National Marine Fisheries Service
Endangered Species Act Section 7
Biological Opinion

Title:	Biological Opinion on the Issuance of Scientific Research Permit No. 22677 to the National Marine Fisheries Service's Pacific Islands Fisheries Science Center for Research and Enhancement Activities on Hawaiian Monk Seals
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Action Agency:	Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Publisher:	Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Approved:	______________________________ Donna S. Wieting Director, Office of Protected Resources
Date:	_______________
Consultation Tracking number:	OPR-2019-02068

Digital Object Identifier (DOI): *https://doi.org/10.25923/tn4v-nr32*

This page left blank intentionally

TABLE OF CONTENTS

List of Tables

Page

LIST OF FIGURES

1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 C.F.R. §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS concur with that determination for species under NMFS jurisdiction, consultation concludes informally (50 C.F.R. §402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, NMFS provides reasonable and prudent alternatives that can be taken by the Federal agency or the applicant and allow the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) to minimize such impacts and terms and conditions to implement the RPMs.

Updates to the regulations governing interagency consultation (50 C.F.R. 402) are effective on October 28, 2019 (84 FR 44976). This consultation was pending at the time the regulations became effective and we are applying the updated regulations to the consultation. As the preamble to the final rule adopting the regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." We have reviewed the information and analyses relied upon to complete this biological opinion (Opinion) in light of the updated regulations and conclude the Opinion is fully consistent with the updated regulations.

The action agency for this consultation is the NMFS, Office of Protected Resources, Permits and Conservation Division (hereafter NMFS Permits and Conservation Division). The NMFS Permits and Conservation Division proposes to issue a scientific research permit (Section 3) pursuant to section 10(a)(1)(A) of the ESA, section 104 of the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. 1361 et seq.). Permit No. 22677 will be issued to NMFS Pacific Islands Fisheries Science Center (PIFSC), 1845 Wasp Boulevard, Honolulu, Hawaii 96818. The purpose of the proposed permit is to allow an exception to the moratorium and prohibition on takes established under the ESA and MMPA in order to allow the NMFS PIFSC to conduct scientific research and enhancement activities on Hawaiian monk seals in the surrounding waters of the Hawaiian Archipelago and Johnston Atoll, including the Northwestern Hawaiian Islands and Main Hawaiian Islands.

Under the ESA take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct.” Harm is further defined as “an act which actually kills or injures fish or wildlife and may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering.” While the U.S. Fish and Wildlife Service further defines harass by regulation (50 C.F.R. §17.3), until NMFS promulgates a regulatory definition, we rely on NMFS’ interim guidance, which defines harass as an act that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering” (NMFSPD 02-110-19).

Under the MMPA take is defined as “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal (16 U.S.C. 1361 et seq.) and further defined by regulation (50 C.F.R. §216.3) as “to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal.” This includes, without limitation, any of the following:

- The collection of dead animals, or parts thereof;
- The restraint or detention of a marine mammal, no matter how temporary;
- Tagging a marine mammal;
- The negligent or intentional operation of an aircraft or vessel;
- The doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal;
- Feeding or attempting to feed a marine mammal in the wild.

For purposes of this action, the two levels of MMPA harassment are further defined under the MMPA as any act or pursuit, torment, or annoyance which:

- Has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or,
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). Under NMFS regulation, MMPA Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.

NMFS’ interim ESA harass definition does not specifically equate to MMPA Level A or Level B harassment, but shares some similarities with both in the use of the terms “injury/injure” and a focus on a disruption of behavior patterns. Because the proposed permit will authorize take under both the ESA and MMPA, our ESA analysis, which relies on NMFS' interim guidance on the ESA term harass, may result in different conclusions than those reached by the NMFS Permits and Conservation Division in their MMPA analysis. Given the differences between the MMPA and ESA standards for harassment, there may be circumstances in which an act is considered harassment, and thus take, under the MMPA but not the ESA.

This consultation, Opinion, and ITS, were completed in accordance with section 7(a)(2) of the statute (16 U.S.C. 1536 (a)(2)), associated implementing regulations (50 C.F.R. §§401-16), and agency policy and guidance. This consultation was conducted by NMFS, Office of Protected Resources, ESA Interagency Cooperation Division (hereafter referred to as “we”). This Opinion was prepared by NMFS Office of Protected Resources, ESA Interagency Cooperation Division in accordance with section 7(b) of the ESA and implementing regulations at 50 C.F.R. Part 402.

This document represents the NMFS ESA Interagency Cooperation Division’s opinion on the effects of the proposed action under Permit No. 22677 on blue whale, Main Hawaiian Islands Insular Distinct Population Segment (DPS) of false killer whale, fin whale, North Pacific right whale, sei whale, sperm whale, Central North Pacific DPS of green turtle, hawksbill turtle, leatherback turtle, North Pacific Ocean DPS of loggerhead turtle, all other areas/not Mexico’s Pacific Coast breeding colonies of olive ridley turtle, giant manta ray, and oceanic whitetip shark as well as designated critical habitat for the Main Hawaiian Islands Insular DPS of false killer whale and Hawaiian monk seal. A complete record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

The NMFS PIFSC’s Hawaiian Monk Seal Research Program (HMSRP) has been a scientific research permit holder for similar research and enhancement activities on Hawaiian monk seals in the same action area since at least 1986. The NMFS PIFSC’s proposed research and enhancement activities under Permit No. 22677 are a continuation of work conducted under Permit No. 16632 (from 2014 through 2019). The previous opinions for each of these research and enhancement permits determined that the authorized research and enhancement activities were not likely to jeopardize the continued existence of ESA-listed species nor were the activities likely to adversely affect designated critical habitat. The annual reports demonstrate the applicant’s compliance with permit conditions.

In this consultation, we build upon our long-term evaluation of the NMFS PIFSC’s research and enhancement activities from previous consultations, considering these previous research permits as part of the *Environmental Baseline* (Section 7) and evaluating the effects of authorizing the NMFS PIFSC to continue to conduct research and enhancement activities under Permit No. 22677, over the next five years.

