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

Endangered Species Act (ESA) Recovery Implementation Strategy

October 2021

Version 1

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

Disclaimer

Recovery implementation strategies delineate such reasonable activities as may be necessary, based upon the best scientific and commercial data available, for the conservation and survival of listed species. We publish these implementation strategies that we sometimes prepare with the assistance of recovery teams, contractors, state agencies, and others. Recovery implementation strategies do not necessarily represent the views, official positions, or approval of any individuals or other agencies involved in the plan or strategy formulation. Recovery implementation strategies are guidance and planning documents only. Identification of an activity to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this Recovery Implementation Strategy 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. Recovery implementation strategies are subject to modification as dictated by new findings, changes in species' status, and the completion of recovery actions and activities.

Acknowledgements

We developed the Implementation Schedule Table in this Recovery Implementation Strategy in cooperation with federal and state agencies in Hawaiʻi, universities, research organizations, and non-governmental organizations, to which we express our gratitude for their participation in recovery of the main Hawaiian Islands insular false killer whale distinct population segment.

Literature Citation and Availability

NOAA Fisheries. 2021. Endangered Species Act Recovery Implementation Strategy for the Main Hawaiian Islands Insular False Killer Whale (*Pseudorca crassidens*) Distinct Population Segment. October 2021, Version 1. NOAA Fisheries, Pacific Islands Regional Office, Honolulu, HI 96818. 75 pages.

Download a digital copy of this Recovery Implementation Strategy 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 Recovery Implementation Strategy from the following:

NOAA Fisheries
Pacific Islands Regional Office
Protected Resources Division
1845 Wasp Blvd., Building 176
Honolulu, HI 96818
(808) 725-5000

Table of Contents

I. Guide to the Recovery Implementation Strategy

This Recovery Implementation Strategy represents a format in which recovery planning components for the main Hawaiian Islands insular false killer whale (MHI IFKW) distinct population segment (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.

The second document, the Recovery Plan (NOAA Fisheries 2021b), focuses on the statutory requirements of the Endangered Species Act (ESA): (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.

The third document, this 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 Recovery Plan, while affording us the ability to modify these activities in real time to reflect changes in the information available as well as progress towards recovery. This Recovery Implementation Strategy is intended to assist NOAA Fisheries and other stakeholders in planning and implementing activities to carry out the recovery actions in the Final ESA Recovery Plan for the Main Hawaiian Islands Insular False Killer Whale Distinct Population Segment (NOAA Fisheries 2021b). The stepped-down recovery activities, as well as their time, costs, and potential agencies/organizations involved, identified here in this Recovery Implementation Strategy may be revised at any time during the recovery process, whenever experience and information gained call for a change in tactics, therefore maximizing flexibility of recovery implementation.

All documents used to inform the recovery of the MHI IFKW, including the Recovery Status Review, the Recovery Plan, and the Recovery Implementation Strategy, are available on the Conservation and Management tab of the NOAA Fisheries false killer whale species profile web site, specifically at https://www.fisheries.noaa.gov/species/false-killer-whale#conservation-management.

As used in the Implementation Schedule (see Table II–1), recovery "actions" (i.e., Tiers 1 and 2 (e.g., 1., 1.1., 1.2.)) are broad measures from the Recovery Plan that clearly describe what needs to be done to accomplish the goal of long-term viability; recovery "activities" (i.e., Tiers 3 and 4 (e.g., 2.1.1., 2.1.1.1., 2.1.1.2.)) are the detailed, on-the-ground tactical steps needed to implement the recovery actions. The Implementation Schedule includes action/activity numbers, descriptions, priority (see Box I–1), estimated duration or frequency, potential agencies/organizations involved, and estimated costs. It also includes the ESA section 4(a)(1) listing factor (see Box I–2) as well as recovery objective (see Box I–3). It is a guide for planning and meeting the recovery objectives and criteria discussed in the Recovery Plan.

The Implementation Schedule estimates costs for carrying out the first 5 years of recovery activities as well as costs from years 6 through year 50. We initially project at least a 50-year timeframe to achieve recovery 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. The Implementation Schedule therefore estimates the total cost to implement activities through year 2060 (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), or through year 2065 (if using the 2015 estimated abundance (Bradford et al. 2018)). This is the approximate date to reach the goal of recovery, which is to be considered recovered and delisted from the ESA. Actual expenditures by agencies and other partners are contingent upon appropriations and other budgetary constraints.

Site-specificity for all recovery actions and activities are within the range of the MHI IFKW, which surrounds the main Hawaiian Islands (Figure I–1). 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.

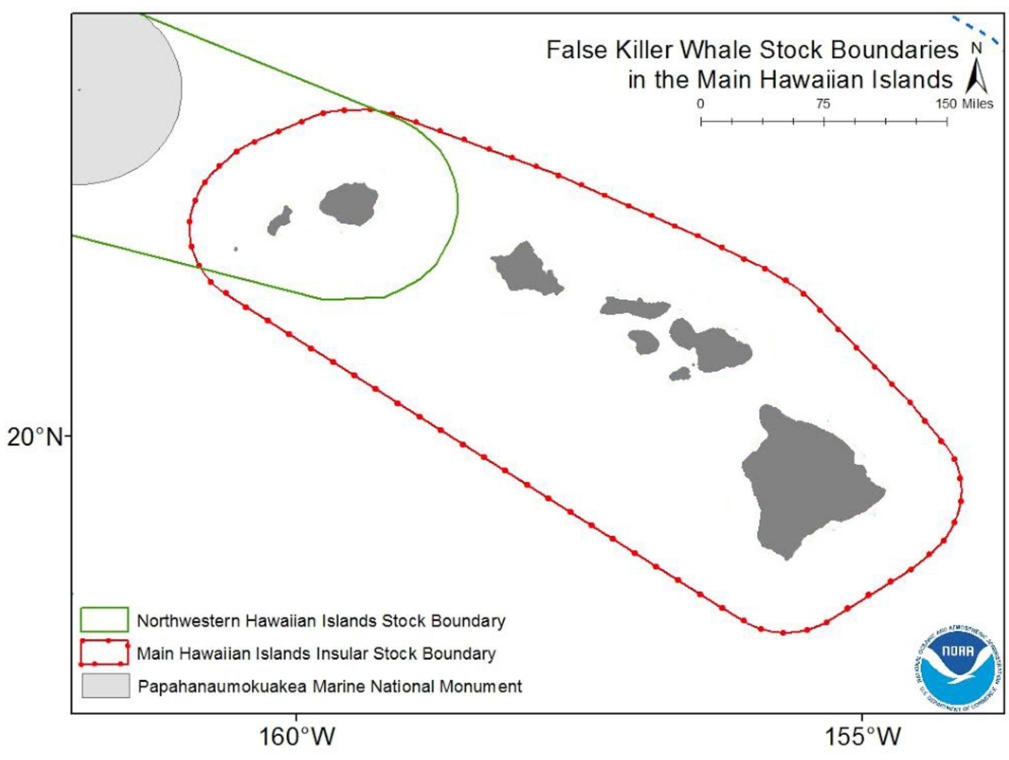

Figure I–1: Close up view of false killer whale population boundaries in Hawaiʻi, focusing on the MHI IFKW (represented by the red dotted line) (Source: NOAA Fisheries unpublished 2021 (modified from Bradford et al. (2015, 2020)).

While the ESA assigns a strong leadership role to NOAA Fisheries for the recovery of listed marine and anadromous species, it also recognizes the importance of other federal agencies, states, and other stakeholders in the recovery process. The "Potential Agencies / Organizations Involved" column of the Implementation Schedule identifies partners who can make significant contributions to specific recovery tasks. The identification of agencies and other stakeholders within the Implementation Schedule does not constitute any additional legal responsibilities beyond existing authorities (e.g., ESA).

Prioritized recovery actions from the Recovery Plan and their associated activities are listed below in the Implementation Schedule (see Table II–1). The assignment of priorities does not imply that some actions and activities are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented (Box I–1).

Box I–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 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 NOAA Fisheries Recovery Action Mapping Tool Database.

Box I–2: Section 4(a)(1) Factors.

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 be evaluated when reclassifying or delisting any species.

Box I–3: Recovery Objectives and Criteria.

Demographic-Based Objective and Criteria

Objective 1: Ensure productivity and social connectedness of the MHI IFKW DPS (trend, abundance, and social clusters) have met or exceed 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; 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.

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; 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.

Threats-Based Objectives and Criteria

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

Reclassification and Delisting Criteria (the same; 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. 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:* 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:* 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 interactions/injuries comports with the visible rate.

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. This can be measured in quantity (biomass), quality (size), and accessibility (availability) of prey species and/or body condition of the MHI IFKWs.

Objective 3: Address threats from environmental contaminants and biotoxins.

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

A. *Environmental contaminants:* There is sufficient evidence to indicate that contaminant levels in the marine environment (i.e., persistent organic pollutants (POPs), polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethanes (DDTs), polybrominated diphenyl ethers (PBDEs), heavy metals, and chemicals of emerging concern (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*: 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.

Objective 4: Address threats from anthropogenic noise.

Reclassification and Delisting Criteria (the same; 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 climate change and manage accordingly.

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

A. *Climate change*: 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:* 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.

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.

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

Reclassification Criteria:

A. *Marine debris ingestion:* 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:* 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:* Oil and hazardous substance spill prevention and response plans are in place and effectively address protections for MHI IFKWs.

D. *Predation:* 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. 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:* 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:* 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:* There is sufficient evidence that commercial and recreational whale/dolphin or other ecotours are not causing population-level effects to 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:* 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:* 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. *Cumulative and synergistic effects:* 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.

Acronyms Used in the Implementation Schedule

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–Division of Aquatic Resources' Protected Species Program
EM	Electronic monitoring
ENSO	El Niño–Southern Oscillation
EPA	Environmental Protection Agency
FHA	Federal Highways Administration
FKWTRT	False Killer Whale Take Reduction Team
HFACT	Hawai'i Fishermen's Alliance for Conservation and Tradition
HLA	Hawai'i Longline Association
HPU	Hawai'i Pacific University
LLEZ	Longline Exclusion Zone
NGO	Non-governmental Organizations
NOAA	NOAA Fisheries
ONMS	Office of National Marine Sanctuaries
OSI	Oceanwide Science Institute
PacIOOS	Pacific Islands Ocean Observing System
PDO	Pacific Decadal Oscillation
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
SEZ	Southern Exclusion Zone
SWFSC	Southwest Fisheries Science Center
UAS	Unmanned Aerial System
UH	University of Hawai'i (at Manoa or Hilo)
USCG	U.S. Coast Guard
VMS	Vessel Monitoring System
WPRFMC	Western Pacific Regional Fishery Management Council

II. Implementation Schedule

Table II–1: Implementation schedule for the main Hawaiian Islands insular false killer whale DPS. Recovery "actions" (i.e., Tiers 1 and 2 (e.g., 1., 1.1., 1.2.)) are broad measures from the Recovery Plan that clearly describe what needs to be done to accomplish the goal of long-term viability; recovery "activities" (i.e., Tiers 3 and 4 (e.g., 2.1.1., 2.1.1.1., 2.1.1.2.)) are the detailed, on-the-ground tactical steps needed to implement the recovery actions. Projected time and cost estimates for each recovery action and activity is intended as a planning aid only. The "potential agencies/organizations involved" are not obligated to expend the amounts shown, and the first name noted in that column is the likely lead for the action.

Action /Activ -ity #	Action or Activity 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, DLNR-DAR
	Conducted 3 times over 1–1.5-year period; repeat every 5 years, if possible.												
1.2	**Continue and expand MHI IFKW annual photo-**	2	--	1	400	400	400	400	400	18000	20000	Ongoing	CRC, NOAA (PIFSC), UH,

[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 /Activ -ity #	Action or Activity 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±
	ID efforts and maintain photo-ID database.												OSI, PWF, DLNR-DAR
	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.												
1.2.1	*Continue current photo-ID efforts.*	2	--	1	150	150	150	150	150	6750	7500	Ongoing	CRC, NOAA (PIFSC), UH, OSI, PWF, DLNR-DAR
1.2.2	*Expand photo-ID efforts to windward sides or other hard-to-survey areas.*	2	--	1	200	200	200	200	200	9000	10000	Ongoing	CRC, NOAA (PIFSC), UH, OSI, PWF, DLNR-DAR
1.2.3	*Promote submission of photos/videos.*	2	--	1	50	50	50	50	50	2250	2500	Ongoing	CRC, NOAA (PIFSC), UH, OSI, PWF, DLNR-DAR
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)
1.4	**Deploy and analyze acoustic instrumentation**	2	--	1	100	100	100	100	100	4500	5000	Continuous, not yet initiated	NOAA (PIFSC), CRC, OSI, UH,

Action /Activ -ity #	Action or Activity 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±
	statewide, particularly in hard to survey areas.												PacIOOS, Navy, ONMS
	Some costs (deployment/retrieval of instruments) are captured under Action 1.2.2.												
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
1.6	**Develop a post-delisting monitoring plan for MHI IFKWs.**	4	--	6	--	--	--	--	--	*	*	Once with updates as needed	NOAA (PIRO), DLNR-DAR
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.												
2.1.1	*Analyze non-longline commercial and recreational fishing gear*	2	E	2	**/0	**/ 250	**/0	**/0	**/0	**/300	**/550	Once with updates as needed	DLNR-DAR, NOAA (PIFSC),

