales, which are at the top of the food web. Contaminants and biotoxins can remain in their system during their long life, ultimately causing both individual health effects as well as population-level effects.

Objective 4: Address threats from anthropogenic noise.

Reclassification and Delisting Criteria (the same; reclassification criteria are optional):

A. **Anthropogenic noise (Factors A and E):** Management actions sufficiently address the effects of anthropogenic ocean noise (e.g., vessel traffic, sonar, alternative energy development) on MHI IFKWs and their habitat such that it is not affecting and/or reducing their ability to successfully travel, communicate, and forage, and is not causing population-level effects. Effects from this threat are more difficult to measure than others but may include noticeable change in or avoidance of habitat use; temporary behavioral change documented by observers during events such as construction activities, alternative energy development, or active military sonar use; and/or measured by determining if cause of death from a stranding is due to anthropogenic noise that caused temporary or permanent hearing loss, etc.

Justification*:* Certain anthropogenic sounds such as vessel noise, sonar, underwater construction, and alternative energy development can interfere with false killer whales' acoustic sensory systems. Effects can include permanent or temporary hearing loss; masked reception of navigation, foraging, or communication signals; and disrupted reproductive, foraging, or social behavior. Addressing this threat will minimize or prevent both individual and population-level effects.

Objective 5: Better understand the effects of climate change and manage accordingly.

Reclassification and Delisting Criteria (the same; reclassification criteria are optional):

A. **Climate change (Factors A, C, and E):** There is sufficient evidence to indicate that short- and long-term effects from climate change-related threats, such as ocean warming, low productivity zones, and ocean acidification, are not impeding the viability of MHI IFKWs. This can be measured in quantity (biomass), quality (size), and accessibility (availability) of prey species and/or body condition of the MHI IFKWs. That is, catch reports indicate that preferred prey stocks are healthy in both abundance and size, and photogrammetry—or aerial measurements of the length and girth—as well as tissue samples of MHI IFKWs indicate that individuals are adequately nourished and not experiencing starvation or other associated negative health effects.

B. **Disease vectors (Factor C):** There is sufficient evidence to indicate that effects from climate change are not increasing the widespread presence of disease vectors and thus impeding the viability of MHI IFKWs. This can be measured by the prevalence or severity of infectious diseases caused by pathogens (e.g., Morbillivirus, Brucella), fungi, worms, or parasites (e.g., *Toxoplasma gondii*). That is, results from biopsies, breath analyses, and/or necropsies do not indicate that there is an over burdensome load of infectious disease(s) leading to reduced health and fitness or mortality in individuals.

Justification*:* Effects from climate change are numerous and include redistribution of prey species, changes in species richness and carrying capacity, the increased presence of disease vectors, the expansion of pathogen ranges, and changes to host susceptibility to name a few. As such, effects are more likely to cause population-level effects rather than individual-level effects. Thus, better understanding the effects from climate change will help us improve how we manage the root cause as well as our response.

Objective 6: Ensure that regulatory mechanisms, including state and federal management and post-delisting monitoring, are in place prior to delisting.

Delisting Criteria (no reclassification criteria):

A. **State and federal management:** Regulatory mechanisms other than the ESA are in place to successfully manage threats and ensure that the MHI IFKW population remains stable or increases after it is delisted.

B. **Post-delisting monitoring:** A post-delisting monitoring plan is in place.

Justification*:* Potential regulatory mechanisms could include trigger-dependent emergency management action(s) that are in place to provide an immediate stopgap or temporary prevention of further population decline. Note that strandings are extremely infrequent, representing less than 5% of the animals that die (West et al. in review), and thus there is a high probability of missing a deceased MHI IFKW. Additionally, and where feasible, the emergency management action(s) should be the direct result of a causal link between the decline of the population and the specific threat to be managed. This could include time-area closures if there is an increased number of serious injuries/mortalities from fishery interactions, or closure to certain activities if there is an increase in individual strandings or a mass stranding. Additional regulatory mechanisms could include fisheries catch limits if stocks and/or MHI IFKW body condition indicate there is overfishing of preferred prey items as evidenced by emaciated or unhealthy individuals, implementing thorough reporting, observing of non-longline commercial and recreational fisheries, maintaining the longline exclusion zone around the main Hawaiian Islands, etc.

As for a post-delisting monitoring plan, this will not only guide monitoring activities after the MHI IFKW DPS is recovered and delisted but will also ensure that necessary monitoring is in place so that recovery progress does not backslide. The plan will also identify triggers that would warrant an emergency re-listing, if necessary.

Objective 7: Ensure secondary threats and synergies among threats are not limiting recovery of the population.

Reclassification Criteria:

A. **Marine debris ingestion (Factor E):** There is sufficient evidence that ingestion of marine debris is not causing population-level effects by impeding the viability of MHI IFKWs. This can be measured by examination of cause of death during necropsy. That is, while marine debris may be found in stomach contents, there is not an increase of strandings and known deaths attributable to ingestion of marine debris leading to population-level effects of MHI IFKWs.

B. **Intentional harm (Factor E):** There is sufficient evidence to indicate that illegal and intentional harming or deterring of MHI IFKWs via shooting, stabbing, explosives, or chemicals to avoid losing catch or bait is not occurring or, if occurring, is not causing population-level effects by impeding the viability of MHI IFKWs. This can be measured via photo analysis and resighting data as well as during necropsies. That is, photo-IDed animals with a noticeably intentional anthropogenic wound (e.g., bullet, spear, or knife) are monitored during resightings to ensure the wound is healing, and animals are examined for intentional injuries during necropsies. Additionally, while anecdotal, this can be regularly queried via anonymous surveys and talk stories.

C. **Oil spills (Factors A and E):** Oil and hazardous substance spill prevention and response plans are in place and effectively address protections for MHI IFKWs.

D. **Predation (Factor C):** There is sufficient evidence that predation from killer whales, tiger sharks, or other marine predators is not causing population-level effects by impeding the viability of MHI IFKWs. This can be measured by evidence that the number of predators in an area is not artificially increased due to human activities (e.g., an increase in the number and frequency of tiger shark sightings at offshore aquaculture facilities) and there is not an increase in bite wounds to MHI IFKWs or mortality due to predation.

E. **Interactions with aquaculture facilities and other marine structures (Factor E):** There is sufficient evidence that interactions with aquaculture facilities and other marine structures (e.g., wave arrays, wind farms, solar farms) are not causing population-level effects by impeding the viability of MHI IFKWs. This can be measured in a marked increase of sighting rate and duration and altered behavior of MHI IFKWs near structures. If MHI IFKWs are being negatively affected by these marine structures, regulations or other measures have been implemented to reduce interactions.

F. **Vessel strikes (Factor E):** There is sufficient evidence that vessel strikes are not causing population-level effects by impeding the viability of MHI IFKWs. This can be measured by evidence of either no propeller wounds or propeller wounds healing as documented by long-term photo-ID (i.e., resightings over years). If MHI IFKWs are being negatively affected by vessel strikes, regulations and/or protected areas have been implemented.

G. **Whale/dolphin watching and other ecotours (Factor E):** There is sufficient evidence that commercial and recreational whale/dolphin or other ecotours are not causing population-level effects by impeding the viability of MHI IFKWs. If MHI IFKWs are negatively affected by ecotours (e.g., by illegally swimming with, chasing, or harassing false killer whales), this can be measured by evidence of a marked change to habitat use as documented by satellite tags and resightings, and changes in the number of observed approaches that result in harassment. If necessary, enforcement actions have been implemented.

H. **Competition with marine species (Factor E):** There is sufficient evidence that competition for prey with marlins, sharks, and other top predators is not causing population-level effects by impeding the viability of MHI IFKWs. This can be measured in quantity (biomass), quality (size), and accessibility (availability) of both prey and top predators as well as body condition of the MHI IFKWs. That is, catch reports indicate that preferred prey stocks are healthy in both abundance and size, and photogrammetry—or aerial measurements of the length and girth—as well as tissue samples of MHI IFKWs indicate that individuals are adequately nourished and not experiencing starvation or other associated negative health effects.

Delisting Criteria:

A. **Secondary threats (Factors A, C, and E)*:*** There is sufficient evidence that each of the secondary threats (Criteria A–H of Objective 7) independently are not causing population-level effects by impeding the viability of MHI IFKWs.

B. **Cumulative and synergistic effects (Factors A, C, D, and E):** There is sufficient evidence that cumulative and synergistic effects among all of the threats are well understood and are not causing population-level effects by impeding the viability of MHI IFKWs.

Justification*:* Threats of any magnitude could potentially work synergistically and therefore with increased severity or frequency and act both directly and indirectly on MHI IFKWs. This could result in negative effects on individuals and the population. Having a better understanding of many of these threats is needed to fully understand the potential for cumulative and synergistic effects among them as well as how best to mitigate them.