1.2 Consultation History

This opinion is based on information provided in the applicant's permit application, correspondence, and discussions with the NMFS Permits and Conservation Division and the applicant, previous biological opinions for research permits on research and enhancement activities conducted by NMFS PIFSC, annual reports from previous research and enhancement activities by researchers at NMFS PIFSC, other similar research and enhancement activities for which we have conducted ESA section 7 consultations, and the best scientific and commercial data available from the literature.

Our communication with the NMFS Permits and Conservation Division regarding the permit is summarized as follows:

- On March 11, 2019, the NMFS Permits and Conservation Division requested early technical assistance and review of the permit application by NMFS ESA Interagency Cooperation Division.
- On April 11, 2019, we provided comments on the permit application to the NMFS Permits and Conservation Division. The NMFS Permits and Conservation Division provided these comments to the applicant and requested additional information.
- On May 1, 2019, the NMFS Permits and Conservation received responses to comments and a revised application from the NMFS PIFSC.
- On July 22, 2019, the NMFS Permits and Conservation Division sent us a memorandum and initiation package (including a biological assessment, draft permit, permit application, previous annual reports, and supplementary information) requesting formal consultation on the proposed issuance of Permit No. 22677. The NMFS Permits and Conservation Division requested we review the initiation package and respond by August 22, 2019 to inform whether the application package was complete. The NMFS Permits and Conservation Division requested the consultation be concluded and the signed biological opinion received by December 1, 2019.
- On August 5, 2019, we received the draft of Permit No. 22677 from the NMFS Permits and Conservation Division.
- On August 12, 2019, we determined there was sufficient information to initiate formal consultation. We provided the NMFS Permits and Conservation Division with an initiation letter on the same day.
- On October 30, 2019, we received a revised application from the NMFS Permits and Conservation Division based on comments from the Marine Mammal Commission. This revised application made slight changes to the proposed action but did not change our effects determinations.
- On November 14, 2019, we received a revised draft permit for Permit No. 22677 from the NMFS Permits and Conservation Division.

- On December 4, 2019, we received a revised draft permit for Permit No. 22677 from the NMFS Permits and Conservation Division

2 The Assessment Framework

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

An ESA section 7 assessment involves the following steps:

Description of the Proposed Action (Section 3): We describe the proposed action and those aspects (or stressors) of the proposed action that may have direct or indirect effects on the physical, chemical, and biotic environment.

Action Area (Section 4): We describe the action area with the spatial extent of those stressors.

Potential Stressors (Section 5): We identify the stressors that could occur as a result of the proposed action and affect ESA-listed species and designated critical habitat.

Species and Critical Habitat Not Likely to be Adversely Affected (Section 6.1): We identify the ESA-listed and designated critical habitat that either are likely to not be affected or are not likely to be adversely affected by the stressors.

Species Likely to be Adversely Affected (Section 6.2): We identify the ESA-listed species that are likely to co-occur with those stressors in space and time in a way that is likely to result in adverse effects and evaluate the status of those species and habitat.

Status of Species Likely to be Adversely Affected (Section 6.2.1): We examine the status of each species that would be adversely affected by the proposed action.

*Environmental Baseline (*Section 7): We describe the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Effects of the Action (Section 8): We identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or sub-populations to which those individuals belong. We also consider whether the action "may affect" designated critical habitat, if applicable. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how the action may affect designated critical habitat, if applicable. This is our response analysis. We assess the consequences of the responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. This is our risk analysis. The adverse modification analysis considers the impacts of the proposed action on the essential habitat features and conservation value of designated critical habitat.

Cumulative Effects (Section 9): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 C.F.R. §402.02). Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Section 10): In this section, we integrate the analyses of *Effects of the Action* (Section 8), the *Environmental Baseline* (Section 7), and the *Cumulative Effects* (Section 11) to formulate the agency's opinion as to whether the action is likely to appreciably reduce the likelihood of survival and recovery of an ESA-listed species in the wild and designated critical habitat under NMFS' jurisdiction.

Conclusion (Section 11): With full consideration of the status of the species and designated critical habitat, we consider the effects of the action within the action area on populations or subpopulations and on essential habitat features when added to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (See 50 C.F.R. §402.14).

In addition, we include an incidental take statement (Section 12) that specifies the impact of the take, reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures (ESA section 7(b)(4); 50 C.F.R. §402.14(i)). We also provide discretionary conservation recommendations that may be implemented by the action agency (Section 15) (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which reinitiation of consultation is required (Section 14) (50 C.F.R. §402.16).

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of Google Scholar and literature cited sections of peer-reviewed articles, species listing documentation, and reports published by government and private entities. This Opinion is based on our review and analysis of various information sources, including:

- Information submitted by the NMFS Permits and Conservation Division and the applicants;
- Government reports (including NMFS biological opinions and stock assessment reports);
- National Oceanic and Atmospheric Administration (NOAA) technical memorandums;
- Annual reports; and
- Peer-reviewed scientific literature.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS' jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

3 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. The proposed action for this consultation is the NMFS Permits and Conservation Division's issuance of a scientific research permit pursuant to Section 104 of the MMPA of 1972, as amended (16 U.S.C. 1361 et seq.), and Section 10(a)(1)(A) of the ESA, as amended (16 U.S.C. 1531 et seq.), to the NMFS PIFSC to conduct scientific research and enhancement activities on marine mammals.

The permit will authorize the NMFS PIFSC to carry out research and enhancement activities. The purpose of the NMFS Pacific Island Fisheries Science Center's research and enhancement activities are designed to conserve and recover the endangered Hawaiian monk seal. Research activities are intended to identify impediments to recovery, inform the design of conservation interventions, and evaluate those measures. Enhancement activities are designed to improve the survival and reproductive success of individual Hawaiian monk seals, with the intent of improving subpopulation and overall species' survival. Research and enhancement activities may occur on beaches and in nearshore waters throughout the Hawaiian Archipelago (including the Northwestern Hawaiian Islands and Main Hawaiian Islands) and Johnston Atoll, and in facilities housing captive Hawaiian monk seals.