Action /Activ -ity #	Action or Activity 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±
	and the mechanics of MHI IFKW interactions with these fisheries.												fishermen, HFACT, WPRFMC
2.1.1.1	Further refine technical descriptions of different gear in state fisheries and analyze trends.	2	E	2	**	**	**	**	**	**	**	Once with updates as needed	DLNR-DAR, NOAA (PIFSC), fishermen, HFACT, WPRFMC
2.1.1.2	Research potential modifications of shortline and non-longline gear.	2	E	2	0	250	0	0	0	250	500	Once with updates as needed	DLNR-DAR, NOAA (PIFSC, PIRO), fishermen, HFACT, WPRFMC
	Complete the study after similar study is conducted on the commercial longline fishery. Would need to provide modified gear to fishers to test and provide feedback. Additional research and development may be needed so costs added to FY6+. Study would need to include a final report.												
2.1.1.3	Further research mechanical testing of fishing gear on stranded odontocete specimens.	2	E	2	0	0	0	0	0	50	50	Once with updates as needed	UH
	To be conducted ad hoc when appropriate specimens are available so exact year is unknown.												
2.1.2	*Develop and evaluate non-longline gear modifications to deter/avoid/prevent depredation of catch and bait, and minimize*	1	E	2	0	530	280	30	0	250	1090	Once with updates as needed	Researchers, fishing clubs, fishermen, WPRFMC

Action /Activ -ity #	Action or Activity Title	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars)							Durat. or Freq.	Potential Agencies / Orgs Involved±
	Additional Info				FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]		
	occurrence and severity of interactions.												
2.1.2.1	Develop and test a gear set-up that allows the hook to stay in the fish head of catch.	1	E	2	0	250	250	0	0	0	500	Once with updates as needed	Researchers, fishing clubs, fishermen, WPRFMC
2.1.2.2	Incorporate testing of gear measures/ modifications in tournaments.	1	E	2	0	30	30	30	0	0	90	Regularly at fishing events until modification is satisfactory (likely up to 3 years)	DLNR-DAR, HFACT, WPRFMC, fishing clubs, fishermen, fishing sponsors
	Cost includes DLNR–DAR staff time and supplies.												
2.1.2.3	Continue to research and evaluate options that encase the bait/catch to prevent depredation.	1	E	2	0	250	0	0	0	250	500	Once with updates as needed	Researchers, HFACT, fishing clubs, fishermen, WPRFMC, DLNR-DAR
	Budgeted for more testing options over time, especially since false killer whales learn quickly, and what is effective at one time might not be later.												
2.1.3	*Conduct targeted research on human dimensions of fishing-false killer whale interactions.*	2	E	2	125	125	125	95	0	350	820	Annually for 4 years with updates as needed	DLNR-DAR, NOAA (PIFSC), HFACT, WPRFMC

Action /Activ -ity #	Action or Activity 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±
													fishing clubs, fishermen
2.1.3.1	Evaluate prevalence of interactions and fishing practices more likely to result in interactions.	2	E	2	75	75	75	75	0	150	450	Annually for 4 years with updates as needed	DLNR-DAR, PIFSC, HFACT, WPRFMC, fishing clubs, fishermen
	Costs include research, outreach/education, with updates needed as fishing practices may change.												
2.1.3.2	Evaluate options for effective reporting of incidental take.	2	E	2	30	30	30	0	0	0	90	Annually for 3 years with updates as needed	DLNR-DAR, NOAA (PIFSC), HFACT, WPRFMC, fishing clubs, fishermen
2.1.3.3	Identify opportunities and means to work with fishermen to reduce interactions.	2	E	2	20	20	20	20	0	200+	280+	Annually for 4 years with updates as needed	DLNR-DAR, NOAA (PIFSC), HFACT, WPRFMC, CRC, fishing clubs, fishermen
	Costs include multiple meetings with fishermen in various locations on each island.												
2.1.4	*Continue fine-scale analysis of state fishing data in relation to MHI IFKW habitat use with an*	2	E	2	**/10	**/10	**/10	**/10	**/10	**/450	**/500	Annually for 4 years with updates as needed	DLNR-DAR, NOAA (PIFSC), CRC, WPRFMC

Action /Activ -ity #	Action or Activity 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±
	increased sample size to address seasonal, inter-annual, and environmentally driven (e.g., ENSO, PDO) variability in MHI IFKW spatial use.												
2.1.4.1	Evaluate the spatial distribution of state non-longline commercial and recreational fishing effort by fishery.	2	E	2	**	**	**	0	0	**	**	Annually for 3 years then once every 3 years	DLNR-DAR, NOAA (PIFSC), CRC, WPRFMC
2.1.4.2	Model habitat hot spots using false killer whale telemetry and sighting data, overlaid with oceanographic data and fisheries catch data for individual fisheries.	2	A,E	2	**/10	**/10	**/10	**/10	**/10	**/450	**/500	Continuous, not yet initiated	DLNR-DAR, CRC, NOAA (PIFSC), WPRFMC
	The DLNR-DAR Data Management and Analysis Section can assist by preparing summary landings and effort by spatial grid areas. The summaries are available by time period, gear, landing port, and species. This spatial data matrix can be provided to the GIS analyst to produce the area plots. $10K annually is included for costs for modeler/statistician.												
2.1.4.3	Investigate the spatial distribution of shortline fishing effort.	2	E	2	**	0	0	0	0	**	**	Once then every 5 years	DLNR-DAR, NOAA (PIFSC), HFACT, WPRFMC, fishermen

Action /Activ -ity #	Action or Activity 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±
	This can only be done after reporting issues within the commercial marine license reporting system are sorted out (i.e., the fact that fishermen can report “mixed” gear and thus obscure how much shortline fishing is actually occurring).												
2.1.5	*Work cooperatively with the State of Hawai'i to identify initiatives and projects that will enhance the conservation and management of MHI IFKWs.*	2	E	2	100	60	160	60	0	1320	1700	Ongoing	DLNR-DAR, NOAA (PIRO, PIFSC), State legislature, CI, fishermen, HFACT, WPRFMC, CRC, Navy
2.1.5.1	Establish a State of Hawai'i recreational fishing license and reporting form.	2	D,E	2,6	100	0	0	0	0	0	100+	Once with updates as needed	DLNR-DAR, State legislature, CI, NOAA (PIRO, PIFSC), fishermen, HFACT, WPRFMC
	See the 2016 final report “Feasibility of a Non-Commercial Marine Fishing Registry, Permit, or License System in Hawaii”												
2.1.5.2	Modify the state commercial marine license reporting forms to include additional information.	2	D,E	2,6	0	0	100	0	0	0	100	Once with updates as needed	DLNR-DAR, fishermen, WPRFMC
	Cost includes DLNR-DAR staff time and travel, holding workshops on the revised forms, web costs to modify and maintain online form, and mailing expenses.												
2.1.5.3	Develop and implement a Habitat Conservation Plan	2	D,E	2,6	0	60	60	60	0	1320	1500	Once with updates as needed	DLNR-DAR, NOAA (PIRO),

Action /Activ -ity #	Action or Activity 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±
	for an ESA section 10 ITP for all protected species.												fishermen, HFACT
	Cost includes staff time, travel, and workshop expenses to hold 3 years of annual workshops on all islands and then workshops every other year on all islands.												
2.1.5.4	Continue to apply for a Species Recovery Grant through the ESA section 6 grant program.	3	D,E	1–6	**	**	**	**	**	**	**	As needed	DLNR-DAR, UH, CRC, NOAA (PIRO)
	Applying for the grant is free (involved only staff time) but would involve committing partial matching funds from the State, if grant is awarded.												
2.1.6	*Continue tracking fishing gear injury rates.*	1	E	2	5	5	5	5	5	225	250	Ongoing	CRC, NOAA (PIFSC), UH
	Cost includes analysis and write up with the remaining cost captured under costs associated with 1.2.1 and 1.2.2.												
2.1.7	*Develop strategic outreach messaging, tools, and programs for the fishing community and other stakeholders.*	2	E	2	220	50	50	50	50	1350	1770	Continuous, not yet initiated	DLNR-DAR, NOAA (PIRO), fishermen, HFACT, WPRFMC, HLA
2.1.7.1	Based on results from actions above, develop an outreach strategy on how to promote best fishing practices.	2	E	2	0	0	0	0	0	0	0	Continuous, not yet initiated	DLNR-DAR, NOAA (PIRO), fishermen, HFACT, WPRFMC, HLA
	Cost is captured under costs associated with 2.1.3, 2.1.2.1, and 2.1.2.2.												
2.1.7.2	Develop and implement a routine non-longline fishing and boating	2	D,E	2	120	40	40	40	40	900	1180	Continuous, not yet initiated	DLNR-DAR, NOAA (PIRO), fishermen,

Action /Activ -ity #	Action or Activity 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±
	protected species workshop.												HFACT, WPRFMC, CRC
	Cost assumes using a contractor to develop the learning management system (online interactive training course) that fishermen take annually. Site would need out-year options to upgrade or modify. This training is supplemented with an in-person training developed and delivered by NOAA Fisheries staff. Cost also includes State staff time to connect with fishermen.												
2.1.7.3	Develop a smartphone application for reporting sightings and interactions of false killer whales.	2	D,E	1,2	100	10	10	10	10	450	590	Once with regular updates as needed	CRC, NOAA (PIFSC), App developers, PWF, WPRFMC
	Look to existing app developers or partner with PWF. Cost assumes partnering with PWF to expand its Whale and Dolphin Tracker app and to add in the electronic logbook anonymous interaction feature. Out-year costs include maintaining the app regularly to ensure updates are available for newer phones and addressing any glitches.												
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), WPRFMC
	Cost includes annual dive tags, satellite tags, costs associated with deployment of devices, and data analysis, etc.												
2.2.1	*Continue research on diet of MHI IFKWs to identify important prey species.*	3	A	2	100	100	100	100	100	4500	5000	Ongoing	UH, CRC, NOAA (PIFSC), fishermen
	Costs include dedicated fecal collection study, including fieldwork and lab analysis. Can also be done passively while conducting photo-ID and necropsies.												
2.2.2	*Complete more targeted analysis of non-longline commercial and*	2	A	2	*/**	*/**	*/**	*/**	*/**	*/**	*/**	Once with yearly updates	NOAA (PIFSC),

Action /Activ -ity #	Action or Activity 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±
	recreational catch data of MHI IFKW prey species to clarify level of competition.												DLNR-DAR, WPRFMC
	There are 2-month and annual estimates of statewide non-commercial catch available on the NOAA MRIP website (www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index).												
2.2.3	*Analyze and model MHI IFKW prey abundance dynamics (i.e., seasonal/spatial variation of prey distribution) within the range of MHI IFKWs and manage, where appropriate.*	2	A	2	0	0	150	0	0	450	600	Once with updates every five years	NOAA (PIFSC, PIRO), researchers, fishermen, DLNR-DAR, Regional Fisheries Mgmt Orgs
	Costs includes fishermen interviews, tagging prey, and use of drifting sensors or gliders. Out-year costs estimated at $50K every five years.												
2.2.4	*Further investigate MHI IFKW foraging behavior and locations.*	2	A	2	350	225	200	200	200	9000	10175	Ongoing	CRC, NOAA (PIFSC)
2.2.4.1	Better understand MHI IFKW foraging movement and behavior.	2	A	2	100	100	100	100	100	4500	5000	Ongoing	CRC, NOAA (PIFSC)
	Cost includes annual dive tags, satellite tags, Critter Cams, costs associated with deployment of devices, and data analysis.												
2.2.4.2	Continue to assess the social dynamics of foraging behavior.	2	A	2	0	0	0	0	0	0	0	Ongoing	CRC, NOAA (PIFSC)
	Costs associated with this effort are incorporated into other actions (e.g., Actions 1.1, 1.2.1, and 1.2.2).												
2.2.4.3	Investigate what makes "hot spot" areas such	2	A	2	150	25	0	0	0	0	175	Already underway	CRC, NOAA (PIFSC)

Action /Activ -ity #	Action or Activity 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±
	high-use areas for MHI IFKWs.												
	Cost includes mid-water surveys in FY1, and FY2 travel and publication costs. (Cost does not include $25K spent in FY2018 on completing computer modeling component.)												
2.2.4.4	Monitor for seasonal / spatial changes in MHI IFKW foraging activity over time.	2	A	2	100	100	100	100	100	4500	5000	Continuous, not yet initiated	NOAA (PIFSC), CRC, DLNR-DAR
	Most costs associated with this effort are incorporated into other actions (e.g., Actions 2.2.4.1, 2.2.4.2, and 2.2.4.3). Additional costs include fieldwork.												
2.2.5	*Assess body condition of MHI IFKWs over time.*	2	A	2	180	150	150	180	150	5490	6300	Ongoing	NOAA (PIFSC), CRC, UH
2.2.5.1	Conduct regular biopsy surveys and use cortisol measurements to detect nutritional stress.	2	A	2	50	50	50	50	50	450	700	Yearly for 5 years, then once every 5 years	NOAA (PIFSC), CRC, UH
	Biopsy analysis during the first five years will build the dataset and allow for initial analysis, with subsequent surveys allowing for population monitoring. Fieldwork costs are captured in other actions (e.g., 1.1, 3.1.1.).												
2.2.5.2	Use UAS/drone with aerial photogrammetry to measure body condition.	2	A	2	130	100	100	130	100	5040	5600	Continuous, not yet initiated	NOAA (PIFSC), UH, CRC, PWF
	Costs include fieldwork, analysis of data, and purchase of two UASs with replacements as needed, likely every 3 years.												
2.2.5.3	Determine if certain genes are expressed in nutritionally-stressed animals.	2	A	2	*	*	*	*	*	*	*	Continuous, not yet initiated	NOAA (SWFSC)
	Samples would come from Actions 2.2.5.1. and 3.1.1 and utilize staff time for the analysis.												