Table 3–1. A summary of the criteria for considering reclassification (from endangered to threatened) or delisting (from threatened to not listed) for MHI IFKWs. Note: even if not all criteria are met, a species may be reclassified or delisted if it is determined that it no longer meets the definition of threatened or endangered. Equally, even if all criteria are met, a species may not be reclassified or delisted if it still meets the definition of threatened or endangered. In the latter, we would revise the recovery criteria and seek public comment.

Status	Demographic-based Criteria		Threats-based Criteria
Reclassified from Endangered to Threatened (i.e., downlisted)	*Productivity:* An increasing average annual population trend is ≥ 2% over one generation (25 years), and there are, at a minimum, 248 individuals; and *Abundance:* The consistency and frequency (e.g., occurring at least every 5 to 10 years) of abundance surveys are sufficient to detect changes in population size or trend; and *Social connectedness:* There are at least 3 social clusters, and no more than 50% of the population exists within a single social cluster.	**AND**	The 17 reclassification threats-based criteria are satisfied.
Reclassified to Recovered (i.e., delisted)	*Productivity:* The population is stable or increasing over at least two generations (50 years), and there are, at a minimum, 406 individuals; and *Abundance:* The consistency and frequency (e.g., occurring at least every 5 to 10 years) of abundance surveys are sufficient to detect changes in population size or trend; and *Social connectedness:* There are at least 3 social clusters, and no more than 50% of the population exists within a single social cluster.	**AND**	The 13 delisting threats-based criteria are satisfied.

Part 4. RECOVERY ACTIONS

This section provides an outline of, and narrative for, research, management, monitoring, and outreach actions targeted at achieving recovery criteria for the MHI IFKW. We have organized these recovery actions into seven main categories: 1) population dynamics; 2) non-longline commercial and recreational fisheries; 3) environmental contaminants and biotoxins; 4) anthropogenic noise; 5) climate change; 6) secondary threats and synergies; and 7) other actions. These actions will assist us in understanding and reducing threats, and restoring the MHI IFKW to long-term viability.

It is unlikely that recovery could be achieved if actions and activities are only undertaken by us (NOAA Fisheries); indeed, we do not have the authority to undertake many actions, such as management of state and recreational fisheries. As comprehensive implementation of the Recovery Plan and Recovery Implementation Strategy is needed in order to achieve recovery, we must rely on others to realize recovery. This includes other federal and state agencies, academia, non-profit organizations, and members of the community to aid in securing the necessary resources and orchestrating collaborations.

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. The recovery action narratives are intended to provide guidance to resource managers, recreational and non-commercial fishermen, researchers, charter and ecotour industries, 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 Part 5, Recovery Action Implementation. Note that the order of recovery actions does not imply the order of importance.

As previously mentioned, we have designed this Recovery Plan to provide the foundation for how to conserve and recover the MHI IFKW population. It is meant to provide an overall road map for achieving the recovery goal, objectives, criteria, and strategic, site-specific recovery actions and includes time and cost estimates for these recovery actions. Accompanying the Recovery Plan is the Recovery Implementation Strategy. This document is a more dynamic document that steps-down the recovery actions into specific activities that support the recovery actions. The Recovery Implementation Strategy will 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 MHI IFKW DPS is reviewed during its five-year review. 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 and again seek public comment.

A. Recovery Action Outline

The recovery actions listed below will occur throughout the range of the MHI IFKW (see Figure 1–2 and Figure 1–3.

1. POPULATION DYNAMICS

1.1 Design and implement a robust survey effort and/or advanced analytical methods to determine and monitor the abundance, trends, movements, and population structure of the MHI IFKW DPS.
1.2 Continue and expand MHI IFKW annual photo-ID efforts and maintain the photo-ID database.
1.3 Deploy and analyze satellite tags on MHI IFKWs from all social clusters, particularly on windward side of islands.
1.4 Deploy and analyze acoustic instrumentation statewide, particularly in hard to survey areas.
1.5 Develop trigger-dependent emergency management action(s) to implement if demographic information indicates that the MHI IFKW is in decline (while still listed).
1.6 Develop a post-delisting monitoring plan for MHI IFKWs.

2. NON-LONGLINE COMMERCIAL AND RECREATIONAL FISHERIES

2.1 Analyze and manage non-longline commercial and recreational fishery interactions.
2.2 Better understand prey resources and foraging needs of MHI IFKWs, and analyze and manage competition with fisheries.

3. ENVIRONMENTAL CONTAMINANTS AND BIOTOXINS

3.1 Research and monitor environmental contaminants and biotoxins in MHI IFKWs.
3.2 Undertake management measures to reduce environmental contaminants around the main Hawaiian Islands.

4. ANTHROPOGENIC NOISE

4.1 Better characterize and understand the soundscape of the main Hawaiian Islands.
4.2 Study both the physiological and physical effects of noise on MHI IFKWs.
4.3 Undertake management measures to reduce effects from anthropogenic noise, as necessary.

5. CLIMATE CHANGE

5.1 Conduct a climate vulnerability assessment of prey species.
5.2 Downscale Pacific-wide climate models to look at productivity and ecological effects in Hawaiʻi.
5.3 Screen for pathogens, parasites, diseases, and biotoxins and monitor for changes over time.
5.4 Reduce greenhouse gas emissions both locally and globally.

6. SECONDARY THREATS AND SYNERGIES

6.1 Develop a conceptual model of ecosystem relationships and how threats to MHI IFKWs are interconnected with these ecosystem relationships.
6.2 Continue to monitor false killer whales for ingestion of marine debris.
6.3 Update the "Pinniped and Cetacean Oil Spill Response Guidelines" and monitor false killer whales that have encountered spills for long-term health effects.
6.4 Continue to respond to false killer whales that are stranded, sick, or injured.
6.5 Monitor for predation events from killer whales, tiger sharks, etc.
6.6 Continue to monitor and manage the Hawaiʻi-based commercial deep-set and shallow-set longline fisheries to ensure they are not contributing to MHI IFKW decline.
6.7 Monitor development of aquaculture projects and other marine structures that have the potential to change the behavior of false killer whales, and manage as necessary.
6.8 Monitor for vessel strikes of false killer whales, and manage as necessary.
6.9 Develop ways to mitigate negative effects from whale/dolphin ecotourism operations or other boat approaches to MHI IFKWs through community-based management.
6.10 Research the role of sharks, marlins, and other top predators as competitors for prey species, and monitor for negative effects.

7. OTHER ACTIONS

7.1 Maintain an outreach website about MHI IFKWs.
7.2 Engage the public about false killer whale conservation through media and other means.
7.3 Better engage with fishermen to reduce frequency and severity of false killer whale interactions.
7.4 Incorporate false killer whales into naturalist programs.
7.5 Incorporate false killer whales into school programs.

B. Recovery Action Narrative

The recovery actions listed below will occur throughout the range of the MHI IFKW (see Figure 1–2 and Figure 1–3.

1. POPULATION DYNAMICS

Obtaining more information on the status, demography, and life history of MHI IFKWs, such as abundance, population trends, survival rates, calving rates, injury trends, social dynamics, movement, and habitat use, will help us better understand MHI IFKWs and their recovery needs. This foundation of knowledge can drive research, management, and monitoring to determine if and to what extent recovery actions are successful. The actions listed below are specific ways we will collect additional demographic information as well as ensure that regulatory mechanisms are in place prior to delisting. They are designed to address Recovery Objectives 1 and 6.

1.1 Design and implement a robust survey effort and/or advanced analytical methods to determine and monitor the abundance, trends, movements, and population structure of the MHI IFKW DPS.

Recent abundance data, while available, cannot be analyzed for trends due to sampling biases of unknown magnitude. To determine and monitor population trends as well as monitor abundance, movements, and population structure, we strongly suggest using a research framework similar to SPLASH (Structure of Populations, Levels of Abundance, and Status of Humpback Whales). This entails an intensive collection of demographic information via an archipelago-wide simultaneous survey that is conducted multiple times over a short period (e.g., three times over a 1–1.5-year period). This, ideally, should be repeated every five years. Surveys should include photo identification (photo-ID) and biopsy sampling for sex determination, contaminant load, genetics, fatty acid composition, and epigenetic aging (to examine age structure of the population and of social clusters, as well as assessing reproductive potential of social clusters (e.g., what proportion of the individuals may be post-reproductive)). Photo-ID data should be analyzed using mark-recapture methods. This would be done in addition to ongoing photo-ID and biopsy efforts under actions 1.2 and 1.3 below (although it may supplant them in years when it is being conducted). These efforts should also incorporate new unmanned aerial system (UAS) technology (e.g., hexacopter drones), especially as technology continues to advance, to survey large areas in less time than boat-based surveys and help fill in demographic and health data gaps (e.g., number of individuals in the group, presence of calves, robustness of individuals). With robust data from this effort, we may have a higher capacity to detect trends within the population and within social clusters. The resulting trend analysis and demographic information will influence and prioritize future research.