Research and enhancement activities include visual and photographic monitoring, tagging, pelage marking, health screening, foraging studies, deworming research, experimental translocation, necropsies, tissue sampling, import/export of parts, behavioral modification research, and vaccination research. Enhancement activities include hazing and removal of aggressive adult male animals that harm or kill other animals, disentangling, dehooking, deworming, treating injured seals in-situ, behavioral modification, vaccination, and supplemental feeding of post-release rehabilitated animals. A summary of research and enhancement activities and proposed MMPA take estimated for Permit No. 22677 are also presented in Table 1[1].

The NMFS PIFSC's HMSRP holds the only scientific research permit for research and enhancement activities on the wild population of Hawaiian monk seals; therefore, all research and enhancement activities are conducted by or coordinated through the HMSRP. For captive studies, all of the animals are authorized to be maintained in captivity under separate permits issued to the holding facilities (or researcher) for research and enhancement activities (i.e., Minnesota Zoological Gardens, Sea Life Park, Waikiki Aquarium, and Dr. Terrie Williams of University of California, Santa Cruz, Long Marine Laboratory). Research and enhancement activities on captive animals under this scientific research permit will take place at facilities conducting the same studies (i.e., there would not be duplicated efforts on the same animals). Enhancement activities may also occur under the Marine Mammal Health and Stranding Response Program's scientific research permit. The NMFS PIFSC, Pacific Islands Regional Office, and Marine Mammal Health and Stranding Response Program will coordinate on overlapping research and enhancement activities to minimize activity overlap and effects.

The proposed duration of the scientific research permits is five years. In accordance with Federal regulations (50 C.F.R. §216.39), the duration of a permit may be extended for up to one year via a minor amendment to allow uninterrupted continuation of research if a new five-year permit application has been received and is in-process. In such cases, no additional MMPA takes will be authorized during the extension; any takes that were not allocated for the fifth year of the permit that were not used may be used during the extension. Thus, the annual takes proposed in the draft permit may be extended for use over a six-year period[2].

[1] It is important to note that MMPA take may not always equate to ESA take.
[2] This has not occurred for past MMPA authorizations for the PIFSC's HMSRP activities.

Table 1. Proposed permitted annual MMPA take for research and enhancement activities for Endangered Species Act-listed species under Permit No. 22677.

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Wild	All	Male and Female	1500	5	Harass	Other	Observation, mark resight; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Remote vehicle, aerial (fixed wing); Remote vehicle, aerial(VTOL); Remote vehicle, aquatic;	1. MONITORING IN IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Disturbance from visual observation, photo-ID, ground monitoring, vessel (including ROVs) and aerial surveys (includes UAS).

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
2	Seal, Hawaiian monk	Wild	All	Male and Female	300	3	Capture / Handle/ Release	Other	Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, vibrissae (clip); Ultrasound	2A. TAGGING IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Restrain, flipper and PIT tag (retain flipper plugs), cut vibrissae, measure (length and girth), ultrasound; excludes obviously pregnant and lactating females; includes any remaining nursing pups at end of field season

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Wild	All	Male and Female	100	1	Capture / Handle/ Release	Other	Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, vibrissae (clip)	2B. RE-TAGGING IN THE HAWAIIAN ARCHIPELAGO: Restrain, flipper tag to replace tags (retain flipper plugs), cut vibrissae, measure (length and girth); excludes obviously pregnant and lactating females; includes remaining nursing pups at end of field season
4	Seal, Hawaiian monk	Wild	All	Male and Female	1200	4	Harass	Other	Mark, bleach/dye	3. BLEACH MARKING IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Close approach to apply temporary bleach/dye

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
										marks; includes pregnant and lactating females and nursing pups; only rarely 4 takes per animal anticipated
5	Seal, Hawaiian monk	Wild	All	Male and Female	60	2	Capture /Handle / Release	Other	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh;	4A. HEALTH SCREENING IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Capture, sedation; tagging (flipper and PIT if not already); sampling; weigh, measure, ultrasound; recapture to resample; acoustic recording; excludes pregnant or lactating

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
									Acoustic, passive recording	females and nursing pups

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
6	Seal, Hawaiian monk	Wild	All	Male and Female	40	3	Capture / Handle/ Release	Other	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh; Acoustic, passive recording	4B. HEALTH SCREENING AND FORAGING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Same as above AND instrument; recapture to resample/remove instruments; acoustic recording; may have acoustic recording tag attached; excludes pregnant or lactating females and nursing pups. 3rd take allow for rare eventuality that attempt to remove instrument fails on first recapture

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
7	Seal, Hawaiian monk	Wild	All	Male and Female	40	3	Capture / Handle/ Release	Other	Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, blood; sample, swab all mucus membranes; Sample, vibrissae (cut); Weigh; Acoustic, passive recording	4C. FORAGING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Same as above EXCEPT no Anesthesia/sedation. Flipper-tag mounted instrument; recapture to resample/remove instruments; acoustic recording; excludes pregnant or lactating females and nursing pups; 3rd take allow for rare eventuality that attempt to remove instrument fails on first recapture

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
8	Seal, Hawaiian monk	Wild	All	Male and Female	10	5	Harass/ Sample	Other	Sample, remote biopsy (blubber, skin, hair) using biopsy pole or remote darting (crossbow, rifle).	4D. HEALTH SCREENING AND FORAGING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Sample blubber, skin and hair without capture and restraint using purpose-designed biopsy system delivered via pole or dart/projectile; Excludes nursing females and nursing pups.