Action /Activ -ity #	Action or Activity Title	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars)							Durat. or Freq.	Potential Agencies / Orgs Involved±
	Additional Info				FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]		
2.2.6	*Implement slot limits of fish species in state fisheries, especially in recreational fisheries.*	2	A	2,6	2	2	2	2	2	90	100	Continuous, not yet initiated	DLNR-DAR, NOAA (PIRO), WPRFMC
	Costs include development and distribution of material.												
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).												
3.1.1	*Identify contaminants in false killer whales and incorporate into a general health assessment to see how all of these factors may be interconnected.*	2	A,C	3	50	50	50	50	50	2250	2500	Ongoing	NOAA (SWFSC, PIFSC), UH, CRC
	Costs are only for lab work and to do the statistical analysis. Costs for fieldwork associated with this effort are incorporated into other actions (e.g., Actions 2.2.5.1 and 5.3)												
3.1.2	*Identify sources of environmental contaminants and biotoxins, and form partnerships to manage as necessary.*	2	A,C	3	300	300	300	300	300	13500	15000	Continuous, not yet initiated	DOH, EPA, CCH, FHA, ACOE, DLNR-DAR, NOAA (PIFSC), NGOs

Action /Activ -ity #	Action or Activity Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars)							Durat. or Freq.	Potential Agencies / Orgs Involved±
					FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]		
3.1.2.1	Analyze contaminant levels in prey species collected from fishermen.	2	A,C	3	50	50	50	50	50	2250	2500	Ongoing	NOAA (PIFSC), fishermen
3.1.2.2	Identify and control land-based sources of pollution.	2	A,C	3	250	250	250	250	250	11250	12500	Continuous, not yet initiated	DOH, EPA, CCH, FHA, DLNR-DAR
	Cost may be underestimated and covered in annual budget of other agencies conducting this as part of their regular work.												
3.1.2.3	Determine if mercury sources are local or international and manage, where possible.	3	A,C	3	0	0	0	0	0	0	0	Once with updates as needed	UH, HPU, NGOs
	Costs associated with this effort are incorporated into Action 3.1.2.2.												
3.1.3	*Monitor levels of naturally occurring biotoxins (e.g., algal toxins, ciguatoxin) in the marine environment.*	3	A,C	3	30	30	30	30	30	1350	1500	Continuous, not yet initiated	DOH, EPA, UH, researchers
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		

Action /Activ -ity #	Action or Activity Title	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars)							Durat. or Freq.	Potential Agencies / Orgs Involved±
	Additional Info				FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]		
4. ANTHROPOGENIC NOISE													
4.1	**Better characterize and understand the soundscape of the main Hawaiian Islands.**	2	A,E	4	*/100	*/200	*/100	*/0	*/0	*/900	*/1300+	Once with updates as needed	NOAA (PIFSC, ONMS), Navy, BOEM, Jupiter Research 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).												
4.1.1	*Characterize soundscape, focusing on high-use areas.*	2	A,E	4	100	100	100	0	0	900	1200+	Once with updates every 5 years	NOAA (PIFSC, ONMS), Navy, BOEM, Jupiter Research Found., private sector (Horizon, Matson, Young Brothers)

Action /Activ -ity #	Action or Activity 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±
4.1.2	*Validate sources of sound.*	2	A,E	4	0	100	0	0	0	0	100+	Once with updates as needed	NOAA (PIFSC, ONMS), Navy, BOEM, Jupiter Research Found., private sector (Horizon, Matson, Young Brothers)
4.1.3	*Use soundscape information to update NOAA's CetSound program.*	3	A,E	4	*	*	*	*	*	*	*		NOAA (PIFSC)
4.2	**Study both the physiological and physical effects of noise on MHI IFKWs.**	2	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.												
4.2.1	*Better understand biological stress response related to noise during anthropogenic events.*	2	A,E	4	100	100	100	100	100	4500	5000	Continuous, not yet initiated	NOAA (PIFSC), CRC, UH

Action /Activ -ity #	Action or Activity 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±
4.2.2	*Conduct studies on captive false killer whales to determine the acoustic masking effects (i.e., blocking) of anthropogenic noise on marine mammal communication.*	2	A,E	4	50	0	0	0	0	0	50+	Once with updates as needed	UH, Sea Life Park, other research institutions
4.2.3	*Better understand hearing effects from alternative energy projects on MHI IFKWs.*	2	A,E	4	50	50	50	50	50	2250	2500	Continuous, not yet initiated	NOAA (PIFSC), BOEM, ACOE
4.2.4	*Better understand hearing effects from military training on MHI IFKWs.*	2	A,E	4	50	50	50	50	50	2250	2500	Continuous, not yet initiated	NOAA (PIFSC), Navy, USCG
4.3	**Undertake management measures to reduce effects from anthropogenic noise, as necessary.**	2	A,E	4	--	--	--	--	--	--	--	As needed	NOAA (PIRO), 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		

Action /Activ -ity #	Action or Activity 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. 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
5.2	**Downscale Pacific-wide climate models to look at productivity and species' climate envelopes in Hawaii.**	3	A	5	0	0	0	30	0	300	330	Once with updates every 5 years	PICCC, NOAA (PIFSC), UH, CI
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 Hawai'i, 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**	3	E	7	0	0	50	0	0	450	500	Once with updates every 5 years	NOAA (PIFSC), academia, CRC, fishermen

Action /Activ -ity #	Action or Activity 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±
	these ecosystem relationships.												
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 6.4.4.												
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), 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), 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.												
6.4.1	*Update stranding protocols in the regional marine mammal response plan, as needed.*	2	E	7	100	*	*	*	*	*	100+	Once with updates as needed	PIMMRN, NOAA (PIRO), UH, USCG, CRC

Action /Activ -ity #	Action or Activity 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±
	Costs include developing a mass stranding response plan for MHI IFKWs and includes a workshop among potential responders and scientists to develop it and do trainings.												
6.4.2	*Respond to live-stranded false killer whales.*	1	E	7	--	--	--	--	--	100+	100+	Ongoing	PIMMRN, NOAA (PIRO), 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 develop a rehab facility (upfront cost of ~$150K as well as ongoing support) is not currently included.												
6.4.3	*Encourage the public to report live or dead strandings promptly.*	2	E	7	20	7	7	7	7	315	363	Ongoing	NOAA (PIRO), DLNR-DAR, UH, USCG, PIMMRN
	Costs include outreach materials (e.g. stickers, magnets, brochures, Voice of the Sea ($12k per episode) and other video media development) and staff time to create and facilitate the printing of materials, video production opportunities, and social media outreach.												
6.4.4	*Necropsy false killer whales.*	1	E	7	--	--	--	--	--	500+	500+	Ongoing	PIMMRN, UH, Navy, NOAA (PIRO)
	Costs associated with this effort (e.g., 5 false killer whales necropsied in 2013–2016 resulting in hundreds of curated sub-samples for ongoing and future analyses) have been covered by the PIMMRN, which is funded by NOAA Fisheries. Support for necropsy and the curation of tissues comes from successful grant proposals submitted annually.												
6.5	**Monitor for predation events from killer whales, tiger sharks, etc.**	3	E	7	0	0	0	0	0	0	0	Ongoing	CRC, NOAA (PIFSC), PWF, UH
	This can be done opportunistically in the field and via photo analysis.												
6.6	**Continue to monitor and manage the Hawai‘i-based commercial deep-set and shallow-set**	3	D,E	2	4535	4535	4535	4535	4535	204075	226750	Ongoing	NOAA (PIRO), FKWTRT, fishermen,

Action /Activ -ity #	Action or Activity 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±
	longline fisheries to ensure they are not contributing to MHI IFKW decline.												HLA, WPRFMC
	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.												
6.6.1	*Assess whether implementation of the FKWTRP or subsequent measures (e.g., SEZ closure) resulted in an increase in shortline or other fishing effort inside the range of the MHI IFKW population.*	3	D,E	2	*	*	*	*	*	*	*	Once with updates as needed	NOAA (PIRO), FKWTRT
	Implemented as part of ongoing actions already funded by NOAA Fisheries via the FKWTRP; assumes no additional cost.												
6.6.2	*Continue to analyze data from VMS to ensure location compliance.*	3	D,E	2	0	0	0	0	0	0	0	Ongoing	NOAA (PIRO), FKWTRT, fishermen, HLA, WPRFMC
	Implemented as part of ongoing actions already funded by NOAA Fisheries via the FKWTRP; assumes no additional cost.												
6.6.3	*Increase the use of video electronic monitoring to assist in accurately assessing bycatch and*	3	D,E	2	4535	4535	4535	4535	4535	204075	226750	Ongoing	NOAA (PIRO), FKWTRT, fishermen,

Action /Activ -ity #	Action or Activity 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±
	interactions with protected species.												HLA, WPRFMC
	The annual and total estimated cost is highly variable because of the number of considerations (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.												
6.6.4	*Continue to research and evaluate options that encase the bait/catch to prevent depredation in commercial longline fisheries.*	3	D,E	2	0	0	0	0	0	0	0	Ongoing with updates as needed	NOAA (PIRO, PIFSC), FKWTRT, fishermen, HLA, WPRFMC
	Implemented as part of ongoing actions already funded by NOAA Fisheries via the FKWTRP; assumes no additional cost.												
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	CRC, NOAA (PIFSC), PWF, UH, on-water community
	This can be done opportunistically.												

Action /Activ -ity #	Action or Activity 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±
6.9	**Monitor for negative effects from whale/dolphin ecotourism operations.**	3	E	7	0	0	0	0	0	0	0	Continuous, not yet initiated	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
	Cost is captured in staff time for running the models and in Action 2.2.5.1												
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 general 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 MWP, 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**	1	E	2	15	15	15	15	15	675	750	Ongoing	NOAA (PIRO, PIFSC), DLNR-

Action /Activ -ity #	Action or Activity Title / Additional Info	Prior-ity	Listing Factor	Recov. Obj.	Cost Estimates by FY (thousands of dollars)							Durat. or Freq.	Potential Agencies / Orgs Involved±
					FY1	FY2	FY3	FY4	FY5	FY6+[1]	Total[2]		
	frequency and severity of false killer whale interactions.												DAR, fishermen, HFACT, CRC, fishing clubs
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
	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 MWP, 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)

III. Outline of Recovery Actions and Stepped-Down Activities

As previously mentioned, recovery "actions" (i.e., Tiers 1 and 2 (e.g., 1., 1.1., 1.2.), in bold) are broad measures from the Recovery Plan that clearly describe what needs to be done to accomplish the goal of long-term viability; recovery "activities" (i.e., Tiers 3 and 4 (e.g., 2.1.1., 2.1.1.1., 2.1.1.2.), in italics and normal font) are the detailed, on-the-ground tactical steps needed to implement the recovery actions. The recovery actions and activities listed below will occur throughout the range of the MHI IFKW.

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.

1.2.1 Continue current photo-ID efforts.

1.2.2 Expand photo-ID efforts to windward sides or other hard-to-survey areas.

1.2.3 Promote submission of photos/videos.

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 population 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.

2.1.1 Analyze non-longline commercial and recreational fishing gear and the mechanics of MHI IFKW interactions with these fisheries.

2.1.1.1 Further refine technical descriptions of different gear in state fisheries, improve the recording of the state commercial reporting system to address multiple gear types being fished at once, and analyze trends.

2.1.1.2 Research potential modifications of shortline and non-longline gear.

2.1.1.3 Further research mechanical testing of fishing gear on stranded odontocete specimens.

2.1.2 Develop and evaluate non-longline gear modifications to deter/avoid/prevent depredation of catch and bait, and minimize occurrence and severity of interactions.

2.1.2.1 Develop a gear set-up that allows the hook to stay in the fish head of catch.

2.1.2.2 Incorporate testing of gear measures/modifications in tournaments.

2.1.2.3 Continue to research and evaluate options that encase the bait/catch to prevent depredation in non-longline fisheries.

2.1.3 Conduct targeted research on human dimensions of fishing-false killer whale interactions.

2.1.3.1 Evaluate prevalence of interactions and which fishing practices are more likely to result in interactions.

2.1.3.2 Evaluate options for effective reporting of incidental take.

2.1.3.3 Identify opportunities and means to work with fishermen to reduce interactions.

2.1.4 Continue fine-scale analysis of state fishing data in relation to MHI IFKW habitat use with an increased sample size to address seasonal, inter-annual, and environmentally driven (e.g., ENSO, PDO) variability in MHI IFKW spatial use.

2.1.4.1 Continue to evaluate the spatial distribution of state non-longline commercial and recreational fishing effort by fishery.

2.1.4.2 Model habitat hot spots using false killer whale telemetry in relation to oceanographic data and fisheries catch data for individual fisheries.

2.1.4.3 Investigate the spatial distribution of shortline fishing effort.

2.1.5 Work cooperatively with the State of Hawaiʻi to identify initiatives and projects that will enhance the conservation and management of MHI IFKWs.

2.1.5.1 Establish a State of Hawaiʻi recreational fishing license and reporting form.

2.1.5.2 Modify the state Commercial Marine License reporting forms to include additional information or improve the quality of existing data collection.

2.1.5.3 Develop and implement a Habitat Conservation Plan for an ESA section 10 Incidental Take Permit for all protected species.