1.2 Continue and expand MHI IFKW annual photo-ID efforts and maintain the photo-ID database.

Individual MHI IFKWs are identified via distinct markings on their dorsal fins and bodies, and the long-term photo-ID catalog that exists is used to assess abundance, social organization, survival, and life history. Photographic records of these scars, nicks, notches, or color patterns can be used to identify individuals during surveys and encounters, and should be maintained as a long-term resource. Photographs of false killer whales encountered during sighting surveys are archived and associated with other sighting data, e.g., sighting location, group size and structure, and behavior. Continually collecting photo-IDs will enable us to track individuals and their movements over time and among locations; obtain demographic data, such as gender, minimum age and size, and whether they are a mother-calf pair (determined via repeat associations); and track injury rates from fisheries via injuries to individuals' dorsal fin and/or mouthline. We can also use photo-IDs to determine if (i.e., survivability) and how well injuries are healing (e.g., from fishing gear interactions, marine debris entanglements, and cookie cutter shark bites), as well as gain insight into habitat use and movements, and determine whether there are additional/peripheral social groups.

1.3 Deploy and analyze satellite tags on MHI IFKWs from all social clusters, particularly on windward side of islands.

Satellite tagging of individuals from all social clusters will help to inform movement patterns (both horizontally and vertically, the latter via dive data) throughout the main Hawaiian Islands, and hone our understanding of high-use areas and the range of the MHI IFKW. Future efforts should focus on filling existing data gaps, including information on Clusters 2 and 4, winter and spring habitat use, and habitat use on the windward sides of islands.

1.4 Deploy and analyze acoustic instrumentation statewide, particularly in hard to survey areas.

Passive acoustic instrumentation (e.g., ecological acoustic recorders (EARs), digital acoustic monitors (DMONs), and high-frequency acoustic recording packages (HARPs)) can be placed in waters statewide to provide information for multiple purposes. Deployment of instruments could occur via attachment to statewide fishing aggregating devices (FADs) where a fair amount of trolling or jigging occurs. Deployment of passive acoustic instrumentation could occur during dedicated efforts to deploy/retrieve/service devices, during opportunistic fieldwork, and during research cruises (e.g., during main Hawaiian Islands reef assessment and monitoring program (RAMP) cruises), etc. Deployment would also be useful in hard to survey areas, such as the windward side of each island and in known "hot spot" areas. It may also be possible to place instruments on hook-and-line fishing gear (as long as they do not interfere with fishing success). Analyzing acoustic instrumentation data from windward sides of each of the main islands, from hot spot areas, from FADs, and from existing/archived data stored with the Navy, ONMS (e.g., SanctSound recordings), and others will help us better understand where false killer whales spend their time and how long they are in an area. Over time, acoustic recorders in conjunction with satellite tags will help to further reveal whether false killer whales use certain areas regularly, seasonally, or during particular oceanographic conditions (e.g., El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and La Niña).

It may also be possible to install detection and signaling systems on FADs or buoys that could inform fishermen if satellite-tagged false killer whales were within reasonable range of those buoys. Implementing a system where buoys light up or generate some signal when a satellite-tagged false killer whale is nearby would be useful for both fishermen and managers by informing the former of the potential for interactions and the latter in terms of spatial dynamics of MHI IFKWs. However, we recognize the effectiveness of this strategy is highly dependent upon the number of satellite tags deployed at any given time, which is limited in itself for a number of reasons.

1.5 Develop trigger-dependent emergency management action(s) to implement if demographic information indicates that the MHI IFKW is in decline (while still listed).

In the event that a potential emergency management measure is needed, developing a trigger-dependent emergency management action(s) could provide an immediate stopgap or a temporary way of preventing further decline of the population. For an emergency management action(s) to be warranted there should be a high likelihood that a decline in the population is a result of the specific threat to be managed. For example, the need for this high-priority emergency management action(s) to prevent extinction could be triggered due to an increased number of serious injuries/mortalities from fishery interactions, or an increased number of individual strandings, or a mass stranding, etc. Examples of a causal link emergency management measure to prevent further decline could include closing hot spot area(s) to fishing if there is an increase in the number of serious injuries/mortalities from fishery interactions, or implementing time-area closures if a stranding or mass stranding is deemed to be caused by military training exercises, etc. Once the population indicates it has stabilized and/or rebounded and is no longer at risk of extinction, re-opening measures could include the beginning of a new calendar year, or when specified demographic data indicate it is safe to resume normal activities.

1.6 Develop a post-delisting monitoring plan for MHI IFKWs.

NOAA Fisheries must develop a post-delisting monitoring plan to guide monitoring activities after the MHI IFKW DPS is recovered and delisted. The objective is to ensure that necessary monitoring is in place so that the gains made to recover the MHI IFKW do not backslide. The plan should also identify triggers that would warrant an emergency re-listing, if necessary. This will be completed sometime after the species is downlisted to threatened.

2. NON-LONGLINE COMMERCIAL AND RECREATIONAL FISHERIES

Threats related to interactions (i.e., hooking and entanglement) and competition for prey with non-longline commercial and recreational fisheries are both rated as the highest relative concern for the MHI IFKW. The actions listed below are specific to researching and mitigating these threats and correspond with Recovery Objective 2.

2.1 Analyze and manage non-longline commercial and recreational fishery interactions.

Foundational information is lacking on non-longline gear types and interactions (i.e., hooking and entanglement); yet, this is critical to informing future management and determining if management actions are working. Conducting fishing gear research, tests, and potential modifications to deter/avoid/prevent depredation of catch and bait as well as minimize occurrence and severity of interactions will help us understand the gear types responsible for, and mechanisms of, injuries to MHI IFKWs. Using this information, coupled with verifying assumptions and anecdotal information regarding non-longline fisheries, we can determine if/how gear or fishing practices (e.g., time/area closures, reduced effort) can be modified to prevent interactions with false killer whales. This action also includes conducting targeted research on human dimensions of fishing–false killer whale interactions (i.e., depredation of catch and bait, hooking, entanglements, boat following, etc.). This can provide insight into understanding how, when, where, and why interactions between fisheries and cetaceans tend to occur, as well as assess the attitudes, perspectives, and values of those fishermen to obtain a better understanding of what cooperative bycatch mitigation efforts would be most effective. These studies can provide audience research and baseline data to inform design of management interventions to affect awareness, knowledge, skills, or behavior. For example, understanding the values of fishermen could inform what kind of benefits or rewards (e.g., anonymity or actual reward) could be implemented to encourage reporting bycatch or interactions.

Activities for this action should also continue to evaluate the spatial distribution of state non-longline commercial and recreational fishing effort by fishery, model habitat hot spots, and work with the State of Hawaiʻi to identify initiatives and projects that will enhance the conservation and management of MHI IFKWs. This includes establishing a State of Hawaiʻi recreational fishing license and reporting form and modifying the state Commercial Marine License reporting forms to include additional information or improve the quality of existing data collection to help us glean how, why, when, and where depredation events of catch/bait and interactions with false killer whales are occurring.

2.2 Better understand prey resources and foraging needs of MHI IFKWs, and analyze and manage competition with fisheries.

Better understanding prey resources and foraging needs of MHI IFKWs, including variation in diet among demographic classes (e.g., social cluster, sex, age) and over time—inferring a change in prey selection—as well as the extent of competition with non-longline commercial and recreational fisheries, will help us determine if nutritional needs of MHI IFKWs are being met. Sub activities should include identifying the most important prey species, including the extent of the importance of squid and other prey such as mahi mahi; analyzing and modeling prey abundance dynamics (i.e., seasonal/spatial variation of prey distribution) and managing, where appropriate; and investigating foraging behavior and locations. This includes better understanding the locations of hot spots and travel corridors and their importance so we can manage these areas, if needed.

In concert with this research is a targeted analysis of non-longline commercial and recreational catch data to help clarify how much competition is occurring for prey species with non-longline fisheries as these fisheries operate almost entirely within the MHI IFKWs' core nearshore habitat (less than 40 km from shore). Examine what, where, when, and the quantity of fish these fisheries take to determine if local depletion of prey species is occurring.

3. ENVIRONMENTAL CONTAMINANTS AND BIOTOXINS

Environmental contaminants and biotoxins were rated as a threat of medium–high relative concern for the MHI IFKW. The actions below are specific to researching and mitigating this threat and correspond with Recovery Objective 3.