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
9	Seal, Hawaiian monk	Wild	All	Male and Female	80	6	Harass/ Sample	Other	Acoustic, passive recording	5. VOCALIZATION STUDIES IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Passive acoustic recording in air using microphone on boom; underwater using deployed passive recorder or manual hydrophone.
10	Seal, Hawaiian monk	Wild	All	Male and Female	99999999	1	Handle/ Release	Other	Salvage (carcass, tissue, parts)	6. NECROPSY IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Necropsy any seal found dead, that died during restraint, or that was euthanized. After, use seal tissue as bait

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author- ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
										for permitted shark removals.
11	Seal, Hawaiian monk	Wild	All	Male and Female	1100	99999	Harass/ Sample	Other	Collect, molt; Collect, scat; Collect, spew; Other	7. OPPORTUNISTIC RETRIEVAL OF SAMPLES IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Collect parts (placentae, scat, spew, molted fur/skin) from haul out sites; incidental harassment
12	Seal, Hawaiian monk	Wild	All	Male and Female	99999999	99999	Import/ export/ receive only	Other	Import/export/receive, parts	8A. EXPORT/RE-IMPORT SAMPLES WORLD-WIDE: Export and re-import

Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
										Hawaiian monk seal samples taken under permit for analyses.
13	Seal, Mediterranean monk	All	All	Male and Female	99999999	99999	Import/ export/ receive only	Other	Import/export/receive, parts	8B. 7. EXPORT/RE-IMPORT SAMPLES WORLD-WIDE: Import and re-export Mediterranean monk seal samples taken under other permit for analyses.

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Wild	All	Male and Female	30	3	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Administer drug, oral; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, milk; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	1A. HEALTH SCREEN / TREATMENT ENHANCEMENT/ FORAGING RESEARCH ON UNHEALTHY SEALS in Hawaiian Archipelago and Johnston Atoll; sedation for health screening & instrument; other = treat as warranted (e.g., lance abscess, antibiotic, deworm); any age/sex condition. Adult females may be injected with oxytocin.

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
2	Seal, Hawaiian monk	Wild	All	Male and Female	99999999	99999	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Administer drug, oral; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, hand; Restrain, net; Sample, vibrissae (clip); Sample, vibrissae (pull)	1B. TREATMENT ENHANCEMENT / RESEARCH ON UNHEALTHY SEALS in Hawaiian Archipelago and Johnston Atoll: As warranted (estimated 30 seals/year); all procedures above except full health screening or attaching instrument with epoxy; flipper-tag mounted instrumentation allowed; treatment enhancement any age/sex/condition. Adult females may be injected with oxytocin.

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Wild	Pup/ Juvenile	Male and Female	300	8	Capture / Handle/ Release	Other	Administer drug, IM, oral, subcutaneous; Collect, scat; Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, hand; Restrain, net; Sample, fecal loop; Ultrasound; Weigh	2. INTESTINAL PARASITE TREATMENT (DEWORMING RESEARCH AND ENHANCEMENT): Up to 4 treatments using injectable; up to 4 post treatment recaptures to repeat weight, morphometrics, ultrasound, and fecal samples; pups 120 days post-weaning and juvenile up to 3 years; any condition. Includes control seals who are treated identically except no drug administered.

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
4	Seal, Hawaiian monk	Wild	Pup/ Adult female	Male and Female	99999999	99999999	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IM; Restrain, handle, Captive, maintain temporary	3A. TRANSLOCATION ENHANCEMENT - ESTABLISHING/RE-ESTABLISHING MATERNAL ASSOCIATION: As warranted (estimated 20 per year), capture and translocate abandoned nursing pups to natural or foster mother. Typically fewer than 6. Adult females will not be translocated but may be held temporarily in beach pens and/or injected with oxytocin.

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
5	Seal, Hawaiian monk	Wild	All	Male and Female	99999999	99999999	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, cage; Restrain, hand; Restrain, net; Restrain, other; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	3B. TRANSLOCATION ENHANCEMENT - RISK ALLEVIATION: As warranted (estimated 60 per year) , translocate within or between any subpopulation in the NWHI or Johnston Atoll or within or between any MHI or from MHI to NWHI via boat, ship, vehicle, or air craft; other = hazing from harmful situation; includes pups near weaning at high risk of mortality

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
6	Seal, Hawaiian monk	Wild	Pup	Male and Female	20	1	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Restrain, cage; Restrain, hand; Restrain, net; Restrain, other; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	3C-1. TRANSLOCATION ENHANCEMENT - ONE WAY OR 1st STAGE of 2-STAGE Translocation of weaned pups; within the NWHI or from the MHI to NWHI but NOT from NWHI to MHI; via boat, ship, vehicle, or aircraft; other = treat if warranted; includes health screen and temporary holding

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
7	Seal, Hawaiian monk	Wild	Juvenile/ Subad-ult	Male and Female	30	1	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Mark, bleach/dye; Measure (standard morphometrics); Restrain, cage; Restrain, net; Restrain, other; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	3C-2 TRANSLOCATION ENHANCEMENT - 2nd STAGE of 2-STAGE Translocation; within or between any subpopulation; seals born in MHI and previously taken to NWHI may go back to MHI; surviving seals translocated in 3C1 above returned to natal or other site

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
8	Seal, Hawaiian monk	Wild	Adult	Male	20	1	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain permanent; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Other; Restrain, cage; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull)	4. ADULT MALE REMOVAL (ENHANCEMENT) - Aggressive males translocated or removed from the wild to permanent captivity; temp captivity for quarantine; other = treat if warranted

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
9	Seal, Hawaiian monk	Wild	All	Male and Female	99999999	99999	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, gas w/intubation; Anesthesia, injectable sedative; Captive, maintain temporary; Other; Restrain, cage; Restrain, hand; Restrain, net; Sample, vibrissae (clip); Sample, vibrissae (pull)	5. DISENTANGLE AND DEHOOK (ENHANCEMENT) - Disentangle/dehooking with or without sedation; other = may require surgery w anesthesia and/or treatment; as warranted (est. < 75 seals)
10	Seal, Hawaiian monk	Wild	Pup/ Juvenile	Male and Female	12	99999	Release captive animals	Other	Other	6. SUPPLEMENTAL FEEDING (ENHANCEMENT) - Supplemental feeding of post-rehabilitated seals in the NWHI; seals may be fed at daily or longer intervals for up to a year; seals rehabilitated under MMHSRP permit

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
11	Seal, Hawaiian monk	Wild	All	Male and Female	50	99999	Harass/ Capture / Handle/ Release	Other	Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Other; Restrain, cage; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull), translocation (including MHI to NWHI), acoustic, active playback/broadcast	7A. BEHAVIORAL MODIFICATION IN MHI (RESEARCH AND ENHANCEMENT) - Displace or translocate seals from dangerous locations (e.g., roads). Disrupt/ prevent seals from socializing with humans; alter behavior of seals socialized to humans or behaving in a manner dangerous to the seal or public safety. I; aversive conditioning and other methods including but not limited to hazing, herding, tactile and acoustic harassment, etc.