2.1.5.4 Continue to apply for a Species Recovery Grant through the ESA section 6 grant program.

2.1.6 Continue tracking fishing gear injury rates.

2.1.7 Develop strategic outreach messaging, tools, and programs for the fishing community and other stakeholders.

2.1.7.1 Based on results from actions in 2.1.1. to 2.1.4, develop an outreach strategy on how to promote best fishing practices.

2.1.7.2 Develop and implement a routine non-longline fishing and boating protected species workshop.

2.1.7.3 Develop a smartphone application for reporting sightings and interactions with false killer whales.

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

2.2.1 Continue research on diet of MHI IFKWs to identify important prey species.

2.2.2 Complete more targeted analysis of non-longline commercial and recreational catch data of MHI IFKW prey species to clarify level of competition.

2.2.3 Analyze and model MHI IFKW prey abundance dynamics (i.e., seasonal/spatial variation of prey distribution) within the range of MHI IFKWs and manage, where appropriate.

2.2.4 Further investigate MHI IFKW foraging behavior and locations.

2.2.4.1 Better understand MHI IFKW foraging movement and behavior.

2.2.4.2 Continue to assess the social dynamics of foraging behavior.

2.2.4.3 Investigate what makes "hot spot" areas such high-use areas for MHI IFKWs.

2.2.4.4 Monitor for seasonal/spatial changes in MHI IFKW foraging activity over time.

2.2.5 Assess body condition of MHI IFKWs over time to determine if nutritional needs are being met.

2.2.5.1 Conduct regular biopsy surveys and use cortisol measurements to detect nutritional stress.

2.2.5.2 Use UAS/drone with aerial photogrammetry to measure body condition.

2.2.5.3 Determine if certain genes are expressed in nutritionally-stressed animals.

2.2.6 Implement slot limits of fish species in state fisheries, especially in recreational fisheries.

3. ENVIRONMENTAL CONTAMINANTS AND BIOTOXINS

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

3.1.1 Identify contaminants in false killer whales and incorporate into a general health assessment to see how all of these factors may be interconnected.

3.1.2 Identify sources of environmental contaminants and biotoxins, and form partnerships to manage as necessary.

3.1.2.1 Analyze contaminant levels in prey species.

3.1.2.2 Identify and control land-based sources of pollution.

3.1.2.3 Determine if mercury sources are local or international and manage, where possible.

3.1.3 Monitor levels of naturally occurring biotoxins (e.g., algal toxins, ciguatoxin) in the marine environment.

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.

4.1.1 Characterize soundscape, focusing on high-use areas.

4.1.2 Validate sources of sound.

4.1.3 Use soundscape information to update NOAA's CetSound program

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

4.2.1 Better understand biological stress response related to noise during anthropogenic events.

4.2.2 Conduct studies on captive false killer whales to determine the acoustic masking (i.e., blocking) effects of anthropogenic noise on marine mammal communication.

4.2.3 Better understand hearing effects from alternative energy projects on MHI IFKWs.

4.2.4 Better understand hearing effects from military training 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 species' climate envelopes in Hawai'i.

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.

6.4.1 Update stranding protocols in the regional marine mammal response plan, including developing a mass stranding response plan specific to MHI IFKWs.

6.4.2 Respond to live-stranded false killer whales.

6.4.3 Implore the public to report live or dead strandings promptly.

6.4.4 Necropsy false killer whales.

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

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

6.6.1 Assess whether implementation of the FKWTRP or subsequent measures (e.g., SEZ closure) resulted in an increase in shortline or other fishing effort inside the range of the MHI IFKW population.

6.6.2 Continue to analyze data from VMS to ensure location compliance.

6.6.3 Increase the use of video electronic monitoring to assist in accurately assessing bycatch and interactions with protected species.

6.6.4 Continue to research and evaluate options that encase the bait/catch to prevent depredation in commercial longline fisheries.

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.

IV. Recovery Activities Narrative

This section states the recovery actions and describes the recovery activities. As previously mentioned, recovery "actions" (i.e., Tiers 1 and 2 (e.g., 1., 1.1., 1.2.), in bold) are broad measures from the Recovery Plan that clearly describe what needs to be done to accomplish the goal of long-term viability; recovery "activities" (i.e., Tiers 3 and 4 (e.g., 2.1.1., 2.1.1.1., 2.1.1.2.), in italics or underlined) are the detailed, on-the-ground tactical steps needed to implement the recovery actions. The recovery actions and activities listed below will occur throughout the range of the MHI IFKW.

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.

1.2.1 Continue current photo-ID efforts.

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. As such, 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.

1.2.2 Expand photo-ID efforts to windward sides or other hard-to-survey areas.

For the above reasons, photo-ID efforts should not only be continued but expanded. Expanding photo-ID efforts could entail staging people/boats in areas on the windward sides for opportunistic surveys/monitoring when weather is favorable. Photo-ID and tag deployment (see below) in these hard to survey areas (e.g., Kāneʻohe Bay, Waimanalo, Hawaiʻi Kai, Hilo, Hana, Lihue, etc.) will bolster the existing analyses of abundance, population structure, and demographics.

1.2.3 Promote submission of photos/videos.

In addition to photo-ID by researchers, provide cameras to wildlife ecotourism operators and the fishing community and promote submissions of photos/videos of false killer whales. These efforts will add to our information on species identification, life history, and distribution. Cascadia Research Collective curates a region-wide photo-ID catalog and photos and videos should be submitted to hawaii@cascadiaresearch.org (or can be submitted online via falsekillerwhales.org which uploads files directly to Cascadia Research Collective).

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.

2.1.1 Analyze non-longline commercial and recreational fishing gear and the mechanics of MHI IFKW interactions with these fisheries.

Foundational information is lacking on non-longline gear types and interactions (i.e., hooking and entanglements); yet, this is critical to informing future management and determining if management actions are working. Conducting fishing gear research and tests through various means listed below 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.

2.1.1.1 Further refine technical descriptions of different gear in state fisheries, improve the recording of the state commercial reporting system to address multiple gear types being fished at once, and analyze trends.

It is useful to know how, when, and where each particular type of gear is used, what type of bait or lure is used (if any), and the specifics of the gear being used. For example, mainline and leader length and strength, how the lure is rigged for lure trolling, and hook strength and style for bait fishing. Additionally, knowing whether fishermen use only a single gear type per set or trip or if they use multiple types of fishing gear in a trip (and how they make those decisions) would be valuable information. If multiple types of gear are used (e.g., shortline and handline), this may not be accurately captured in the state reporting system, as this is typically just recorded as “mixed” gear type. Additionally, it would be useful to record the size of the fishing vessel to better understand if there is a difference between the effort by and potential risk from the “smaller small boats” and the “larger small boats.” Much of the relevant information already exists but the recording system for commercial catches needs improvements, as well as independent verification. For example, the commercial fishing report collection is a 70-year time series of fisheries-dependent data with a dataset of approximately 45 different types of gear/method definitions—some now obsolete and others reclassified into standard gear definitions. The Hawaiʻi Marine Recreational Fishing Survey currently has 15 gear types listed (over ~95% of the boat-based surveys are rod-and-reel), 4 methods of fishing (trolling, casting, bottom fishing, and hand lining), and 2 depth ranges for bottom fishing (<20 fathoms and >20 fathoms). Only one gear type is recorded per interview, designated as the primary gear used for a given trip. The primary fishing area (inland, state, and federal waters) is also recorded, though fishers will typically fish different areas and sometimes employ different methods on a single trip. Thus, also recording secondary gear used and secondary fishing areas would be useful.

It is important to address inadequacies and further refine these descriptions and keep them current, especially as new technologies evolve. It may also be useful to prepare a summary report that analyzes spatial and temporal landing or effort trends by gear and species composition. Mining this data could help us better understand which gear/fishing type is more likely to interact with false killer whales. This effort should be combined with efforts from Action 2.1.3 (targeted research on human dimensions of fishing-false killer whale interactions), and should include information via fishermen surveys at hot spot ports/communities/fishing clubs to better characterize gear and other fishing practices that result in incidental take.

2.1.1.2 Research potential modifications of shortline and non-longline gear.

The NOAA Fisheries False Killer Whale Take Reduction Plan includes measures to reduce bycatch of false killer whales in the Hawaiʻi-based commercial longline fisheries, including using certain hook sizes/strengths and line strengths that allow hooks (in the commercial longline fisheries) to straighten when a false killer whale is hooked, thus allowing the animal to go free. Research on the best combination of gear continues to be conducted. If feasible, build on this research through consultation with fishery experts to determine if outcomes are applicable to shortline and non-longline fishing gear. Testing of modified gear can be done via outreach at fishing events and through one-on-one discussions with fishers on the docks and at fishing stores where they could be asked if they would like to try out modified gear and provide feedback. Feedback can be obtained through a short form that is submitted to the DLNR–DAR clerk. This would allow fishers to articulate their ideas and experiences of using the modified gear. If modified gear is applicable, determine perceived benefits to fishermen from adopting this gear as well as barriers to overcome to promote the use of these gear modifications.

2.1.1.3 Further research mechanical testing of fishing gear on stranded odontocete specimens.

Mechanical testing of fishing gear on stranded odontocete specimens can offer insights into potential methods to mitigate the effects of hookings and entanglements (e.g., Winn et al. 2008, Barco et al. 2010, and McLellan et al. 2015). For example, McLellan et al. (2015) used stranded specimens of short-finned pilot whales (*Globicephala macrorhynchus*), Risso's dolphins (*Grampus griseus*), and false killer whales—all species known to engage in depredation of longline fisheries—and investigated how longline hooks interact with soft tissues of the lip and whether the hooks could fracture the mandible (jaw). From this study, they identified that hooks formed by ductile polished steel and of the smallest gape possible will reduce the potential for serious injury in odontocetes that become hooked after engaging in depredation. Therefore, this activity involves further mechanical testing of hooks and line strength from non-longline fisheries tested on the mouths and appendages of deceased stranded false killer whales or proxy species that may help to glean means of modifying non-longline gear so it minimizes serious injuries. (The University of Hawaiʻi has frozen heads and appendages of stranded false killer whales and proxy species available for such a study.) Further, data from these studies may help to assign injuries to a non-longline fishery (e.g., troll, handline, kaka line, shortline) and deter or minimize depredation of bait or catch. The results can also direct/focus our outreach efforts and future research. After conducting these or similar studies, as well as additional analyses on these tissues, a Hawaiian cultural practitioner should be engaged in the culturally appropriate blessing and burial of the remains.

2.1.2 Develop and evaluate non-longline gear modifications to deter/avoid/prevent depredation of catch and bait, and minimize occurrence and severity of interactions.

False killer whales depredating catch and bait is well documented by federal observers aboard commercial longline fishing vessels in Hawaiʻi. The extent of this occurrence in unobserved non-longline fisheries is unknown, although depredation of catch by false killer whales was recorded around the main Hawaiian Islands as early as 1963 (Pryor 1975), and was considered to be "very common" throughout the 1970s (Shallenberger 1981). Given the increasing documentation of mouth and dorsal fin injuries to MHI IFKWs from hooks and lines (Baird et al. 2017b), incidental take (i.e., hooking and entanglements) from depredation—likely from non-longline fisheries given the spatial overlap of MHI IFKWs and non-longline fishing—is presumed to occur. By deterring/avoiding/preventing depredation, during which animals can get caught on the hook with the bait or catch or entangled in fishing line, we can likely reduce the occurrence or severity of incidental hooking and entanglements.

2.1.2.1 <u>Develop a gear set-up that allows the hook to stay in the fish head of catch.</u>

When depredation occurs in the longline fishery, false killer whales consume the body of the fish and often leave the fish head on the hook. False killer whales are thus more likely to become hooked while depredating a hooked fish that has ingested the hook into their abdomen. Keeping the hook in the fish's head (i.e., the mouth or throat) would reduce the likelihood of a whale getting hooked during a depredation event. To accomplish this, this activity involves creating a working group to develop an experimental fishing project (or build on any existing data from other working groups) to research/test various hook sizes and shapes (e.g., circle versus J hooks, barbless versus barbed hooks), and different types of bait that may increase the likelihood of hooking fish in the mouth without the hook being ingested.

2.1.2.2 Incorporate testing of gear measures/modifications in tournaments.

To field test new fishing measures or modifications, collaborate with fishing sponsors (e.g., tackle, equipment, accessory manufacturers, fishing media). Sponsors can support high-dollar prizes for fishermen that volunteer to test gear/modifications.

2.1.2.3 Continue to research and evaluate options that encase the bait/catch to prevent depredation in non-longline fisheries.

Based on results from actions within 2.1.1, design non-longline fishing gear modifications with the potential to reduce or eliminate interactions, or their severity. The Hawaiʻi commercial deep-set longline fishery has already conducted preliminary research of a catch-trigger deterrence device (see Action 6.6.3). Further research from this study by Ishizaki and Itano (2018) could potentially be scaled and made applicable to non-longline fisheries.

2.1.3 Conduct targeted research on human dimensions of fishing-false killer whale interactions.

Ethnographic and survey research on interactions (i.e., depredation of catch and bait, hooking, entanglements, boat following, etc.) between cetaceans and small-boat fishing operations (e.g., trollers, bottom fishers, charter boats) as well as with the Hawaiʻi commercial longline fleets have provided valuable insight into understanding how, when, where, and why interactions between fisheries and cetaceans tend to occur in the main Hawaiian Islands as well as how longline fishermen are affected by, respond to, and attempt to mitigate protected species bycatch (Madge 2016, Ayers and Leong 2020). Using these results as a foundation, additional studies can be designed to gain a deeper understanding of fishermen knowledge, attitudes, motivations, incentives, and behaviors regarding false killer whales. Studies should be designed following social science best practices for collecting sensitive information, ideally in consultation with social scientists, using a culturally-sensitive approach. These may include collecting data anonymously, using methods such as indirect questioning or the randomized response technique, and otherwise designing data collection to protect participants from self-incrimination. The studies/surveys should promote the benefit to fishermen to optimize participation (e.g., less gear loss, more fish landed, etc.), and emphasize that enforcement/prosecution actions will not result from survey participation. Ultimately, these studies can provide audience research and baseline data to inform design of management interventions to affect awareness, knowledge, skills, or behavior.