3.1 Research and monitor environmental contaminants and biotoxins in MHI IFKWs.

Due to their high trophic status (i.e., role as top predator), false killer whales are often exposed to high levels of environmental contaminants (e.g., POPs, PBDEs, PCBs, DDTs, heavy metals, and CECs) and biotoxins (e.g., algal toxin, ciguatoxin) that biomagnify, or exponentially increase by an order of magnitude, up through the food web. Because false killer whales are long-lived, they are exposed to contaminants over their long-life span, including during vulnerable life history stages such as during pregnancy and nursing. Changes to population dynamics caused by contaminants and biotoxins, such as compromised immunosuppression or disease, will be slow to appear due to slow maturation rates. As such, recovery from compromised health will also be slow. In addition to identifying the type and load of contaminants in the MHI IFKW population, comparing this information to other factors of a general health assessment to see how these may be related (i.e., if and to what extent they are acting synergistically) can inform development of management actions. For example, pathogen load can be examined through unmanned aerial survey (UAS) sampling of the respiratory microbiome, body condition can be examined through UAS photogrammetry, reproductive history (presence of neonates and calves) can be determined from UAS, and history and outcome of fishery interactions (based on mouthline and dorsal fin scarring assessment) can be examined through photo-ID. This may help us better understand how, for example, a high contaminant load can lead to disease which can lead to nutritional stress or reproductive issues, or how disease coupled with a serious injury from a fishery interaction can affect individuals, etc.

3.2 Undertake management measures to reduce environmental contaminants and biotoxins around the main Hawaiian Islands.

Based on results from research actions above, measures to reduce or eliminate environmental contaminants should be undertaken, where possible. These may include collaborating with agencies, non-profit organizations, and the community, where possible, to undertake watershed management, secondary treatment of wastewater or sewage for certain areas, reducing or eliminating use of certain chemicals and pesticides, etc.

4. ANTHROPOGENIC NOISE

Anthropogenic noise was rated as a threat of medium relative concern for the MHI IFKW. The actions below are specific to researching and mitigating these threats and correspond with Recovery Objective 4.

4.1 Better characterize and understand the soundscape of the main Hawaiian Islands.

Understanding the underwater soundscape of the main Hawaiian Islands will fill critical knowledge gaps and build understanding of noise effects over ecologically relevant scales. Tools such as acoustic buoys, EARs, HARPs, DMONs, etc., can examine both ambient and anthropogenic sources of sound. Characterizing the soundscape should be repeated over several years and seasons to determine baseline levels and variability (if any).

4.2 Study both the physiological and physical effects of noise on MHI IFKWs.

Studying the effects of noise includes researching whether noise elevates stress hormone (cortisol) levels, if there is temporary or permanent hearing loss, how communication is affected, whether individuals are physically displaced or high-use areas are abandoned, etc. This research should be conducted in accordance with NOAA's Ocean Noise Strategy, and findings from these studies should inform management measures developed under Recovery Action 4.3 below.

4.3 Undertake management measures to reduce effects from anthropogenic noise, as necessary.

Based on results from research actions above, measures to reduce or manage noise should be undertaken, as necessary. Such actions may include various mitigation or minimization techniques, such as ramping up noise slowly, stopping noise if false killer whales are spotted, avoiding certain high-use areas, closures of certain areas for some or all sources of noise established as a stressor, etc.

5. CLIMATE CHANGE

Short- and long-term effects from climate change were rated as a medium relative concern for the MHI IFKW. Threats may include expansion of low productivity zones (i.e., "dead zones") and changes in prey distribution due to ocean warming, effects on the lower food web due to ocean acidification, and changes in composition of microbial communities. The actions below are specific to researching and mitigating these threats and correspond with Recovery Objective 5.

5.1 Conduct a climate vulnerability assessment of prey species.

Changing ocean conditions may cause preferred prey items to undergo range shifts. As a result, MHI IFKWs may need to alter their diet since MHI IFKWs are unlikely to significantly alter their home range (i.e., based around the nearshore areas of the main Hawaiian Islands). A vulnerability assessment for fish—or an assessment of the likelihood and scenarios under which fish (prey) may shift and where they may go—will help researchers and managers anticipate future trophic shifts in primary prey items. For example, tuna, billfish, squid, etc., may move into cooler areas in either depth or latitude. This vulnerability assessment should also consider effects of ocean acidification (i.e., how an increase in ocean acidification (pH) levels could alter the productivity and composition of the main Hawaiian Islands) and temperature changes to smaller pelagic fish (prey of prey).

5.2 Downscale Pacific-wide climate models to look at productivity and ecological effects in Hawaiʻi.

Hawaiʻi's unique oceanographic and ecological features have resulted in diverse and abundant marine species. While researchers continue to build a general understanding about physical climate influences to the base/top of the food web and on a broad Pacific basin-wide scale, little is known about the middle of the food web or climate effects specific to Hawaiʻi. A question to consider includes to what extent basin-wide species, such as tuna and billfish, will be influenced by potential changes in island productivity, etc. The island mass effect (i.e., the enhanced production that occurs around oceanic islands in comparison to the surrounding waters) and climate change models have not yet resolved questions of this nature. In fact, a better understanding of species' physiological responses to climate change and continuing to investigate food web responses to climate change were both identified as priorities in the 2nd Annual Collaborative Climate Science Workshop (Woodworth-Jefcoats et al. 2019). Having a better understanding of how resident and transient marine species will respond to effects from climate change can help managers respond to changing conditions (e.g., implementing size/catch/seasonal limits on fish stocks) in a timelier fashion.

5.3 Screen for pathogens, parasites, diseases, and biotoxins and monitor for changes over time.

Effects from climate change may include the increased prevalence of pathogens, parasites, diseases, and biotoxins, or the creation of an environment that could support new microbes not previously found in the region and thereby exposing MHI IFKWs to novel pathogens, parasites, diseases, and biotoxins. Therefore, infectious diseases caused by pathogens (which include viruses (e.g., Morbillivirus), bacteria (e.g., Brucella), and protozoa (e.g., *Toxoplasma gondii*)), fungi, and worms, may be more of a significant concern as climate change continues. Parasites (e.g., nematodes, trematodes, acanthocephalans, amphipods, and crustaceans) can also cause infections that have been implicated as contributing to false killer whale strandings outside of Hawaiʻi, as well as in Hawaiian marine mammals (e.g., Hawaiian monk seals). Since MHI IFKWs live in close-knit social groups, they have a greater potential for transmission of these organisms and therefore should be screened for these. Previously, health assessment work and analysis could only be done on deceased animals. However, feasibility/proof-of-concept work has successfully collected two breath samples of MHI IFKWs in 2018 using a UAS (Lerma et al. 2019). Continued use of drones to collect breath samples can examine the respiratory microbiome. Biopsy and fecal analyses can also be used in conjunction with breath sampling to conduct a general health assessment. To provide a more holistic health assessment, body condition, age, sex, reproductive history, contaminant load, fatty acid composition, and evidence of prior fishery interactions should also be assessed. If tests are positive for any pathogens, parasites, disease, etc., individuals should be closely monitored for any potential spread in the disease, etc.

5.4 Reduce greenhouse gas emissions both locally and globally.

Although we do not know the precise means by which climate change will affect MHI IFKWs, it will undoubtedly have an effect, either directly or indirectly (and may already be doing so). Addressing climate change cannot be done through local actions alone; addressing climate change will require concerted action on the part of the global community. Therefore, we encourage federal and state agencies, non-governmental organizations, communities, and international partners to reduce the local, national, and global dependency on oil, gas, and coal as well as reduce emissions of carbon dioxide. A clean energy alternative to oil, gas, and coal is to promote the increased production/harnessing of solar, wind, geothermal, biofuels, and hydropower energy.

6. SECONDARY THREATS AND SYNERGIES

Secondary threats, and cumulative and/or synergistic effects among threats, were rated lower than primary threats to the MHI IFKW. However, this does not mean they are not important to address in order to recover the species. The actions below are specific to researching, mitigating, and monitoring these threats and correspond with Recovery Objective 7.

6.1 Develop a conceptual model of ecosystem relationships and how threats to MHI IFKWs are interconnected with these ecosystem relationships.

A conceptual if–then ecosystem model should be designed to identify possible linkages among different social, physical, chemical, and biological aspects of the marine ecosystem. A better understanding of the ecosystem and the interconnected relationship of threats should help to predict synergistic effects acting on MHI IFKWs, and thereby adjust our response to managing these secondary threats. For example, prey size or biomass may be reduced because of a combination of factors acting synergistically including competition with fisheries, competition with natural competitors, and effects from climate change. As a result, the potential associated weight loss of a MHI IFKW could influence how stored contaminants in the blubber and tissue affect the health of the animal. Where possible, this model should include management measures and monitoring of outcomes. For example, a possible response to the above scenario could include catch/size limits to rebuild healthy local fish stocks, coupled with the use of drones/UASs to monitor for emaciated individuals, and biopsies, etc., to measure cortisol and contaminant levels over time.