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
12	Seal, Hawaiian monk	Wild	All	Male	99999999	99999	Harass	Other	Other	7B. ADULT MALE HAZING (ENHANCEMENT) - Aggressive males hazed away from conspecific victims in cases of immediate risk of injury or death or when specific males repeatedly attack conspecifics. Intentional harassment for behavioral modification; aversive conditioning and other methods including but not limited to hazing, herding, tactile and acoustic harassment, etc.

Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
13	Seal, Hawaiian monk	Wild	All	Male and Female	1500	4	Capture / Handle/ Release	Other	Administer drug, IM ; Anesthesia, injectable sedative; Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull)	8. VACCINATIONS IN MHI AND NWHI (RESEARCH AND ENHANCEMENT) - Vaccinations and sampling for antibody testing in wild and rehabilitating seals; prophylactic vaccinations and vaccinations in response to outbreaks

Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/ Origin	Life stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Wild	All	Male and Female	200	1*	Harass	Other	Incidental disturbance	1. INCIDENTAL HARASSMENT DURING ANY RESEARCH OR ENHANCEMENT ACTIVITY IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Incidental disturbance to seals during field research and enhancement including opportunistic sample collection, necropsy, captures, remote camera installation and maintenance, etc.

Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/ Origin	Life stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
2	Seal, Hawaiian monk	Wild	All	Male and Female	2	1	Unintentional mortality	Other	Unintentional mortality	2A. UNINTENTIONAL MORTALITY DURING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 4 unintentional mortalities over a 5-year period not to exceed 2 deaths in any one year. During any research activity in the wild. Includes euthanasia for humane purposes.

Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/ Origin	Life stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Wild	pup	Male and Female	2	1	Unintentional mortality	Other	Unintentional mortality	2B. UNINTENTIONAL MORTALITY DURING ENHANCEMENT IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 4 unintentional mortalities of weaned pups over a 5-year period not to exceed 2 deaths in any one year. During any enhancement activity. Includes euthanasia for humane purposes.

Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/ Origin	Life stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
4	Seal, Hawaiian monk	Wild	Juvenile/ Subad-ult	Male and Female	4	1	Unintentional mortality	Other	Unintentional mortality	2B. UNINTENTIONAL MORTALITY DURING ENHANCEMENT IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 8 unintentional mortalities of juveniles or subadults over a 5-year period not to exceed 4 in any one year. During any enhancement activity. Includes euthanasia for humane purposes.

Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/ Origin	Life stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
5	Seal, Hawaiian monk	Wild	Adult	Male	2	1	Unintentional mortality	Other	Unintentional mortality	2B. UNINTENTIONAL MORTALITY DURING ENHANCEMENT IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 4 unintentional mortalities of adult males over a 5-year period not to exceed 2 in any one year. During any enhancement activity. Includes euthanasia for humane purposes.

Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/ Origin	Life stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
6	Seal, Hawaiian monk	Wild	Adult	Male	10	1	Intentional (Directed) Mortality	Other	Intentional (directed) mortality	3A. INTENTIONAL MORTALITY OF ADULT MALES IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL (ENHANCEMENT): Humane killing or euthanasia of up to 10 aggressive adult males over a 5-year period.

Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/ Origin	Life stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
7	Seal, Hawaiian monk	Wild	All	Male and Female	10	1	Intentional (Directed) Mortality	Other	Intentional (directed) mortality	3B. INTENTIONAL MORTALITY OF MORIBUND OR SEVERELY INJURED SEALS IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL (ENHANCEMENT AND RESEARCH): Humane euthanasia of up to 10 moribund or severely injured seals over a 5-year period at discretion of veterinarian.

Pacific Ocean; State/Territory: HI (Annual takes of non-releasable Hawaiian monk seals in permanent captivity in the U.S.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Captive	All	Male and Female	20	20	Captive animals (resear-ch, enhan-cement, public display)	Captive	Other	1. BEHAVIORAL MODIFICATION RESEARCH: Intentional harassment for behavioral modification; aversive conditioning and other methods including but not limited to hazing, herding, and tactile harassment, etc.

Pacific Ocean; State/Territory: HI (Annual takes of non-releasable Hawaiian monk seals in permanent captivity in the U.S.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
2	Seal, Hawaiian monk	Captive	All	Male and Female	20	5	Captive animals (resear-ch, enhan-cement, public display)	Captive	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Restrain, net; Sample, blood; Sample, nasal swab	2. VACCINATION RESEARCH: Vaccinations on day 0 and 14; serum and nasal sampling on days 0, 24, 42, and 365. Seals injected 2 times per year and sampled 4 times per year; first sampling combined with first injection for a total of 5 takes per animal per year.

Pacific Ocean; State/Territory: HI (Annual takes of non-releasable Hawaiian monk seals in permanent captivity in the U.S.)										
Line	Species	Production/ Origin	Life Stage	Sex	Author-ized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Captive	All	Male and Female	20	99999	Captive animals (resear-ch, enhancement, public display)	Captive	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, vibrissae (pull)	3. VALIDATION STUDIES (RESEARCH): Research to validate or test field methods.
4	Seal, Hawaiian monk	Captive	Adult	Male	10	1	Captive animals (resear-ch, enhancement, public display)	Captive	Captive, maintain temporary	4. ADULT MALE REMOVAL (ENHANCEMENT): Temporary holding at any APHIS-approved facility of adult males removed into permanent captivity until recipient facility is permitted.