2.1.3.1 Evaluate prevalence of interactions and which fishing practices are more likely to result in interactions.

Information on types of gear used, fishing methods/techniques, target species, fishing frequency, and fishermen motivation can be compared to locations, types, and prevalence of interactions, ranging from sightings to incidental hooking and entanglements to intentional harm. If it is determined that certain gear/bait is more likely to attract/interact with false killer whales, consider working with fishermen to conduct research that will identify acceptable alternatives and conduct outreach to encourage/incentivize use of other gear type/bait or modified fishing practices.

2.1.3.2 Evaluate options for effective reporting of incidental take.

Foremost is encouraging/incentivizing fishermen to anonymously report any incidental takes of false killer whales. (All commercial fishermen are already required to report any injuries and mortalities to marine mammals that occur during commercial fishing activities (50 CFR 229.6), but fishermen may not be aware of this requirement as compliance is extremely low.) This can be done via calling the Pacific Islands Marine Mammal Response Network (PIMMRN) at (888) 256-9840. A responder will guide the caller through 1) information we are looking to collect so we can better understand how to prevent or deter these unintentional interactions, and 2) how to release the animal with as little remaining gear as possible, as long as it is safe for the fisherman.

Useful information to collect from the anonymous caller includes but is not limited to: a description of the animal (size, coloration, dorsal fin shape and size etc.); the likely species involved; where on its body it was hooked (e.g., lip, jaw, throat); what type of fishing was occurring (e.g., shortline, kaka line, troll, handline); was a single gear or multiple gear types being used; what type of gear was used (e.g., hook shape [circle versus J], hook type [barbless versus barbed], hook size/strength, and line strength); what type of bait was used; soak time (if applicable); a description of any attempts to remove gear from the animal; what/how much gear remained on the animal (if any); and whether any photos or videos of the event were taken.

Outreach methods to encourage/incentivize anonymous reporting include developing reporting stickers/decals to be given out to all fishermen and boaters. Regular website and social media postings can put out a call for this information and emphasize the anonymity of the reporting.

It is important for fishermen to know that while simply cutting the line and not reporting the interaction may be an easier option for them, the anonymously-collected data are actually incredibly valuable for both fishermen and the whales. For instance, it may help us to not only determine if/how gear can be modified to prevent interactions with false killer whales (and perhaps other odontocetes) while maintaining catch rates of target fish species, but also how to prevent loss of expensive fishing gear. Follow up studies can then be used to determine benefits and barriers that affect reporting of incidental take and improve reporting systems and requirements (see Action 2.1.7.3).

2.1.3.3 Identify opportunities and means to work with fishermen to reduce interactions.

Audience research can be used to inform the design of targeted, strategic management interventions and incentives to affect awareness, knowledge, skills, or behavior most linked to interactions with MHI IFKWs. Depending on the objective, considerations can include, for example, testing outreach messages that resonate best with fishermen including the use of incentives and disincentives, who best the message should come from, the method by which to communicate (e.g., outreach at fishing events, talk stories at fishing clubs, TV/print media, social media), etc.

Also, regarding methods by which to communicate, it would be useful to have a better understanding of the main forms of communication used by fishermen/fishing communities in Hawaiʻi. For example, while there are Facebook pages for offshore "big game" fishermen and for spearfishing in Hawaiʻi, assessing how broadly these reach into the various island fishing communities and how representative they are of the diverse fishing methods used among the islands would be of value. Moreover, if social media is the mode of communication shared broadly among fishing communities, it would be good to identify ways to encourage reporting of observations or interactions with MHI IFKWs (or cetaceans in general).

2.1.4 Continue fine-scale analysis of state fishing data in relation to MHI IFKW habitat use with an increased sample size to address seasonal, inter-annual, and environmentally driven (e.g., ENSO, PDO) variability in MHI IFKW spatial use.

Current analyses illustrate that fishery interaction rates vary among MHI IFKW social clusters (Baird et al. 2015) and thus likely vary among the Hawaiian Islands (e.g., Baird et al. 2017a); however, the sample size of tag data has been limited in terms of seasonal, inter-annual, and environmentally driven (e.g., El

Niño–Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), La Niña) variability in MHI IFKW spatial use. The following sub-actions are discrete analyses that can be done independently using existing data.

2.1.4.1 Continue to evaluate the spatial distribution of state non-longline commercial and recreational fishing effort by fishery.

This action complements and expands on actions within 2.1.3 by assessing from which ports non-longline commercial and recreational fishermen are based (throughout the state and not just near hot spot areas), how many fishermen use each port, type of fishing (commercial versus recreational), what community they are from, types of gear they use, how often they use (and what kinds of) multiple gear per trip, etc. Summaries of landings for commercial effort by spatial grid areas can be produced (available by time period, gear, landing port, and species); however, it should be noted that commercial catch may only be 25–35% of the recreational catch. The spatial data matrix can then be turned into GIS area plots to provide a visual representation, which can then be used to inform fisheries management recommendations and targeted outreach. More detailed information on recreational catch is needed for this to be effective.

2.1.4.2 Model habitat hot spots using false killer whale telemetry data in relation to oceanographic data and fisheries catch data for individual fisheries.

Modeling habitat hot spots and primary travel corridors using telemetry data in conjunction with oceanographic data and fisheries catch data allows for an assessment of where and why MHI IFKWs prefer certain areas, and where they most often overlap with specific gear types or fisheries. Ideally, if a greater number of satellite tags could be deployed on multiple individuals from all social clusters throughout each year, it may be possible to provide this information with real-time updates (see Action 2.1.7.3). Given these animals travel quickly and frequently among island areas, real-time updates of where false killer whales are spending time and traveling through could aid fishermen in avoiding important habitat/areas on a daily or seasonal basis and thus avoiding potential interactions/depredations with MHI IFKWs. Preliminary analyses of travel corridors were undertaken for the designation of critical habitat and can be used to guide further analyses. This would, however, require much more survey effort each year and deployment of many more satellite tags annually. It may also require incentives for fishermen to avoid these areas since hot spot areas likely have more desirable prey species.

2.1.4.3 Investigate the spatial distribution of shortline fishing effort.

Based on the similarities between this fishery and longline fisheries with respect to gear type and target species, shortlining has the potential to interact with false killer whales, but the nature and extent of interactions are unknown. Anecdotal information suggests that this fishery operates nearly exclusively at Cross Seamount, which is outside the range of MHI IFKWs, but as the shortline fishery is a "category II" fishery, and the reporting of gear fished is voluntary and allows for reporting of "mixed" effort, the amount of shortline fishing and where it is occurring is largely unknown. This could be addressed by mandating electronic monitoring (EM) on any vessel equipped for shortline fishing (e.g., with a reel for long- or shortlines). A clear understanding of the spatial extent of this fishery will help us either eliminate it as a potential cause for concern for this DPS (if it does not overlap with the MHI IFKW range), or better understand its potential to interact with the MHI IFKW.

2.1.5 Work cooperatively with the State of Hawaiʻi to identify initiatives and projects that will enhance the conservation and management of MHI IFKWs.

A number of opportunities exist for the state to lead activities in conserving, managing, and recovering MHI IFKWs and their habitat. We encourage this and are willing to assist in any way we can to make this happen.

2.1.5.1 Establish a State of Hawaiʻi recreational fishing license and reporting form.

Currently, there is no requirement for a marine recreational fishing license for Hawaiʻi residents if the catch is not sold. The State does not currently have the legislative authority to create a residential recreational fishing license; however, the State is supportive of creating one (it was proposed but denied during the 2018 legislative session). This concept was reviewed by an independent group—the Registry, Permit, or License study group—that held a public information and feedback process in 2016 (see the 2016 final report "Feasibility of a Non-Commercial Marine Fishing Registry, Permit, or License System in Hawaii.") This concept is also in discussion with the State of Hawaiʻi's Department of Land and Natural Resources' Division of Aquatic Resources (DLNR–DAR) and they intend to hold their own set of public informational meetings. A recreational fishing license for residents, coupled with a recreational fishing reporting form, would provide a way to monitor recreational fishing effort and catch levels, as well as sightings and interactions with MHI IFKWs and other protected species.

Although a residential marine recreational fishing license does not yet exist, in June 2021, House Bill 1023 was signed into law and establishes and requires a marine recreational fishing license for all non-Hawai'i residents. Visitors must purchase this license in order to fish from the shoreline or a boat in Hawaiian waters, including charter boat clients. However, the bill requires DLNR–DAR to first adopt a corresponding administrative rule and to develop a licensing system. This process could take close to a year to complete.

2.1.5.2 Modify the state Commercial Marine License (CML) reporting forms to include additional information or improve the quality of existing data collection.

Additional information on state CML forms could help us glean how, why, when, and where depredation events of catch/bait and interactions with false killer whales are occurring. Currently the state CML forms collect data on catch, season, location, gear type/method, etc., but additional information (similar to commercial longline fishing reporting forms), such as some gear aspects not reported, intensity, distribution of each of the different types of fishing, and interactions with cetaceans and other protected species could provide valuable insight. (In 2019, the State was awarded an ESA section 6 Species Recovery Grant (see Action 2.1.5.4) to add protected species sightings to the current online reporting forms. Consultations with NOAA on what other information would be useful is included in that grant.) Consider testing the revised form before officially modifying it to ensure it meets the objectives.

2.1.5.3 Develop and implement a Habitat Conservation Plan for an ESA section 10 Incidental Take Permit (ITP) for all protected species.

Under the ESA, it is unlawful to "take" all endangered species and those threatened species with ESA section 4(d) rules invoking take prohibitions (take means to harm, harass, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct). However, it is possible to obtain an ITP to "take" a listed species under section 10(a)(1)(b) of the ESA, if taking is incidental to, and not the purpose of, an otherwise lawful activity. To obtain an ITP, it is necessary to develop a conservation plan that specifies such information as the effects of a taking, the steps that will be taken to minimize and mitigate those effects, alternatives considered, etc. The State of Hawai'i can develop a conservation plan (with the assistance of NOAA Fisheries) for all marine protected species in state waters (e.g., Hawaiian monk seals, sea turtles, MHI IFKWs, fin whales, sei whales, sperm whales) that may be incidentally and unintentionally taken by non-longline commercial and recreational fisheries. This will ensure these fisheries are complying with the ESA.

As a first step, the State of Hawaiʻi and NOAA Fisheries should work with fishermen to foster understanding among the fishing community about the purpose of an ITP. Because incidental take of MHI IFKWs is already occurring, an ITP would allow fishermen to report hookings and entanglements without fear of prosecution; this could thus potentially result in increased self-reporting of incidental interactions with MHI IFKWs (and other protected species; see Action 2.1.7.3). Subsequent steps would be to develop the ITP and then implement it via a series of workshops, meetings, or other outreach.

2.1.5.4 Continue to apply for a Species Recovery Grant through the ESA section 6 grant program.

NOAA Fisheries annually advertises a competitive Species Recovery Grant (ESA section 6) Program for states with cooperative agreements in place. Federal funding provided through these grants can be used to support management, outreach, research, and monitoring projects that have direct conservation benefit for listed species. In 2015, the State of Hawaiʻi DLNR–DAR received a three-year section 6 Species Recovery Grant to strengthen efforts to minimize and mitigate the incidental take of MHI IFKWs through fieldwork, spatial and temporal analysis of the overlap between fisheries and false killer whale habitat, stranding response support, and targeted outreach efforts. In 2019, they were awarded another three-year grant to continue these and similar efforts. Continuing to apply for (and successfully being awarded) this highly competitive grant can provide much needed funding to aid in recovery of MHI IFKWs (and other protected species), fill essential data gaps for the False Killer Whale Take Reduction Team, and support both NOAA Fisheries and state efforts to manage MHI IFKWs.

2.1.6 Continue tracking fishing gear injury rates.

False killer whales that depredate catch and bait from fishing gear may acquire linear injuries on the mouth gape or break teeth, either from the abrasion of the line itself or as a hook pulls out (Moore and Barco 2013). For hooked individuals that struggle against a taut line, linear wounds also may occur on the dorsal fin or other appendages as the animal reacts to the hooking (Baird and Gorgone 2005, Kiszka et al. 2008, Nery et al. 2008, Baird et al. 2015, 2017b). By obtaining high-quality photographs of false killer whale dorsal fins and mouthlines, we can identify individuals and attribute them to a population (insular, pelagic, or NWHI), collect ancillary information (e.g., gender and social group or cluster), and monitor trend rate of interactions. This will allow us to determine if recovery actions are successful in reducing the rate of incidental take. Cascadia Research Collective currently tracks these injuries as part of their photo-ID efforts of live animals.

Additionally, the University of Hawaiʻi has the opportunity to both externally and internally evaluate fishing gear injuries on deceased animals. This can be done via routine examination of mouth scars, broken teeth, and other internal injuries such as examination of the entire gastrointestinal tract and stomach chamber linings for potential perforations and scarring. It is also possible to obtain tissue samples of areas of injury for histopathological assessment. Continuing to track fishing gear injuries can also help to chart health outcomes following fisheries interactions. This information could potentially be used in fine-tuning the guidelines for distinguishing serious from non-serious injury of marine mammals pursuant to the Marine Mammal Protection Act (MMPA) and assessing the degree of threat to the population.