6.2 Continue to monitor false killer whales for ingestion of marine debris.

Various marine debris items such as plastic water bottles, caps, bags, and fishing hooks and line have been documented in the stomachs of necropsied MHI IFKWs. Continuing to monitor for the prevalence of marine debris in stranded false killer whales during necropsies, and reporting the outcomes back to NOAA Fisheries in a timely manner, will help determine if marine debris is limiting the recovery of MHI IFKWs.

6.3 Update the "Pinniped and Cetacean Oil Spill Response Guidelines" and monitor false killer whales that have encountered spills for long-term health effects.

False killer whales are not specifically mentioned in NOAA Fisheries' "Pinniped and Cetacean Oil Spill Response Guidelines." Although they do not typically travel into Hawaiian bays and harbors where an oil and/or hazardous substance spill is likely to occur, the terminal site at Barbers Point, Oʻahu, where oil is offloaded is within an important travel corridor for MHI IFKWs. However, while MHI IFKWs are treated similarly to other cetaceans where the concern is more about the inhalation of toxic chemical vapors, it should be specifically noted that the MHI IFKW is an endangered DPS. Additionally, because its habitat entirely surrounds the main Hawaiian Islands and there are numerous important hot spot areas and travel corridors, extra precautions and priority should be considered for this species. Updating the 2015 response guidelines with lessons learned from past spill responses as well as with considerations of protecting the endangered MHI IFKW will ensure that the most up-to-date response protocols and procedures are used if or when a hazardous spill occurs. Additionally, it is important to identify (photo-ID) which whales (and thus which social cluster) are exposed to a spill since that will be critical for assessing the survival (or other changes, e.g., reduced reproductive rates) of any individuals that are exposed. Satellite tags should also be deployed, where possible, on exposed individuals.

6.4 Continue to respond to false killer whales that are stranded, sick, or injured.

False killer whale strandings in the main Hawaiian Islands are quite rare and thus far have only involved a single animal per occurrence (six total) since 2010—though this is not the case elsewhere since the species is known to mass strand. Strandings of false killer whales in Hawaiʻi generate intense scientific interest and continued responses to strandings will primarily provide an opportunity to medically attend to an individual(s). Medical assistance may result in caring for an individual until it may be safely returned to the wild. This high-priority action not only provides medical assistance to address the immediate health of the individual animal, but helps to ensure overall long-term well-being of the population since every individual matters, especially when the population size is already low. This response could also ensure that we are able to capitalize on rare opportunities to obtain information on false killer whales—in general and on MHI IFKWs specifically—especially when the information could aid in conserving the species and/or preventing its extinction. Vital information includes seasonal and spatial distribution, natural history, population health, environmental contaminant levels, incidence of human interaction, incidence of disease, causes of mortality, and threats to the population. Sub activities for this action also include encouraging the public to report live or dead strandings promptly; conducting extensive necropsies and cause of death investigations to help determine whether the cause of death is natural (e.g., disease, old age, predation, naturally occurring biotoxins) or anthropogenic (e.g., ingestion/injury from fishing gear or marine debris, heavy contaminant load, ship/vessel collision); and updating stranding protocols in the regional marine mammal response plan, including developing a mass stranding response plan specific to MHI IFKWs.

6.5 Monitor for predation events from killer whales, tiger sharks, etc.

Although no predation events have been recorded on Hawaiian false killer whales from killer whales or tiger sharks, there are individuals in the population with evidence of survival after attacks by large sharks, and predation by killer whales has been documented elsewhere. Monitoring for such events could include photos or videos of predation events, and documenting long-term health effects such as whether the individual is able to heal from the wound, etc.

6.6 Continue to monitor and manage the Hawaiʻi-based commercial deep-set and shallow-set longline fisheries to ensure they are not contributing to MHI IFKW decline.

In accordance with the MMPA, Hawaiʻi commercial longline fisheries are currently managed under a Take Reduction Plan. The measures in the FKWTRP are described in 77 FR 71260 (November 29, 2012) and at our False Killer Whale Take Reduction website. This plan calls for gear requirements in the deep-set longline fishery, longline closure areas, training and certification for vessel owners and captains in marine mammal handling and release, captains' supervision of marine mammal handling and release, and posting of placards (species ID, handling techniques) on longline vessels. Commercial longline fishing is not currently considered a significant threat to MHI IFKWs because commercial longline fishing areas only overlap with approximately 5.4% of the MHI IFKWs' range (due to the Longline Fishing Exclusion Zone, which prohibits longline fishing year-round in a portion of the waters surrounding the main Hawaiian Islands). However, the FKWTRP is subject to change and, prior to downlisting or delisting the species, steps should be made to ensure longline fishing is not a threat to MHI IFKWs. Sub activities for this action include assessing whether implementation of the FKWTRP or subsequent measures (e.g., Southern Exclusion Zone closure) resulted in an increase in shortline or other fishing effort inside the range of the MHI IFKW population, and increasing the use of video electronic monitoring to assist in accurately assessing bycatch and interactions with protected species.

6.7 Monitor development of aquaculture projects and other marine structures that have the potential to change the behavior of false killer whales, and manage as necessary.

Aquaculture pens that contain tuna and other pelagic species of fish may attract or in other ways change the behavior of MHI IFKWs. Because MHI IFKWs have a diverse diet, including eating a variety of reef-associated fish (e.g., bonefish, giant trevally, amberjack, threadfin jack), even fish other than pelagic species have the potential to attract MHI IFKWs. These structures may also attract MHI IFKWs if located in either a high-use area (e.g., off Kohala on the northern tip of Hawaiʻi Island) or in a travel corridor (e.g., west and south shore of Oʻahu) and thus have potential to have high enough visitation rates as to potentially result in interactions. Development of other marine structures, such as alternative energy arrays (e.g., wave, wind, and solar), may also affect MHI IFKW behavior. If evidence indicates that false killer whale behavior is changing (e.g., increased presence or duration of time in area, avoidance of areas because of anthropogenic noise), engage with federal permitting/authorizing/funding agencies and project developers to address any changes needed through the ESA section 7 process. The

ESA section 7 consultation process is a process in which federal agencies or actions with a federal nexus are required to consult on the effects of their project on ESA-listed species or their designated critical habitat. Include specific reporting requirements from the project developers.

6.8 Monitor for vessel strikes of false killer whales and manage as necessary.

Available observations of propeller wounds/scars thus far indicate that vessel strikes with false killer whales are a rare event in Hawaiʻi. However, MHI IFKWs are known to spend time under boats trying to get fish that are seeking shelter from predators, thus exposing them to the possibility of propeller strikes. Review photo databases to determine the proportion of individuals struck by propellers and monitor the trend of interactions and ability of individuals to heal over time. Any analysis to assess the frequency of propeller injuries should take into account the proportion of the population that has sufficient quality photos to assess such injuries, and recognize that wounds in false killer whales typically heal to the same color as the original skin, and thus may only be visible for a period of months, rather than years. If the proportion of individuals struck by propellers increases by more than 5%, conduct outreach about vessel interactions to tour operators, charter vessels, residents, etc. This could include incentivizing recreational boaters (and others, if applicable) to install propeller guards on their boats. This could be done proactively/immediately and not after a 5% increase in propeller–related injuries, given that not all individuals are documented each year and photos that are obtained often are not of sufficient quality to identify propeller injuries, even if they are occurring frequently. Lastly, consider management actions to address vessel strikes, if necessary.

6.9 Develop ways to mitigate negative effects from whale/dolphin ecotourism operations or other boat approaches to MHI IFKWs through community-based management.

Whale and dolphin tour operators in Hawaiʻi are primarily focused on sighting humpback whales (*Megaptera novaeangliae*) and spinner dolphins (*Stenella longirostris*) since both of these species are much more abundant and occur further inshore than false killer whales. When false killer whales are seen by tourist operations they receive a lot of attention off all the islands. Because of the infrequency of sightings, it will be difficult to detect negative effects, if they were occurring; thus, there is value in conducting outreach to tour operators, residents, and tourists to determine appropriate guidelines to minimize or mitigate interactions. Management actions should be considered, if necessary.

6.10 Research the role of sharks, marlins, and other top predators as competitors for prey species, and monitor for negative effects.