Pacific Ocean; State/Territory: HI (Annual incidental harassment of cetaceans during Hawaiian monk seal research and enhancement activities.)											
Line	Species	Stock/ Listing Unit	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Dolphin, spinner	Hawaiian Islands Stock Complex	Wild	All	Male and Female	500	5	Harass	Survey, vessel	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE HAWAIIAN ARCHIPELAGO.
2	Dolphin, bottlenose	Hawaiian Islands Stock Complex	Wild	All	Male and Female	20	1	Harass	Survey, vessel	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE HAWAIIAN ARCHIPELAGO.
3	Dolphin, spinner	Hawaiian Islands Stock Complex	Wild	All	Male and Female	200	1	Harass	Acoustic playback (to seals)	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE MHI.
4	Dolphin, bottlenose	Hawaiian Islands Stock Complex	Wild	All	Male and Female	200	1	Harass	Acoustic playback (to seals)	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE MHI.

*Takes=the maximum number of animals, not necessarily individuals, that may be targeted for research annually for the suite of procedures in each row of the table.
**99999=unlimited/as warranted.
IV=Intravascular
IM=Intermuscular
SC=Subcutaneous
VHF=Very High Frequency
SLTDR=Satellite Linked Time Depth Recorders
PIT=Passive Integrated Transponder

3.1 Proposed Activities

The proposed research and enhancement activities under Permit No. 22677, which includes aerial surveys (manned and unmanned), vessel surveys, land surveys, capture and restraint activities, biological sampling, tagging, population assessment and monitoring, bleach and dye marking, health studies and treatments, foraging studies, vocalization studies, translocations, behavioral modifications, lethal take, disentanglement and dehooking, vaccinations, supplemental feeding, necropsy, sample collection and import/export of samples, unintentional disturbance, and conservation measures. These activities will take place in the Hawaiian Archipelago and Johnston Atoll.

The timeframe for the NMFS PIFSC's research and enhancement activities is from January 1, 2010 through January 1, 2025 with the potential for a one-year extension that will not allow additional MMPA take of animals. Researchers may conduct fieldwork year-round, with a peak of research and enhancement activities typically during March through September when field camps are deployed annually in the Northwestern Hawaiian Islands. Field camps are ideally timed to encompass the pupping and nursing season in order to monitor births and tag all pups in each cohort. Timing may vary depending on budget constraints and logistics as the Northwestern Hawaiian Islands are extremely remote and accessibility by vessel or aircraft is limited. Research and enhancement activities in the Main Hawaiian Islands and Johnston Atoll may occur at any time of the year, but rarely occur at Johnston Atoll due to the small number of animals that visit this location.

3.1.1 Aerial Surveys

Aerial surveys counting Hawaiian monk seals will involve manned and unmanned aerial surveys.

3.1.1.1 Manned Aerial Surveys

Manned aerial surveys will be conducted from either a fixed-wing aircraft or helicopter. Aircraft will maintain an altitude of 152.4 meters (500 feet) or lower (e.g., to a minimum of 91.4 meters [300 feet]; (vector combination of vertical and horizontal distance) for fixed-wing aircraft and 76.2 meters (250 feet) for helicopters. Manned aerial surveys are typically conducted by flying offshore of shorelines until an animal is spotted, then circling (or hovering) to observe and photograph the individual for approximately five minutes or less.

3.1.1.2 Unmanned Aerial Surveys

Unmanned aerial surveys will be conducted from unmanned aircraft systems. Unmanned aircraft systems can be used to enhance population assessment and monitoring, as well as assess body condition with photogrammetry tools. Unmanned aircraft systems will be used for counting animals and identifying them in locations where they are difficult to access by land or vessel surveys.

The HMSRP will use an APH-22 hexacopter (Aerial Imaging Solutions, LLC.) for unmanned aerial surveys. The APH-22 hexacopter is a six-rotor vertical takeoff and landing unmanned aircraft system that is controlled by a pilot and connects to a ground station with video output and information about the altitude, orientation, operation time, and battery life. The APH-22 hexacopter is equipped with an Olympus E-PM2 mirrorless camera with an exchangeable lens mounted on a gimbal designed to keep the camera facing straight down. The APH-22 hexacopter is powered by a four-cell 6200 milliamp hours lithium polymer battery. The unmanned aircraft system's attitude, altitude, and heading are stabilized by an electronic control system that incorporates three gyros, three accelerometers, a magnetic compass, a barometric pressure sensor, a global positioning system (GPS) receiver, and eight microprocessors. The APH-22 hexacopter is preferred because, if a motor goes out during flight, it can compensate with the remaining motors and land safely rather than losing stability and falling.

A two-person team consisting of a pilot-in-command and ground station operator operates the APH-22. The-pilot-in command leads the flight and operates the unmanned aircraft system with the remote control unit. The ground station operator monitors the video feed, battery status, and directs the pilot in command based on this information.

The APH-22 hexacopter will be remotely controlled by a pilot continuously or programmed for a mission (typically 15 to 20 minute flights; maximum speed of 48.3 kilometers per hour [30 miles per hour]). If needed, the pilot-in-command will be able to override a pre-programmed mission in progress and control the unmanned aircraft system. The mounted camera will send a live feed to the operators and can take photographs at one per second or one per two seconds. Video can also be taken by the mounted camera, but cannot be controlled in flight (i.e., it must be turned on before flight and turned off after flight). Cameras will be used to read flipper tags for identification purposes. Generally, unmanned aerial surveys will be conducted at altitudes of 10 to 60 meters (32.8 to 196.9 feet), depending upon the objective. However, researchers will try to use the best practice of using a 45-millimeter (1.8 inches) lens at an altitude above 12 meters (39.4 feet) to identify individuals and cause less disturbance. The minimum altitude will be 7.5 meters (24.6 feet).