2.1.7 Develop strategic outreach messaging, tools, and programs for the fishing community and other stakeholders.

To achieve changes in behavior that result in conservation value for MHI IFKWs, close coordination among federal agencies, state partners, the fishing community, fishing charter operators, ecotourism operators, and other stakeholder groups is essential. Some identified needs are (1) ensuring correct species identification of false killer whales, (2) increasing knowledge of their status and importance as a unique Hawaiian resource, and (3) reducing fishery interactions. Messages, tools, and approaches should be tailored to each stakeholder group based on social science research to understand audience values (e.g., results from studies in 2.1.3). Outreach programs and tools should promote the use of MHI IFKW-friendly hooks (see Actions 2.1.2.1, 2.1.2.2, and 2.1.7.1) to the fishing community and perhaps include an incentive program for using these hooks. They should also be geared toward specific stakeholder groups and tailored appropriately.

2.1.7.1 <u>Based on results from actions in 2.1.1 to 2.1.4, develop an outreach strategy on how to promote best fishing practices.</u>

Using results from the investigations detailed above, develop best fishing practices for different gear types and fishing groups, and develop a strategy to promote these practices. Examples may include using specific gear and bait (depending on desired catch) to avoid interactions with MHI IFKWs, hauling in gear and departing an area if false killer whales are seen, how to de-hook/disentangle an animal if an interaction occurs, and how to anonymously report the incidental interaction. Consider using protocols developed as part of the FKWTRP, the Council's protected species handling guidelines, as well as the Fishing Around Seals and Turtles program. Target these strategies to non-longline fishermen that operate out of Kāneʻohe, Molokaʻi, north shore of Maui, and Kawaihae, or other areas that are identified as having significant overlap between fishing effort and MHI IFKW high-density areas.

Dissemination of best fishing practices should be done via an array of preferred methods identified by fishermen. This could include waterproof hard copy materials, a video on how to de-hook and disentangle an animal, peer-to-peer messages, demonstrations/hands-on trainings, etc. Before material is distributed, convene workshops with fishermen (in places with a high likelihood of overlap such as Kāneʻohe, Molokaʻi, north shore of Maui, and Kawaihae) to ground truth information since their experiences may alter how best to respond to an interaction with a cetacean. Distribute materials at locations that target audiences visit, such as fishing tournaments, supply stores, harbors, boat ramps, etc., and through established communication channels (e.g., fishing associations, clubs, social media, and gatherings).

2.1.7.2 <u>Develop and implement a routine non-longline fishing and boating protected species workshop.</u>

To improve relationships, exchange information, and build trust with Hawaiʻi's sport/recreational/commercial fishing and boating sectors, it might be useful to hold a series of voluntary workshops in multiple locations on each island to discuss how best to enjoy and utilize the marine environment while avoiding interactions with protected species. Information could include false killer whale identification, including how to differentiate among different species of "blackfish"; best fishing practices to avoid interacting with protected species; handling and release techniques if an interaction with an MHI IFKW or other protected species occurs; how to use a smartphone app for reporting sightings and interactions of MHI IFKW and other protected species (if developed, see below); and how to photograph dorsal fins/mouthlines of MHI IFKWs and other protected species, and submit photos/videos to Cascadia Research Collective. Information to glean from fishermen, boaters, tour operators, etc., could include methods they deem best to de-hook or disentangle false killer whales, how often and where they see false killer whales, their home port, how best to continue to engage and communicate with them in the future, etc.

2.1.7.3 Develop a smartphone application for reporting sightings and interactions with false killer whales.

Promoting the real-time location and reporting of false killer whales (either via visual sightings or satellite tag reporting) will not only provide researchers with valuable information but also inform fishermen about which areas to avoid. An example of such a mobile application or "app" is Alaska's Whale mAPP, which is a free app for iPads and iPhones for fishermen, recreational boaters, industry partners, and volunteer networks to share real-time sightings of humpback whales. Another example is the app Whale Alert, which has been used in the U.S. Atlantic Coast to display whale "safety zones," and allows users to report any live, dead, or distressed whale sightings to the appropriate response agency, thus making this app an important tool for reducing ship strike threats to all whale species.

The Pacific Whale Foundation's Whale & Dolphin Tracker is another example of an app (for both Apple and Android devices) that primarily collects scientific data about marine wildlife in the four-island region of Maui, Kahoolawe, Lānai, and Molokaʻi (most specifically for humpback whales). Type of species, GPS location, group dynamics, observed behaviors, and other data in real time is uploaded instantly into their research database. Since this app already has a solid interface that receives contributions from numerous users currently utilizing the app, this free app easily could be used to collect sightings from all areas within the main Hawaiian Islands. In addition to displaying real or near-real-time visual sightings on a map of the Hawaiian Islands and allowing photos to be uploaded, the app could be modified to integrate real-time satellite location data from any tagged false killer whale into the sightings map, create a "false killer whale" user group who would only receive data on false killer whales, and create a push-notifications feature for sightings of false killer whales that would send an alert out to all apps within a set radius or a set user group, provide information on how to identify false killer whales from other "blackfish" cetaceans, steps to take in case an interaction occurs, and the ability to upload videos. Additionally, since there is also a research aspect to the app in that it collects both sighting data as well as effort data (recording vessel GPS track), this feature could have important implications for false killer whales given that the app can collect information 365 days/year.

A more advanced modification of this app could include an electronic logbook feature whereby fishermen could anonymously report an interaction with a false killer whale (or any marine species). Data could include the species type, the GPS location of the interaction, the type of fishing and gear used, whether dehooking was attempted/successful, what kind and how much gear remained on the animal, where the gear remained (e.g., in the jaw, in the lip), the animal's disposition following the interaction, and any photos or videos of the interaction. To keep the information anonymous, the app administrators (Pacific Whale Foundation) could scrub identifying information from the data (e.g., fisherman's name, vessel name) before providing the interaction data to NOAA Fisheries. Collecting valuable data of this type could help researchers to further modify gear in an effort to reduce the frequency and severity of interactions (see Action 2.1.1.2).

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

2.2.1 Continue research on diet of MHI IFKWs to identify important prey species.

Researching the diet of MHI IFKWs will help identify their most important prey species, including the extent of the importance of squid and other prey such as mahi mahi. Several approaches may be used to determine the specific diet of MHI IFKWs, including observations of and data from predation events, and continued analysis of stomach contents of stranded deceased animals. Other potential approaches that have not yet been implemented include DNA analysis of fecal samples, stable isotope studies, and predation event samples (e.g., scales and tissue of prey). Additionally, compound specific stable isotopes of amino acids provide a promising new technique to better understand diet from biopsies of live false killer whales. Results should inform management actions to keep those prey stocks healthy.

2.2.2 Complete more targeted analysis of non-longline commercial and recreational catch data of MHI IFKW prey species to clarify level of competition.

A targeted analysis of non-longline commercial and recreational catch data will 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.

2.2.3 Analyze and model MHI IFKW prey abundance dynamics (i.e., seasonal/spatial variation of prey distribution) within the range of MHI IFKWs and manage, *where appropriate.*

As a first step, this activity involves investigating whether non-tuna prey species are highly migratory (i.e., typically come and go with the seasons on a regular basis to spawn, feed, or winter elsewhere), or are local stocks**.** One qualitative way to investigate this is to tap into the local knowledge of fishermen and local fishery researchers who likely have noticed seasonal or daily variations in the availability of various target species. These fluctuations may also be mined from quantitatively analyzing fishing effort locations and landing records, where available. A more sophisticated investigation may include internal or external tagging of fish species.

If non-tuna stocks are local, examine how short- and long-term effects from ocean conditions (e.g., eddies, ENSO, PDO, La Niña events) affect distribution and abundance of prey, and how a decrease in local biomass might affect MHI IFKWs. Systematically use an array of drifting sensors or gliders to monitor ocean dynamics on a wide range of spatio-temporal scales, and couple this information with prey species' distributions to examine how ocean conditions influence prey availability. Focus on the windward side of the archipelago and near MHI IFKW hot spots to better understand the oceanographic features. Also, develop stock assessments and consider fishery management actions (e.g., catch/size limits to maintain or rebuild healthy local stocks), where appropriate.

If non-tuna prey species are highly migratory, advance international conservation of these prey species. This may include collaborating with organizations such as the South Pacific Regional Fisheries Management Organization.

2.2.4 *Further investigate MHI IFKW foraging behavior and locations.*

Studies indicate that social cluster dynamics in Hawaiʻi play an important role in where false killer whales spend their time and how frequently they interact with fisheries (Mahaffy et al. 2017). We can help mitigate fisheries interactions by knowing where and why false killer whales spend their time. Information such as the amount of energy spent foraging and the caloric content of different prey types and sizes will further inform dietary needs of MHI IFKWs and whether they are being met. Location information to further investigate includes what specifically makes hot spot areas important foraging areas.

2.2.4.1 <u>Better understand MHI IFKW foraging movement and behavior.</u>

On animals from all known social clusters, continue to deploy tags that record behavior (e.g., dive depth, video, three-dimensional accelerator, acoustics) to investigate time spent foraging, average/maximum dive depth, time spent at depth, time of day of dive, prey sharing, location of hot spots, etc. More robust information on foraging behavior, prey types (e.g., the importance of mahi mahi and ulua versus diamondback squid), and feeding habits during the day versus at night will help us understand how fisheries may influence prey availability. Additional useful information that may result from video instruments such as Critter Cams© includes data on fisheries interactions and habitat use in identified hot spots. This additional information may help inform both fisheries management and other management actions to reduce human interactions with MHI IFKWs.

2.2.4.2 Continue to assess the social dynamics of foraging behavior.

Continue to use underwater camera poles and Unmanned Aerial Systems (UAS) to further investigate fusion-fission (coming together and splitting) of foraging groups as well as prey sharing within social clusters. There may be cluster-specific differences in diet, though they are likely subtle if they do exist. Examination of stable isotopes and fatty acids from biopsy samples may also provide evidence of dietary differences among demographic classes (e.g., sex, age) and over time—inferring a change in prey selection that could be related to temporal trends in fisheries catch/effort. Better understanding diet preferences may help if/when considering how to manage fish stocks.

2.2.4.3 Investigate what makes "hot spot" areas such high-use areas for MHI IFKWs.

Increasing our understanding of what makes an area a high-use area is important because it can give us a clearer picture of how and why MHI IFKWs use certain areas. We know that high-use areas are, on average, shallower, closer to shore, and have gentler slopes than lower-use areas, and have higher chlorophyll-a concentration. These features likely indicate that different oceanographic processes in these areas may enhance productivity. Based on satellite-tagged pelagic false killer whales, behavior of MHI IFKWs may differ by foraging area, which may suggest changes in foraging strategy for different conditions (Anderson et al. 2017). Therefore, having a better understanding of hot spot locations and why they are important can help us manage these areas, if needed.

One method to investigate hot spot areas is to conduct a computer-based modeling exercise to simulate a population of vertically-migrating micronekton (prey of prey) that are easily preyed upon by MHI IFKW prey (tuna, billfish, etc.) and add in layered currents from circulation models to drive this process. Dynamic maps produced from this modeling exercise could lead to hypotheses about why these particular areas are important. Such dynamic maps may also indicate other spatial/temporal areas where predators are cued into the diurnal migration of micronekton. A ship-based midwater trawl could help confirm this process with some targeted surveys in hot spot areas and adjacent areas for comparison. This information can be compared with the observed patterns of habitat use from tags and visual observations of MHI IFKWs. Use results to tailor outreach about the importance of hot spot areas and continue to monitor these areas over time.

2.2.4.4 <u>Monitor for seasonal/spatial changes in MHI IFKW foraging activity over time.</u>

We assume that spatial aspects of foraging activity change with seasons and are correlated with ocean productivity/changes in fish abundance. Results from the research-oriented actions listed above (e.g., 2.2.4.1, 2.2.4.2, and 2.2.4.3) will provide further clarity on foraging behavior and spatial distribution. Using those results, consider refining fisheries management actions, if needed.

2.2.5 Assess body condition of MHI IFKWs over time to determine if nutritional needs are being met.

We can assess body condition—via biopsy analysis (including adipocyte area and index of blubber) and photographic morphometric analysis (photogrammetry)—to determine whether nutritional needs are being met using multiple methods, including those listed below. If nutritional stress (i.e., emaciation) is detected in multiple individuals over time, monitor the condition and consider developing and implementing additional fisheries management actions, if necessary.

Assessing body condition via biopsies and photogrammetry can also detect other health issues such as growth and maturation, pregnancy, diet preferences/changes, disease, contaminants, etc. (see Actions 1.1, 3.1.1, 4.2.1, and 5.3).