Better knowledge of prey preferences and predator-prey dynamics is needed to fully understand the potential effects to MHI IFKWs from natural competition. Monitor for potential negative effects from competition with other top predators if species diversity and abundance shift due to effects of climate change or for any other reason (e.g., changes in temperature regimes could cause a change in the movement of other large predators, which could affect competition with MHI IFKWs).

7. OTHER ACTIONS

The actions below are specific to outreach programs. While these actions do not specifically address a particular threat, they support all recovery objectives.

Because people are more likely to protect and support protection of what they know, more effective outreach and messaging about false killer whales will assist in the conservation and recovery of the species. Unlike other charismatic marine species in Hawaiʻi, the public often is not familiar with false killer whales because they are rarer, do not regularly come into bays or nearshore areas, and because they can easily be confused with other "blackfish" cetaceans.

7.1 Maintain an outreach website about MHI IFKWs.

In 2018, NOAA Fisheries created a new agency-wide website, including a webpage about false killer whales. The NOAA Fisheries false killer whale species profile web site provides an overview of the species as well as population highlights, conservation and management activities, scientific publications, and other resources. We will continue to strive to provide up-to-date maps of high-density areas, real-time satellite tag maps, and the latest research on false killer whales, and either receive false killer whale sighting photos/videos or direct users to this repository, falsekillerwhales.org. Updates to this web site should be undertaken regularly.

7.2 Engage the public about false killer whale conservation through media or other means.

The general public in Hawaiʻi is relatively aware of the unique environment that Hawaiʻi provides to species, both terrestrial and marine. Many charismatic species such as humpback whales, sea turtles, and Hawaiian monk seals are prominently featured in the media. The false killer whale, however, is much less known to the general public. Therefore, in order to conserve and recover MHI IFKWs, the public should be made more aware of their endangered status and this can be done through engaging the media. For example, engage the media (print, online, and social) during newsworthy events, such as a research trip to collect demographic information on cetaceans, or a false killer whale stranding event. Such events can provide false killer whale outreach opportunities, during which the public and stakeholders can learn that false killer whales are an important local resource, why they are endangered, what NOAA Fisheries and partners are doing to try to conserve and recover the species, and how the public can help.

7.3 Better engage with fishermen to reduce frequency and severity of false killer whale interactions.

As discussed in other actions, work with fishermen to ensure that the frequency and severity of hookings or entanglements with false killer whales are reduced or eliminated. This high-priority action will help to ensure that we adequately address one of the most significant threats to the MHI IFKW—incidental take in fisheries. These efforts could include encouraging/incentivizing fishermen to report anonymously any incidental takes of false killer whales. Additionally, work with fishermen to develop and test strategic outreach messaging, tools, and programs. These collaborative partnerships may foster innovative opportunities that benefit both fishermen and false killer whales.

7.4 Incorporate false killer whales into naturalist programs.

Some of the most receptive audiences to learning about the conservation of marine species are people participating in marine wildlife viewing activities. Dozens of ecotourism companies exist throughout the main Hawaiian Islands and many employ naturalists to provide interpretive talks to the guests about the marine environment and species. Information about false killer whales can be incorporated into interpretive talks. Topics to discuss include not only their endangered status and threats to the species but also social and cultural components that people can easily relate to such as social clusters and networks between clusters, prey sharing, spreading out when traveling but coming together when food is found, etc. Naturalist training programs or certifications should ensure that messaging is consistent and accurate.

7.5 Incorporate false killer whales into school programs.

Several NOAA Fisheries outreach programs in Hawaiʻi target teachers and students, providing information and curricula about science and the marine environment. These programs should be expanded to reach additional classrooms and school systems throughout all the main Hawaiian Islands, and incorporate false killer whales into the discussion and material.

Part 5. RECOVERY ACTION IMPLEMENTATION

The Implementation Schedule that follows (Table 5–1) outlines recovery actions and estimated time and costs for the recovery program for the MHI IFKW, as set forth in this Recovery Plan. This schedule indicates the action number, action description, action priority (Box 5–1), the ESA section 4(a)(1) listing factor it is addressing, recovery objective, estimated costs for the first five fiscal years, estimated costs for the subsequent 45 fiscal years, the 50-year estimated cost, and estimated duration or frequency of 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 action(s) or secure funding for implementing the action(s). In addition, site-specificity for all recovery actions are within the range of the MHI IFKW, which surrounds the main Hawaiian Islands. More specifically, and as discussed in the Recovery Status Review (NOAA Fisheries 2021a), the range is a minimum convex polygon bounded by a 72-km radius of the main Hawaiian Islands. See Figure 1–2 for a map.

Box 5–1: Recovery Action Priority Numbers.

RECOVERY ACTION PRIORITY NUMBERS

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 (or DPS, in this case) 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 Recovery 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).

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 Mapping Tool Database.

Table 5–1. MHI IFKW DPS Implementation Table.

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
1. POPULATION DYNAMICS													
1.1	**Design and implement a robust survey effort and/or advanced analytical methods to determine the abundance, trends, movements, and population structure of the MHI IFKW DPS.**	2	--	1	1500	750	0	0	0	20250	22500	Continuous, not yet initiated	NOAA (PIFSC), CRC, UH, OSI, ONMS, PWF
	Conducted 3 times over 1–1.5-year period; repeat every 5 years, if possible.												
1.2	**Continue and expand MHI IFKW annual photo-ID efforts and maintain photo-ID database.**	2	--	1	400	400	400	400	400	18000	20000	Ongoing	CRC, NOAA (PIFSC), UH, OSI, PWF
	Cost includes satellite tags, tag data analysis, and field expenses, including staging people/boats in areas on windward sides for opportunistic surveys/monitoring during favorable weather, and providing cameras. Location-only tags (with darts, arrows, and Argos fees) cost $4300/each; depth-transmitting tags cost $6350/each. Idea is to deploy multiple tags on all social clusters in each year.												
1.3	**Deploy and analyze satellite tags on MHI IFKWs from all social clusters, particularly on windward side of islands.**	2	--	1	50	50	50	50	50	2250	2500	Ongoing	CRC, NOAA (PIFSC)
	(this row intentionally left blank)												

[1] For actions with a duration exceeding five fiscal years, the FY6+ column includes total costs anticipated after FY1–5.
[2] The total is the sum of anticipated costs across the action's duration.

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
1.4	**Deploy and analyze acoustic instrumentation statewide, particularly in hard to survey areas.**	2	--	1	100	100	100	100	100	4500	5000	Continuous, not yet initiated	NOAA (PIFSC), CRC, OSI, UH, PacIOOS, Navy, ONMS
	Some costs (deployment/retrieval of instruments) are captured under Action 1.2.												
1.5	**Develop trigger-dependent emergency management action(s) to implement if demographic information indicates that the MHI IFKW is in decline (while still listed).**	1	--	1	*	*	*	*	*	*	*	Once with updates as needed	NOAA (PIRO), DLNR-DAR, WPRFMC, Navy
	(this row intentionally left blank)												
1.6	**Develop a post-delisting monitoring plan for MHI IFKWs.**	4	--	6	--	--	--	--	--	*	*	Once with updates as needed	NOAA (PIRO), DLNR-DAR
	(this row intentionally left blank)												
TOTAL FOR 1. POPULATION DYNAMICS					2050	1300	550	550	550	45000+	50000		
2. NON-LONGLINE COMMERCIAL AND RECREATIONAL FISHERIES													
2.1	**Analyze and manage non-longline commercial and recreational fishery interactions.**	2	E	2	460	1030	630	250	65	4245	6680	Continuous, not yet initiated	DLNR-DAR, NOAA (PIFSC), fishermen, HFACT, WPRFMC
	Cost includes research, development, and testing of modified gear, cost of improving the recording of the state commercial reporting system, education and outreach to fishermen, etc.												