The APH-22 hexacopter is one of several unmanned aircraft systems approved by the NOAA Aircraft Operations Center that has appropriate operational capabilities for research on Hawaiian monk seals. Researchers may also use fixed-wing and vertical take-off and landing unmanned aircraft systems, as well as other platforms that may become available and be approved by the NOAA Aircraft Operations Center. The additional unmanned aircraft systems will have similar, smaller, or quieter specifications and be used for the same purposes.

3.1.2 Vessel Surveys

Vessel surveys typically occur in areas where researchers cannot access land or where sand spits occur that are too small to access without disturbing animals. In the Northwestern Hawaiian Islands, the typical research vessels is approximately 5.5 meters (18 feet) long (e.g., Boston

Whaler) or smaller. The research vessel will circle a haulout site from a minimum approach distance of approximately 10 meters (32.8 feet). NOAA research vessels used during the proposed vessel surveys conform to the requirements of 33 C.F.R. §151, the Federal Water Pollution Control Act, International Maritime Organization ballast water guidelines, and MOC Environmental Guideline ENV 09.

In the Main Hawaiian Islands, the typical research vessel varies opportunistically, depending upon the agency or charter that is available and traveling to inaccessible areas where observations are important (e.g., remote areas of Kauai, Kahoolawe). The minimum approach distance to haulouts in the Main Hawaiian Islands is approximately 10 meters (32.8 feet). Vessel surveys may also be conducted using kayaks maneuvered manually using paddles. Kayaks may be preferred when adjacent to islands or emergent reefs that are too shallow to approach using a larger motorized research vessel. Kayaks are low profile and quiet, and will not have a minimum approach distance to animals. Typically, only one kayak at a time will be used to approach animals at haulouts.

3.1.2.1 Remotely Operated Aquatic Vehicles

NMFS PIFSC will use remotely operated aquatic vehicles (i.e., remote control boats) to improve assessment and monitoring of animals in certain situations. When animals are sick or injured they will float or log in nearshore waters, and it is often difficult to effectively assess an animal's health or behavior visually without researchers entering the water or approaching via vessel. Using remotely operated aquatic vehicles will allow researchers to acquire visual and behavioral information for assessments without needing researchers to directly approach the animals. The exact specifications of each remotely operated aquatic vehicle may vary, but they will have the ability to record and livestream high quality imagery used for health assessments. An example of a remotely operated aquatic vehicle that may be used is the PowerVision PowerRay (https://www.powervision.me/en/product/powerray)

3.1.3 Land Surveys

NMFS PIFSC will use stationary video and still camera systems mounted in remote locations or relatively inaccessible areas in the Main Hawaiian Islands (e.g., offshore islets or selected beaches) and throughout the Hawaiian Archipelago in order to increase monitoring at these sites. For example, cameras are currently installed at Nihoa Island in the Northwestern Hawaiian Islands and can be used at other sites including offshore islets that are important for pupping in the Main Hawaiian Islands (e.g., Manna Island on Oahu). Individuals may be identified remotely from their identification tags and markings.

The camera system(s) will be placed in a location to view the area of the island that supports the majority of the Hawaiian monk seal population and birth areas. The camera is solar and battery-powered with a dish or antenna for data transmission in some applications. The camera is approximately 17.8 by 27.9 by 10.2 centimeters (7 by 11 by 4 inches) in size. Some of the camera systems may have remote pan-tilt-zoom functionality. The camera will be housed in a weatherproof box containing a server and transmission relay station set up near the power system to allow for remote control of the camera and recording systems using the Internet. Video signals may be wirelessly sent to a receiver at the site and transmitted using a satellite or cellular system to Honolulu, Hawaii, where it can be accessed using the Internet. Researchers may also access video and still cameras by retrieving memory cards. The installation of cameras will occur over one to two days with at least one researcher present to monitor, mitigate, and document potential disturbance. Researchers will then regularly conduct maintenance of the camera system during deployments to field camps (one to two times per year at Northwestern Hawaiian Islands sites and as needed at offshore islands in the Main Hawaiian Islands). Camera systems will need to be repaired by engineers if they malfunction. The timing of a repair trip will depend on the availability of the contract or NOAA research vessel in the Northwestern Hawaiian Islands and as weather and logistical constraints allow in the Main Hawaiian Islands.

Researchers will minimize disturbance to animals when installing or repairing video and camera systems whenever possible by avoiding areas with actively nursing mother-pup pairs or molting animals. Data recorded on land surveys includes date, time, location, and variety of information about each individual animal (e.g., size, sex, tag information, bleach marks, body condition, molt status, association with other animals, injuries, behavior [monitoring aggressive adult males], and reaction of animal's to researchers).

3.1.4 Capture and Restraint Activities

Research and enhancement activities involve the capture and restraint of Hawaiian monk seals. Below we discuss general methods as well as more specific measurements.

3.1.4.1 General Methods

Common protocols are used for capture and restraint of all age classes. Adult females will only be captured if they are not obviously pregnant, nursing, or "spent" after lactation, unless in the case of emergency (i.e. dehooking or disentanglement). Non-pups will not be captured if they are immediately pre-molt, molting, in poor body condition after molting, and otherwise compromised (e.g., very old, emaciated, or injured). The method and duration of capture and restraint required to safely and successfully conduct an activity vary greatly. Duration of restraint may last only a few seconds (for removing debris from an entangled pup) to 30 minutes or more (for conducting a full health assessment and telemetry instrument attachment). Researchers may use remote sedation or in-water capture methods in rare circumstances when the life of an animal is at stake (i.e. disentanglement or dehooking) and the threat (i.e., fishing gear) cannot be mitigated using standard capture and restraint methods.

The following are general methods for research and enhancement activities involving capture and restraint (more details are in Appendix C of the application; See Section 16.3).