2.2.5.1 <u>Conduct regular biopsy surveys and use cortisol measurements to detect nutritional stress.</u>

Cortisol is a glucocorticoid or steroid hormone that can be extracted from blood, blubber, or breath samples and is one of the most commonly used indicators of stress-response activation (e.g., from increased anthropogenic noise, increased contaminants, decreased nutrition). If a MHI IFKW is nutritionally stressed, it will have a higher than normal cortisol level. This can indicate the overall well-being of the individual since prolonged or frequent release of this stress hormone can lead to detrimental effects on survival and reproduction. Therefore, continue to conduct regular biopsy surveys and cortisol analyses of MHI IFKWs to monitor changes in condition. (These biopsies can also be used for epigenetic aging, sexing individuals, examining reproductive hormones, and environmental contaminants; see Actions 1.1, 3.1.1, 4.2.1, and 5.3.) For example, measure adipocyte area and index of blubber in stranded animals where body condition is known as well as from MHI IFKW biopsies. Compare results to University of Hawai'i's dataset from stranded odontocetes of known emaciated and robust status with striking differences. Analyses such as these can provide concrete evidence of nutritional health. Reference levels should be obtained from the pelagic/NWHI populations as well as elsewhere and monitored for population-level changes. Consider management actions if needed.

2.2.5.2 Use UAS/drone with aerial photogrammetry to measure body condition.

A UAS may be used to hover over individuals to morphometrically assess the body condition of MHI IFKWs using aerial photogrammetry. These precise measurements of length and girth can differentiate healthy, robust animals from nutritionally stressed animals that are thin or emaciated. A UAS also may be used to collect breath samples from animals to look at the respiratory microbiomes (e.g., Lerma et al. 2019). This can help us learn more about what organisms are effectively inhabiting the lungs of the animals so we can determine if any of them are pathogens that could be causing problems. Cortisol hormones can also be sampled via this method as well.

2.2.5.3 Determine if certain genes are expressed in nutritionally-stressed animals.

Nutrigenomics, or the study of the interaction of nutrition and genes, is a promising means to monitor nutritional status of a species. If MHI IFKWs are experiencing nutritional stress, cellular processes involved in immune response may be down-regulated while other processes may be up-regulated. Expression of deleterious genes caused by nutritional stress could limit recovery of the population through synergistic effects, such as increased susceptibility to contaminants, noise, etc. Knowing if, when, and why false killer whales are nutritionally stressed as well as better understanding what can happen during nutritional stress will help us garner support for managing fish stocks if needed. Biopsies for these analyses (as well as for epigenetic aging, sex, contaminants, etc.) are associated with Action 2.2.5.1.

2.2.6 Implement slot limits of fish species in state fisheries, especially recreational fisheries.

Minimum size limits (usually L50–the length at which 50% of the fish population is reproductively mature) are a management tool that helps ensure individual fish have the opportunity to grow to maturity. To increase biomass and fecundity, slot limits (minimum and a maximum size), should be implemented, as the larger a fish is, the more fecund it is. Reviving the BOFFFs (big old fat female fishes) campaign and gaining support for this management strategy in general is a good idea for nearshore fisheries. After confirming MHI IFKWs' diet and overlap with fisheries' target species per Actions 2.2.1 and 2.2.2, encourage the development of slot limits for fish species in state fisheries.

3. ENVIRONMENTAL CONTAMINANTS AND BIOTOXINS

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

3.1.1 Identify contaminants in false killer whales and incorporate into a general health assessment to see how all of these factors may be interconnected.

Continue to collect biopsies and fecal samples from insular, pelagic, NWHI, and other Pacific populations of false killer whales, and conduct analyses to determine type and level of contaminant load (this can be done in concert with other biopsies like in Actions 2.2.1, 2.2.5.1, 2.2.5.3, 3.1.1, 4.2.1, 4.2.4, 5.3, and 6.1). Compare results from MHI IFKWs to other populations and monitor for changes over time. Continue conducting necropsies (see Action 6.4.4) and post-necropsy analyses (see Action 5.3) to determine if there is a detectable level of contaminants and how this changes over time.

In addition to identifying the type and load of contaminants in the MHI IFKW population, compare this information to other factors of a general health assessment to see how these factors may be related (i.e., if and to what extent they are acting synergistically). For example, pathogen load can be examined through 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 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.

3.1.2 Identify sources of environmental contaminants and biotoxins, and form partnerships to manage as necessary.

3.1.2.1 Analyze contaminant levels in prey species.

A change in contaminant levels in prey species may indicate a change in contaminant levels in MHI IFKWs. By monitoring contaminant levels in prey over time and comparing with contaminant levels from biopsied MHI IFKWs, we can track the trend of overall contaminant levels in the main Hawaiian Islands. Consider collaborating with fishermen to collect biopsies from prey species.

3.1.2.2 Identify and control land-based sources of pollution.

This activity entails identifying sources of contaminants. These may include landfills and Superfund sites (i.e., land contaminated by hazardous waste and identified by the Environmental Protection Agency (EPA) as a candidate for cleanup because it poses a risk to human health and the environment), chemicals used in tenting for termites, poor quality of effluent from wastewater or sewage in certain areas, and cat feces infected with the *Toxoplasma gondii* parasite. If these contaminants are found in runoff and streams, investigate if and to what extent levels increase during periods of heavy rainfall.

For all of the above, if deemed a source of contaminants, investigate ways to mitigate the source(s) and their effects. This will likely entail partnering with federal and state agencies charged to control environmental contaminants, such as the EPA and the five counties of Hawaiʻi, to implement secondary treatment of wastewater or sewage, as well as working with communities to minimize inputs and clean up contaminated sites.

3.1.2.3 Determine if mercury sources are local or international and manage, where possible.

If mercury sources are local, investigate ways to mitigate. This could include reducing consumption of raw materials and products that generate mercury releases, or substituting products and processes containing or using mercury with products or processes without mercury, or improving waste management of mercury wastes.

3.1.3 Monitor levels of naturally occurring biotoxins (e.g., algal toxins, ciguatoxin) in the marine environment.

Biotoxins such as domoic acid, saxitoxin, brevetoxin, ciguatoxin, and maitotoxin have been shown to accumulate in fish and top-level predators such as marine mammals (Trainer 2002) and have caused a number of marine mammal stranding events. Marine environmental toxins should be monitored with some regularity and when detected, should include monitoring for any potential effects to MHI IFKWs.

Eutrophication, which can occur in bays and harbors of Hawaiʻi, is excessive nutrient input into the marine environment and can occur when runoff is heavy in nitrogen, nutrients, detergents, fertilizers, sewage, and other chemicals. This type of excessive nutrient input can cause harmful algal blooms as well as dead zones and should be monitored and managed, where possible.

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

4. ANTHROPOGENIC NOISE

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

4.1.1 Characterize soundscape, focusing on high-use areas.

False killer whales have a highly evolved acoustic sensory system that they rely on for navigation, foraging, and communicating. There are many sources of anthropogenic sound throughout the main Hawaiian Islands, consequences of which may include avoidance/attraction of an area, change in behavior, masking of other sounds, hearing damage, and even stranding. Therefore, this activity will involve investigating whether MHI IFKW hot spot areas have different levels of acute, chronic, and/or cumulative levels of ambient/anthropogenic noise compared to surrounding areas. This should occur over several years, seasons, and sea states (ocean sounds can vary with all of these) to determine the complete acoustic soundscape and if any variability exists. Ideally, this would be a repeatable activity and with a long-term duration (e.g., every 5 years). Use this to inform development of trigger-dependent emergency management action(s) to implement if demographic information indicates that the MHI IFKW is in decline (see Action 1.5 for more information).

4.1.2. Validate sources of sound.

Anthropogenic sounds can vary greatly by such parameters as frequency range, intensity, and location. Effects to a species can vary depending on such things as how far the sound carries; whether the sound is continuous, intermittent, or one-time pulses; impulsive versus non-impulsive (e.g., sonar, pile driving); continuous versus non-continuous (e.g., vibratory versus impact pile driving); acute versus chronic; stationary versus mobile; etc. Validating sound sources (e.g., sonar, explosives, pile driving, alternative energy, and boat engines) will help to determine if noise is propagating (traveling) as believed. This activity will involve using validation to confirm or update noise models that are used for ESA section 7 consultations (current models take into account distance of source, but the focus has primarily been on closer sources). Also, use validation to modify best management practices such as safe zones, buffer zones, marine mammal monitoring and lookouts, timing windows, etc.

4.1.3 Use soundscape information to update NOAA's CetSound program.

NOAA's CetSound, or Cetacean and Sound Mapping, is a program to manage cumulative effects to marine species from underwater noise and consists of two mapping tools: CetMap, which is a NOAA mapping tool that aims to improve our ability to visualize cetacean density and distribution; and SoundMap, which applies mapping methods to depict temporal, spatial, and spectral characteristics of resulting underwater noise. Continuing to update CetMap with the latest available data, including data from SanctSound being conducted by the NOAA Office of National Marine Sanctuaries and funded by the Navy, as well as downloading new acoustic monitoring information into CetSound will aid NOAA's Ocean Noise Strategy to guide science and management actions towards minimizing the acute, chronic, and cumulative effects of noise on marine species and their habitat.

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

4.2.1 Better understand biological stress response related to noise during anthropogenic events.

For this activity, biopsy and collect fecal samples from false killer whales before, during, and after anthropogenic noise events to analyze stress hormone (cortisol) levels. Natural experiments to monitor and sample include military training and exercises, sonar use, drilling, pile driving, etc. False killer whale individuals in an area prior to a known event that will generate high levels of anthropogenic noise could be satellite tagged to look at movements before, during, and after the noise is introduced. Manage sources of noise if results indicate that false killer whales are harassed and/or harmed from anthropogenic noise sources (see Action 4.3, below).

4.2.2 Conduct studies on captive false killer whales to determine the acoustic masking (i.e., blocking) effects of anthropogenic noise on marine mammal communication.

Unfortunately, the captive false killer whale at Oʻahu's Sea Life Park (originally from China) passed away in 2019. If possible, corroborate findings on other captive false killer whales to potentially determine what amount of noise (e.g., engine noise) interferes with the ability of a cetacean to detect vocalization calls and to hunt for prey.

4.2.3 Better understand hearing effects from alternative energy projects on MHI IFKWs.

According to the U.S. Energy Information Administration, Hawaiʻi is the most petroleum-dependent state in the nation. The Hawaiʻi Clean Energy Initiative began in 2008 with the goal to achieve 100% clean energy by 2045. Clean energy sources from the ocean include waves, tides, currents (marine hydrokinetic), temperature differences in the ocean (ocean thermal energy conversion), and wind. We need to better understand potential effects to hearing of MHI IFKWs from construction and operation of these energy sources. For example, how will noise generated from construction and operation of offshore floating wind farms, undersea power cables, wave generation projects, ocean thermal energy conversion projects, etc., change the environment, and how will MHI IFKWs be affected? Satellite tagging could be used when construction begins or during operations to monitor behavior and assess affects. Since many of these renewable technologies are still in the conceptual/early development phase in Hawaiʻi, and thus the effects to false killer whales (and other marine mammals) is unknown, consider reviewing available research on proxy species for marine renewable energy projects in the North Atlantic Ocean and elsewhere. Also, consider using captive false killer whales or proxy species to test sound sources and levels.

4.2.4 Better understand hearing effects from military training on MHI IFKWs.

This activity involves determining if military training events (i.e., use of sonar and explosives) in the Hawaiian Archipelago are causing temporary or permanent displacement, or if military training events are having no discernable effect. Acoustically and visually observing false killer whales before, during, and after a training exercise will provide valuable information about temporary behavioral responses, and if repeated long-term, could demonstrate displacement from an area. Where possible, tag (and biopsy) MHI IFKWs near hydrophones in military training areas (e.g., Pacific Missile Range Facility) and analyze reactions to military vessel movement and sonar use.

At this time, it is not possible to determine temporary or permanent hearing loss as it cannot be measured in the field since it would require data measurements of the individual animal's hearing abilities. Exposure to underwater sound levels would also not confirm that an animal is experiencing temporary or permanent hearing loss, and determining adverse effects to an animal's ability to communicate and forage effectively would require long-term behavioral data (i.e., more than reactions to military vessel movements and sonar).

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.

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.

6.4.1 Update stranding protocols in the regional marine mammal response plan, including developing a mass stranding response plan specific to MHI IFKWs.

The Pacific Islands Region Marine Mammal Response Network has collaborated with federal and state agencies, members of the response network, cooperating scientists, and education specialists to develop response protocols for strandings of live, dead, or entangled whales. Updates to response protocols should occur when necessary to ensure the response network can access and function in remote locations, has the capacity to handle multiple animals, and includes coordination with other federal agencies and partners to assist in a wide range of potential response activities. This also includes ensuring adequate funding to support the stranding response needs and activities, including extensive necropsy and cause of death investigation.

In addition, since false killer whales are known to mass strand and because the insular population is endangered, mass stranding response protocols should be developed specific to this species. General response protocols include maintaining information on response team personnel, storing and mobilizing equipment, identifying necropsy facilities and testing labs, making triage decisions, identifying animals, maintaining contact lists for different islands, updating communication policies, and considering cultural practices and sensitivities. Specific protocols for false killer whales include directing trained photographers to obtain appropriate photos for individual identification so that the social group/cluster involved in the stranding is identified, allowing for monitoring of longer-term survival of these individuals. Satellite tags should also be kept on hand or made readily available to be deployed on a number of individuals. As such, training in the deployment of satellite tags may be needed if it is not already available within the stranding response team. The draft mass stranding response plan should be put out for public comment and peer review before being finalized.