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
2.2	**Better understand prey resources and foraging needs of MHI IFKWs, and analyze and manage competition with fisheries.**	2	E	2	632	477	602	482	452	19530	22175	Continuous, not yet initiated	CRC, NOAA (PIFSC, PIRO), WPRFMC
	Cost includes annual dive tags, satellite tags, costs associated with deployment of devices, and data analysis, etc.												
TOTAL FOR 2. NON-LONGLINE COMMERCIAL AND RECREATIONAL FISHERIES					1092	1507	1232	732	517	23775	28855		
3. ENVIRONMENTAL CONTAMINANTS AND BIOTOXINS													
3.1	**Research and monitor environmental contaminants and biotoxins in MHI IFKWs.**	2	A,E	3	380	380	380	380	380	17100	19000	Ongoing	NOAA (SWFSC, PIFSC), UH, CRC
	Costs are only for lab work and to do statistical analysis. Costs for fieldwork associated with this effort are incorporated into other actions (e.g., 2.2, 5.3).												
3.2	**Undertake management measures to reduce environmental contaminants around the main Hawaiian Islands.**	2	A,E	3	--	--	--	--	--	--	--	As needed	EPA, DOH, ACOE, FHA, DLNR, City & Counties, NGOs
	Estimated costs are not available at this time, though may be considered a part of the federal and state budgets.												
TOTAL FOR 3. ENVIRONMENTAL CONTAMINANTS AND BIOTOXINS					380	380	380	380	380	17100	19000		
4. ANTHROPOGENIC NOISE													
4.1	**Better characterize and understand the soundscape of the main Hawaiian Islands.**	3	A,E	4	*/100	*/200	*/100	*/0	*/0	*/900	*/1300+	Once with updates as needed	NOAA (PIFSC), ONMS, Navy, BOEM, Jupiter Research

Action #	Action Title / Additional Info	Priority	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
													Found., private sector (Horizon, Matson, Young Brothers)
	Cost include tools such as acoustic buoys, EARs, HARPS, DMONs, hydrophones, etc., that can examine both ambient and anthropogenic sources of sound. Costs also include fieldwork and data analysis. Activity should be repeated over several years and seasons to determine baseline levels and variability (if any).												
4.2	**Study both the physiological and physical effects of noise on MHI IFKWs.**	3	A,E	4	250	200	200	200	200	9000	10050	Continuous, not yet initiated	NOAA (PIFSC), CRC, UH, Navy, BOEM, ACOE
	Cost includes fieldwork, data collection, and data analysis to undertake biopsies, breath/blow samples, fecal collections, and satellite tagging before, during, and after anthropogenic noise events to analyze cortisol levels.												
4.3	**Undertake management measures to reduce effects from anthropogenic noise, as necessary.**	3	A,E	4	--	--	--	--	--	--	--	As needed	NOAA (PIRO, OPR), Navy, USCG, BOEM, ACOE
	Estimated costs are not available at this time, though may be considered a part of annual federal budgets.												
TOTAL FOR 4. ANTHROPOGENIC NOISE					350	400	300	200	200	9900	11350		
5. CLIMATE CHANGE													
5.1	**Conduct a climate vulnerability assessment of prey species.**	3	A,C, E	5	0	0	0	30	0	300	330	Once with updates every 5 years	NOAA (PIFSC), CI
	(this row intentionally left blank)												

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
5.2	**Downscale Pacific-wide climate models to look at productivity and ecological effects in Hawaii.**	3	A	5	0	0	0	30	0	300	330	Once with updates every 5 years	PICCC, NOAA (PIFSC), UH, CI
	(this row intentionally left blank)												
5.3	**Screen for pathogens, parasites, diseases, and biotoxins and monitor for changes over time.**	2	A,C, E	3,5	50	50	50	50	50	2250	2500	Ongoing	UH
	Much of this can be done by sampling breath samples for microbiome. Cost includes processing and analyzing samples.												
5.4	**Reduce greenhouse gas emissions both locally and globally.**	0	A,C, E	5	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Ongoing	EPA, State of Hawaiʻi, NGOs
	It is unrealistic to estimate a cost for this action.												
TOTAL FOR 5. CLIMATE CHANGE					50	50	50	110	50	2850	3160		
6. SECONDARY THREATS AND SYNERGIES													
6.1	**Develop a conceptual model of ecosystem relationships and how threats to MHI IFKWs are interconnected with these ecosystem relationships.**	3	E	7	0	0	50	0	0	450	500	Once with updates every 5 years	PIFSC, academia, CRC, fishermen
	(this row intentionally left blank)												
6.2	**Continue to monitor false killer whales for ingestion of marine debris.**	3	E	7	0	0	0	0	0	0	0	Ongoing	UH, NOAA (PIFSC)
	Costs are included under Action 6.4.												

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
6.3	**Update the "Pinniped and Cetacean Oil Spill Response Guidelines" and monitor false killer whales that have encountered spills for long-term health effects.**	3	E	7	50	0	0	0	0	450	500	Once with updates every 5 years	NOAA (PIRO, OPR), USCG
	Updating guidelines entails staff time as well as meetings with stakeholders and trainings throughout the main Hawaiian islands to carry out response and monitoring; cost of monitoring whales that have encountered a spill is unknown as it has not occurred but could include cost of numerous tags to track individual(s), fieldwork to use UASs, etc.												
6.4	**Continue to respond to false killer whales that are stranded, sick, or injured.**	1	E	2,3,4, 5,7	*/120	*/7	*/7	*/7	*/7	*/915	*/1063	Ongoing	PIMMRN, NOAA (PIRO), ONMS, UH
	Live false killer whale strandings are rare events and the cost of a live stranding response varies greatly depending on situation, location, local capabilities, status, and number of whales. The PIMMRN is involved in ongoing stranding response and the Prescott stranding grant program has been instrumental in providing funding for strandings historically but it is an annual, competitive grant program (and its continuation is currently in question). Potential cost to get a rehab facility (upfront cost of ~$150K as well as ongoing support) is not currently included.												
6.5	**Monitor for predation events from killer whales, tiger sharks, etc.**	3	E	7	0	0	0	0	0	0	0	Ongoing	NOAA (PIFSC), CRC, PWF, UH
	This can be done opportunistically in the field and via photo analysis.												
6.6	**Continue to monitor and manage the Hawaiʻi-based commercial deep-set and shallow-set longline fisheries to ensure they are not contributing to MHI IFKW decline.**	3	D,E	2	4535	4535	4535	4535	4535	204075	226750	Ongoing	NOAA (PIRO, PIFSC), FKWTRT, fishermen, HLA, WPRFMC

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
	The annual and total estimated cost is highly variable because of the number of considerations (e.g., what percentage of the fleet is using EM, what percentage of EM will be reviewed, review speed [4x, 8x, or 16x], is the review for all catch accounting or just protected species, and data storage protocols). The estimate for all catch accounting with 100% coverage and the most accurate review speed (4x) whereby a reviewer can typically review two longline retrievals per day is $3,628,520 annually. Adding 50% to the total annual cost (to account for the average technology consulting overhead to deliver data statistically similar to the current at-sea observer data stream for the entire fleet) puts the total annual cost between $3,628,520 and $5,442,780, so using the annual mean of 4,535,000. This is not factored into total cost at this time.												
6.7	**Monitor development of aquaculture projects and other marine structures that have the potential to change the behavior of false killer whales.**	3	E	7	0	0	0	0	0	0	0	Ongoing	ACOE, BOEM, private industry, NOAA (PIRO), CRC, PWF
	Cost is captured in staff time of aquaculture/other marine structure companies as they regularly inspect structures, as well as staff time for ACOE (permitting staff) and NOAA Fisheries (section 7 staff).												
6.8	**Monitor for vessel strikes of false killer whales, and manage as necessary.**	3	E	7	0	0	0	0	0	0	0	Ongoing	NOAA (PIRO, PIFSC), CRC, PWF, UH, on-water community
	This can be done opportunistically.												
6.9	**Monitor for negative effects from whale/dolphin ecotourism operations.**	3	E	7	0	0	0	0	0	0	0	Continuous, not yet initiated	NOAA (PIRO) CRC, PWF, NGOs
	This can be done opportunistically.												
6.10	**Research the role of sharks, marlins, and other top predators as competitors for prey species, and monitor for negative effects.**	3	E	7	0	0	0	0	0	0	0	Once with updates as needed	NOAA (PIFSC), UH

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars) FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
	Cost is captured in staff time for running the models and in Action 2.2.												
TOTAL FOR 6. SECONDARY THREATS AND SYNERGIES					4705	4542	4592	4542	4542	205890	228813		
7. OTHER ACTIONS													
7.1	**Maintain an outreach website about MHI IFKWs.**	0	--	--	**/7	**/7	**/7	**/7	**/14	**/736	**/778	Ongoing	DLNR-DAR/CRC, NOAA (PIRO)
	Cost includes $2.5K annually for web-related maintenance (updates, including blogs, relevant science, populating the database with science reports, etc., to the falsekillerwhale.org website that was originally funded by an ESA section 6 grant), $10K every 5 years for an upgrade, as well as staff time.												
7.2	**Engage the public about false killer whale conservation through media and other means.**	0	--	--	85	85	85	85	85	3825	4250+	Continuous, not yet started	NOAA (PIRO), DLNR-DAR, NGOs, local / national media
	Cost includes a dedicated DLNR–DAR MWP Education Specialist salary of $75K (based on $50K/annual + 40% fringe +10% overhead/admin) plus $10K/annual in travel to outer islands, and development and distribution of print and digital media materials. Total cost does not include inflation.												
7.3	**Better engage with fishermen to reduce frequency and severity of false killer whale interactions.**	1	E	2	15	15	15	15	15	675	750	Ongoing	NOAA (PIRO, PIFSC), DLNR-DAR, fishermen, HFACT, CRC, fishing clubs
	(This row intentionally left blank)												
7.4	**Incorporate false killer whales into naturalist programs.**	0	--	--	15	0	15	0	15	375	420	Once with updates every other year or as needed	NOAA (PIRO), DLNR-DAR, PWF, NGOs