6.4.2 Respond to live-stranded false killer whales.

A live-stranded false killer whale provides a unique opportunity to learn more about the species and the threats facing false killer whales. The PIMMRN, including authorized veterinarians, under the NOAA Fisheries Marine Mammal Health and Stranding Response Program will make the appropriate determination of whether the live stranded animal is deemed releasable or is a candidate for rehabilitation or euthanasia. Samples taken from live stranded animals provide important data that veterinarians can use to determine the best course of action and treatment for the animal; the information also helps build a more comprehensive understanding of wild animals. In the event of a stranding of any size, live stranded false killer whales that are released to the wild should be photographed, biopsied, and tagged so their population/social cluster can be identified and monitored. This will help provide a longer-term health assessment of the individual(s). Specifically, it is particularly important to obtain high quality photographs of individuals that might be returned to the water. Moreover, obtaining skin biopsy samples of live-stranded animals that are returned to the water may also allow for genetic confirmation of individuals that are poorly marked or that have had markings change since the last time they were photographically documented. Biopsies from live-stranded whales could also be included in hormone chemistry analyses, from which a baseline stranding “stress” hormone level could be deduced and referred to in future efforts to understand physiological stress levels. Tagging an animal before refloating should also be considered, as this could inform the movement dynamics of recently stranded individuals, or if the animal were to re-strand, allow researchers to respond effectively to the animal.

6.4.3 Implore the public to report live or dead strandings promptly.

For this activity, remind and urge the public to immediately contact the PIMMRN at (888) 256-9840 whenever stranded false killer whales are encountered (this number is applicable for injured or entangled animals as well). Prompt notification of a live stranding can help responders assess the health of the animal and provide supporting care while determining the best course of action for the individual(s). With dead strandings, it is imperative to obtain high quality photographs of the deceased animal(s) prior to transport as transport may obscure markings that are critical for individual photo-ID. It is also vital that a post-mortem examination is conducted promptly to maximize the possibility of cause of death determination. Furthermore, conducting a necropsy before decomposition occurs beyond the point of collecting valuable samples will ultimately maximize the information gained on the threats to false killer whales, including anthropogenic threats.

Outreach to support stranding reporting can include outreach materials such as stickers, magnets, brochures, “Voice of the Sea” episodes, and other video media development. Social media postings and general marine wildlife outreach events could also promote the importance of reporting strandings immediately. Outreach also needs to include details on previous strandings, including results from cause of death investigations. Many people in Hawaiʻi do not report strandings as they feel that information on individual animals that do strand is not released to the public. Increasing the release of necropsy reports from previous strandings (of any species) may help improve public reporting as much, or more, than other types of outreach.

6.4.4 Necropsy false killer whales.

Extensive necropsy and cause of death investigations can 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). Sampling and storage of necropsied specimens can maximize physiological and biological information, including diet and life history, which cannot be obtained from animals in the wild or through other means. For example, the National Marine Mammal Tissue Bank stores marine mammal tissue to support multiple analyses and provide long-term sample stability for future research. These types of sampling opportunities also help validate and increase understanding and interpretation of data collected from wild populations. Considering that there is much data obtained from past strandings of false killer whales that would be of high interest to the scientific community and the public, support for integrated scientific analysis and report publication should be prioritized. This will aid in effectively communicating results and presenting appropriate findings to the public.

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.

6.6.1 Assess whether implementation of the FKWTRP or subsequent measures (e.g., SEZ closure) resulted in an increase in shortline or other fishing effort inside the range of the MHI IFKW population.

There are two commercial longline management areas in the main Hawaiian Islands: a year-round Longline Exclusion Zone (LLEZ) around the entire main Hawaiian Islands, and a Southern Exclusion Zone (SEZ) south of the main Hawaiian Islands that is closed if the deep-set longline fishery exceeds sustainable levels of bycatch of false killer whales. The SEZ, if triggered, would be re-opened following a specified time interval or when certain bycatch reduction thresholds were met. As of 2019, the SEZ has been closed twice because of at least two observed false killer whale mortalities and serious injuries within the Hawaiian Exclusive Economic Zone in a given year. The first SEZ closure occurred in July 2018 (83 FR 33848; July 17, 2018) and the area was closed through December 31, 2018. The second SEZ closure occurred in February 2019 (84 FR 5356; February 21, 2019) and was closed through August 24, 2020 (85 FR 50959; August 19, 2020). Anecdotal evidence indicates that some smaller commercial longline vessels that tend to fish closer to the islands might switch to shortline fishing inside the LLEZ because of closures of the SEZ. As such, this has the potential to increase longline-type gear inside the range of the MHI IFKW population. With the inadequate reporting system for fishing methods (i.e., fishing using multiple methods (e.g., setting shortlines and then fishing handlines while shortlines are soaking) but then only reporting just one method type (e.g., handlining), it is possible that this type of switch of effort could go completely unrecorded (Dr. Robin Baird, Cascadia Research Collective, pers. comm. April 2019). Assessing whether and to what extent implementation of the FKWTRP or subsequent measures such as year-round expansion of the LLEZ and implementation of the SEZ is occurring is needed.

6.6.2 Continue to analyze data from VMS to ensure location compliance.

Vessel monitoring systems (VMS) use GPS to track fishing location. Monitoring this GPS data ensures that commercial longline vessels are complying with federal regulations. This includes remaining outside of the LLEZ throughout the year; vessels on deep-set longline trips remaining outside of the SEZ, as necessary (an area on the southern portion of the Hawaiian Islands that is closed if a threshold number of false killer whale serious injuries or mortalities are observed in a single calendar year); and remaining outside of the Papahānaumokuākea Marine National Monument boundary. Monitoring this GPS data can also indicate whether any vessels turn off their VMS and do not report longline fishing for a period of time. This could be indicative of switching to shortline fishing. This activity also entails addressing any infractions of fishing in prohibited areas or not reporting commercial fishing through the NOAA Office of Law Enforcement.

6.6.3 Increase the use of video electronic monitoring to assist in accurately assessing bycatch and interactions with protected species.

In 2013, NOAA Fisheries issued a policy directive (30–133) that provides guidance on the adoption of electronic technology solutions in fishery-dependent data collection programs. Electronic technologies include the use of VMS, electronic logbooks, video cameras for EM, and other technologies that provide electronic monitoring and reporting. Video EM technology can supplement commercial fishery observers in accurately assessing bycatch and interactions with protected species. This includes determining serious versus non-serious injuries of false killer whales (and other protected species), photo-IDing individuals (where possible), and assessing the effectiveness of FKWTRP handling measures during interactions. Given the potential for interactions with false killer whales, vessels that fish shortline gear, or have reels for hauling long- or shortlines, should be prioritized for EM. Video EM is considered a national priority and occurs in other fleets (e.g., the entire Atlantic longline fleet). Use of this tool in the Pacific Islands Region began as a pilot project in 2009 by the Western Pacific Regional Fishery Management Council (WPRFMC) on a few longline commercial fishing boats as part of a pre-implementation initiative to capture all catch accounting data, monitor for protected species interactions with fishing gear, and collect other fishery dependent data used for management. Currently, nearly two-dozen commercial longline fishing vessels now voluntarily use EM in the Pacific Islands Region, which is a small portion of the 143 vessels/persons in the Hawaiʻi deep-set longline fishery and the 11 vessels/persons in the Hawaiʻi shallow-set longline fishery (data as of the 2021 Final List of Fisheries (86 FR 3028; January 14, 2021)).

6.6.4 Continue to research and evaluate options that encase the bait/catch to prevent depredation in commercial longline fisheries.

In a study by Ishizaki and Itano (2018) for the Hawaiʻi commercial longline deep-set fishery, four catch-triggered deterrence devices were developed and field-tested. Useful information can be gleaned from preliminary research of the commercial viability and practicality for mitigating cetacean depredation in the Hawaiʻi deep-set longline fishery.

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 or 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.

V. Literature Cited

Anderson, D., R. Baird, A. Bradford, D. Webster. 2017. Longline fishery interactions and resource selection of satellite-tagged pelagic false killer whales in the North Pacific. Abstract (Proceedings) 22nd Biennial on the Biology of Marine Mammals, Halifax, Nova Scotia, October 22–27, 2017.

Ayers, A.L. and K. Leong. 2020. Stories of conservation success: results of interviews with Hawaiʻi longliners. U.S. Dept. of Commerce, NOAA Administrative Report H-20-11, 43 pp. https://doi.org/10.25923/6bnn-m598.

Baird, R.W., and A.M. Gorgone. 2005. False killer whale dorsal fin disfigurements as a possible indicator of long-line fishery interactions in Hawaiian waters. Pacific Science 59: 593–601.

Baird, R.W., S.D. Mahaffy, A.M. Gorgone, T. Cullins, D.J. McSweeney, E.M. Oleson, A.L. Bradford, A.L., J. Barlow, and D.L. Webster. 2014. False killer whales and fisheries interactions in Hawaiian waters: evidence for sex bias and variation among populations and social groups. *Marine Mammal Science*, *31*(2), pp.579-590. doi: 10.1111/mms.12177

Baird, R.W., S.D. Mahaffy, and A.M. Gorgone. 2015. False killer whales and fisheries interactions in Hawaiian waters: evidence for sex bias and variation among populations and social groups. Marine Mammal Science 31(2): 579–590.

Baird, R., D. Anderson, and D. Webster. 2017a. Bringing the right fishermen to the table: An index of overlap between false killer whales and nearshore fisheries in Hawaiʻi, with implications for targeting observer programs and outreach efforts. Abstract (Proceedings) 22nd Biennial on the Biology of Marine Mammals, Halifax, Nova Scotia, October 22-27, 2017.

Baird, R.W., S.D. Mahaffy, A.M. Gorgone, K.A. Beach, T. Cullins, D.J. McSweeney, D.S. Verbeck, and D.L. Webster. 2017b. Updated evidence of interactions between false killer whales and fisheries around the main Hawaiian Islands: assessment of mouthline and dorsal fin injuries. Pacific Scientific Review Group Document. 8pp.

Barco, S.G., L.R. D'Eri, B.L. Woodward, J.P. Winn, and D.S. Rotstein. 2010. Spectra fishing twine entanglement of a bottlenose dolphin: a case study and experimental modeling. Marine Pollution Bulletin, 60: 1477–1481.

Bradford, A.L., E.M. Oleson, R.W. Baird, C.H. Boggs, K.A. Forney, N.C. Young. 2015. Revised stock boundaries for false killer whales (*Pseudorca crassidens*) in Hawaiian waters. U.S. Dept. of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFS-PIFSC-47, 29pp. doi:10.7289/V5DF6P6J.

Bradford, A.L., E.A. Becker, E.M. Oleson, K.A. Forney, J.E. Moore, and J. Barlow. 2020. Abundance estimates of false killer whales in Hawaiian waters and the broader central Pacific. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-104, 78 p. doi:10.25923/2jjg-p807

Ishizaki, A. and D. Itano. 2018. Summary of the recent testing of depredation-deterrent devices in the Hawaiʻi longline fishery. Presentation on April 11, 2018, to the False Killer Whale Take Reduction Team. NOAA Fisheries Pacific Islands Fisheries Science Center. Administrative Report H-16-07. doi:10.7289/V5/AR-PIFSC-H-16-07.

Kiszka, J., D. Pelourdeau, and V. Ridoux. 2008. Body scars and dorsal fin disfigurements as indicators of interaction between small cetaceans and fisheries around the Mozambique Channel island of Mayotte. Western Indian Ocean Journal of Marine Science 7:185–193.

Lerma, J., L. Rhodes, B. Hanson, and R. Baird. 2019. Assessing respiratory microbiome of small- and medium-sized cetaceans using unmanned aerial system surveys: breath sampling humpbacks is so 2016. In: Abstracts of the World Marine Mammal Conference, Barcelona, Spain, December 9-12, 2019.

Madge, L. 2016. Exploratory study of interactions between cetaceans and small-boat fishing operations in the main Hawaiian Islands.

McLellan, W.A., L.H. Arthur, S.D. Mallette, S.W. Thornton, R.J. McAlarney, A.J. Read, and D.A. Pabst. 2015. Longline hook testing in the mouths of pelagic odontocetes. ICES Journal of Marine Science, 72(5): 1706–1713. doi:10.1093/icesjms/fsu181

Moore, K.T., and S.G. Barco. 2013. Handbook for recognizing, evaluating, and documenting human interaction in stranded cetaceans and pinnipeds. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-510.

Nery, M.F., M.A. Especie, and S.M. Simao. 2008. Marine tucuxi dolphin (*Sotalia guianensis*) injuries as a possible indicator of fisheries interaction in southeastern Brazil. Brazilian Journal of Oceanography 56:313–316.

NOAA Fisheries. 2021a. Recovery status review for the main Hawaiian Islands insular false killer whale (*Pseudorca crassidens*) distinct population segment. August 2021, Version 2. NOAA Fisheries, Pacific Islands Regional Office, Honolulu, HI 96818. Available at: https://www.fisheries.noaa.gov/species/false-killer-whale#resources

NOAA Fisheries. 2021b. Final Endangered Species Act recovery plan for the main Hawaiian Islands insular false killer whale (*Pseudorca crassidens*) distinct population segment. NOAA Fisheries, Pacific Islands Regional Office. Honolulu, HI 96818. Available at https://www.fisheries.noaa.gov/species/false-killer-whale#resources

Pryor, K. 1975. Lads before the wind: diary of a dolphin trainer. Sunshine Books, North Bend, WA.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Report No. MMC-77/23 of the U.S. Marine Mammal Commission.

Trainer, V. L. 2002. Marine mammals as sentinels of environmental biotoxins. Handbood of Neurotoxicology. E. J. Massaro. Totowa, NJ, Humana Press Inc. I**:** 349–361.

Winn, J.P., B.L. Woodward, M.J. Moore, M.L. Peterson, and J.G. Riley. 2008. Modeling whale entanglement injuries: an experimental study of tissue compliance, line tension, and draw-length. Marine Mammal Science, 24: 326–340.