Action #	Action Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]	Durat. or Freq.	Potential Agencies / Orgs Involved±
	Cost includes development and distribution of materials, and supporting training in alternate years (or 22 additional alternating years).												
7.5	**Incorporate false killer whales into school programs.**	0	--	--	100	10	10	10	10	450	590	Continuous, not yet initiated	DLNR-DAR, NOAA (PIRO)
	Cost includes materials for annually creating or refreshing science kits, science camp, etc., and training teachers and holding science camp. Cost for DLNR–DAR MWP staff time captured in Action 7.2.												
TOTAL FOR 7. OTHER ACTIONS					222	117	132	117	139	6061	6788		
GRAND TOTALS					**8849**	**8296**	**7236**	**6631**	**6378**	**310576+**	**347966+**	**$347,966,000+**	

±Potential agencies/organizations involved: The first name noted in the “Potential Agencies/Orgs Involved” column is the likely lead for the action. Abbreviations are as follows: ACOE = Army Corps of Engineers; BOEM = Bureau of Ocean Energy Management; CCH = City and County of Honolulu; CI = Conservation International; CRC = Cascadia Research Collective; DOH = Department of Health; DLNR-DAR = Department of Land and Natural Resources–Department of Aquatic Resources Protected Species Program; EPA = Environmental Protection Agency; FHA = Federal Highways Administration; FKWTRT = False Killer Whale Take Reduction Team; HFACT = Hawaiʻi Fishermen’s Alliance for Conservation and Tradition; HLA = Hawaiʻi Longline Association; HPU = Hawaiʻi Pacific University; NGO = Non-governmental Organizations; NOAA = NOAA Fisheries; ONMS = Office of National Marine Sanctuaries; OPR = Office of Protected Resources; OSI = Oceanwide Science Institute; PacIOOS = Pacific Islands Ocean Observing System; PICCC = Pacific Islands Climate Change Cooperative; PIFSC = Pacific Islands Fisheries Science Center; PIMMRN = Pacific Islands Marine Mammal Response Network; PIRO = Pacific Islands Regional Office; PWF = Pacific Whale Foundation; SWFSC = Southwest Fisheries Science Center; UH = University of Hawaiʻi (at Manoa or Hilo); USCG = U.S. Coast Guard; and WPRFMC = Western Pacific Regional Fishery Management Council.

*No cost associated (NOAA Fisheries staff time)
**No cost associated (DLNR–DAR MWP state staff time)

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Part 7. APPENDICES

A. List of Posted Supporting Materials

The following materials related to the MHI IFKW are available on the NOAA Fisheries false killer whale species profile web site:

- Recovery Outline
- Recovery Planning Workshop Agenda
- Recovery Planning Workshop Summary
- Recovery Status Review
- Recovery Implementation Strategy
- Final listing rule (77 FR 70915)
- Status Review Report (Oleson et al. 2010)
- Map of false killer whale stock boundaries
- Map of false killer whale stock boundaries with longline fisheries overlaid
- Map of designated critical habitat

B. MHI IFKW Estimated Population Growth Table

Table 7–1: MHI IFKW estimated population growth based on a 2% annual growth rate.

Notes	Year	Compounding population size	2010 compounding population growth	2015 compounding population growth	Years from 2010 estimate	Years from 2015 estimate
Oleson et al. (2010) abundance estimate	**2010**	**151**	**0.00%**		**0**	
	2011	154	2.00%		1	
	2012	157	4.04%		2	
	2013	160	6.12%		3	
	2014	163	8.24%		4	
Bradford et al. (2018) abundance estimate	**2015**	**167**	**10.41%**	**0.00%**	**5**	**0**
	2016	170	12.62%	2.00%	6	1
	2017	173	14.87%	4.04%	7	2
	2018	177	17.17%	6.12%	8	3
	2019	180	19.51%	8.24%	9	4
	2020	184	21.90%	10.41%	10	5
	2021	188	24.34%	12.62%	11	6
	2022	192	26.82%	14.87%	12	7
	2023	195	29.36%	17.17%	13	8
	2024	199	31.95%	19.51%	14	9
	2025	203	34.59%	21.90%	15	10
	2026	207	37.28%	24.34%	16	11
	2027	211	40.02%	26.82%	17	12
	2028	216	42.82%	29.36%	18	13

Notes	Year	Compounding population size	2010 compounding population growth	2015 compounding population growth	Years from 2010 estimate	Years from 2015 estimate
	2029	220	45.68%	31.95%	19	14
	2030	224	48.59%	34.59%	20	15
	2031	229	51.57%	37.28%	21	16
	2032	233	54.60%	40.02%	22	17
	2033	238	57.69%	42.82%	23	18
	2034	243	60.84%	45.68%	24	19
25 years from 2010 abundance estimate	**2035**	**248**	**64.06%**	**48.59%**	**25**	**20**
	2036	253	67.34%	51.57%	26	21
	2037	258	70.69%	54.60%	27	22
	2038	263	74.10%	57.69%	28	23
	2039	268	77.58%	60.84%	29	24
25 years from 2015 abundance estimate	**2040**	**274**	**81.14%**	**64.06%**	**30**	**25**
	2041	279	84.76%	67.34%	31	26
	2042	285	88.45%	70.69%	32	27
	2043	290	92.22%	74.10%	33	28
	2044	296	96.07%	77.58%	34	29
	2045	302	99.99%	81.14%	35	30
	2046	308	103.99%	84.76%	36	31
	2047	314	108.07%	88.45%	37	32
	2048	320	112.23%	92.22%	38	33
	2049	327	116.47%	96.07%	39	34
	2050	333	120.80%	99.99%	40	35
	2051	340	125.22%	103.99%	41	36

Notes	Year	Compounding population size	2010 compounding population growth	2015 compounding population growth	Years from 2010 estimate	Years from 2015 estimate
	2052	347	129.72%	108.07%	42	37
	2053	354	134.32%	112.23%	43	38
	2054	361	139.01%	116.47%	44	39
	2055	368	143.79%	120.80%	45	40
	2056	375	148.66%	125.22%	46	41
	2057	383	153.63%	129.72%	47	42
	2058	391	158.71%	134.32%	48	43
	2059	398	163.88%	139.01%	49	44
50 years from 2010 abundance estimate	**2060**	**406**	**169.16%**	**143.79%**	**50**	**45**
	2061	415	174.54%	148.66%	51	46
	2062	423	180.03%	153.63%	52	47
	2063	431	185.63%	158.71%	53	48
	2064	440	191.35%	163.88%	54	49
50 years from 2015 abundance estimate	**2065**	**449**	**197.17%**	**169.16%**	**55**	**50**

Justification:

The demographic-based productivity criterion uses an increasing average annual population trend averaging greater than or equal to 2% and is similar to what has been used for other cetacean populations that are small and have a low intrinsic growth rate (e.g., Southern Resident killer whale, Cook Inlet beluga whale). Two generations (50 years) for population growth (i.e., one generation to meet the downlisting criterion and an additional generation to meet the delisting criterion) are used because it is a biologically-based time period that is expected to reasonably encompass environmental variability affecting the population over a longer time span. That is, population growth should take into account periods of good survival and periods of poor survival, and should get the species closer towards the revised plausible historical abundance of 655 individuals (NOAA Fisheries 2021a). Therefore, if beginning in 2010 (when the population was first estimated at 151 individuals (Oleson et al. 2010) and when the MHI IFKW was listed in November 2012), with 151 animals and an estimated average annual growth of 2% over the next 50 years (two generations), the population should have about 406 animals in 2060. (The population should be closer to 449 animals if using the

2015 estimated abundance in the surveyed area of 167 individuals (Bradford et al. 2018) over a 50-year period ending in 2065.) We recognize there is variability around survey point estimates, and a single population point estimate may over- or under-estimate the true population size. Survey variance should be taken into consideration as the population size approaches 406 individuals to help ensure that consideration of delisting is not based on anomalous conditions and accounts for the population trend over two full generations. The longer a population sustains a positive growth rate, the more confident we can be that the population is likely to continue to grow and become stable in the future and is therefore more resilient to stochastic events. In the event the population reaches at least 406 individuals before two full generations (50 years), there must be evidence that the population has been stable or increasing for at least one full generation (25 years).