Researchers and will conduct a thorough risk assessment prior to conducting each capture using a Green-Amber-Red model (more details of the Green-Amber-Red model is in Appendix B of the NMFS PIFSC's application; See Section 16.2) and will approach animals during capture and restraint activities with great caution. Once a decision has been made to conduct a capture, the team will make a plan and assign roles to each team member. Researchers will typically restrain animals by hand, or in a stretcher, hoop, or net. The number of researchers required to restrain the animal varies depending on the animal's size, condition, and the capture/handling procedures that are needed to be performed. A minimum number of researchers will be used to safely complete capture and restraint procedures. If sedation is used, restraint is minimal once it takes effect, but researchers will remained ready to apply restraint if necessary. Stress to animals from capture and restraint activities will be minimized by handling animals for as short a time as possible and cooling the animal with water, as well as through the use of sedatives, which are anxiolytic.

Researchers will observe animals for a minimum of five minutes after they are released from capture and restraint to ensure they resume normal behavior (either going into the water or resuming normal respiration rates on land).

Researchers will take precautions during capture and restraint activities that require physical contact with animals to ensure that humans handling animals do not inadvertently transfer pathogens between animals. Researchers that make physical contact with an animal or an animal's bodily fluids will wear appropriate protective clothing (e.g., coveralls, gloves, footwear). All instruments and gear (e.g., nets, tape measures, calipers, pit tag applicators, tag hole punchers, cooler, buckets) are cleaned and disinfected before and after use. All researchers involved in capture and restraint activities will wash their hands with soap or use hand sanitizer prior to handling another animal. Most capture and restraint activities will occur on land, but in some rare cases (e.g., dehooking or health issues that require treatment or diagnosis) animals may be captured in the water or guided ashore for capture to prevent or reduce further harm to the seal (more details are in Appendix D of the NMFS PIFSC's application; See Section 16.4).

3.1.4.2 Morphometric Measurements

To conduct morphometric measurements, seals will need to be captured and restrained as discussed in Section 3.1.4 above. Axillary girth and dorsal straight length are indicators of the health and body condition of Hawaiian monk seals (Craig and Ragen 1999; Baker 2008; Baker et al. 2014). These data are useful for comparing condition of animals in different subpopulations and provide insight into the factors that affect survival and population trends.

3.1.4.3 Blubber Measurements

To conduct blubber measurements, seals will need to be captured and restrained as discussed in Section 3.1.4 above. After capture and restraint, animals will be weighed and blubber depth measurements will be collected using a portable imaging ultrasound. Blubber measurements will be used as an indicator of body condition and nutritional state by assessing fat stores in the body.

3.1.5 Biological Sampling

Researchers will conduct biological sampling that includes remote biopsy sampling, fecal and scat sampling, prey sampling, and spew sampling.

3.1.5.1 Remote Biopsy Sampling

Researchers will collect remote biopsy samples with projectiles or biopsy poles in order to collection biological samples from animals without the need for restraint or sedation, including from animals that might otherwise be deemed too sensitive for capture and handling. Sensitive animals, such as obviously pregnant females, which are not handled in non-emergency situations, may be remotely biopsied with minimal disturbance. The remote biopsy system uses a crossbow (though a rifle can also be used) to project a dart comprising four key components: (1) a stopper to keep the dart from penetrating too deeply into the tissue; (2) a sharpened biopsy tip to cut, extract, and contain the tissue sample; (3) a retention device designed to keep the sample in the tip for collection; and (4) a tether connected to the dart for retrieval. The NMFS PIFSC plans to complete several modifications to make the darts better-suited for use on Hawaiian monk seals. For example, the biopsy tip will be shortened appropriately for the blubber thickness, the biopsy tip will be smaller in diameter with thinner walls, and the stopper may be padded to lessen impact to animals. Biopsy samples can also be taken with biopsy poles with tips similarly modified to ensure appropriate penetration depth and sample retention for Hawaiian monk seal tissues.

During remote biopsy, researchers will approach on foot and possibly in rare cases from a vessel. The minimum approach distance is the distance of the pole (for pole biopsy). The minimum distance for crossbow or rifle biopsy sampling will be determined during carcass testing to determine the safest distance to minimize injury and disturbance. The ability for researchers to sample adult females throughout their breeding cycles (with the exception of the nursing period to avoid disturbing mother-pup pairs) will help address gaps in the understanding of female reproductive biology. Researchers will collect biopsy samples with punches during health studies as well.

3.1.5.2 Fecal and Scat Sampling

Researchers will opportunistically conduct fecal or scat sampling on the beach without directly taking animals for purposes of diet studies. For captive seals, fecal samples will be collected using free catch taken from the ground in seal pens, as is done as part of husbandry soon after seals are brought in to check for parasites and for efficacy of treatment. In cases where free-catch is not possible, a fecal loop may be used.

3.1.5.3 Prey Sampling

Researchers will conduct prey sampling and collect prey remains from gastrointestinal tracks during necropsies and from fecal samples for purposes of diet studies. Researchers will only conduct necropsies on carcasses of Hawaiian monk seals found dead in the action area.

3.1.5.4 Spew Sampling

Researchers will opportunistically conduct spew (vomitus) sampling on the beach without directly taking animals for purposes of diet studies.

3.1.5.5 Vibrissae Sampling

Researchers will collect vibrissae (whiskers) for stable isotope and hormone analysis from all animals captured for flipper tagging, instrumentation, biological sampling, or some other research and enhancement activity (e.g., dehooking, treatment of abscesses). The method of collection will vary depending on if the animal is sedated or not sedated. Vibrissae will be pulled, rather than clipped, because clipping results in an unknown length remaining attached to the animal and obtaining the root of the vibrissae, representing the most recent growth is preferable for analysis. Vibrissae will be removed by pulling only from sedated animals or will be clipped at the base with small scissors if the animal is being restrained without sedation. Vibrissae will be pulled by gripping with forceps or fingers and pulling forcefully in one smooth motion. Animals will only have up to two vibrissae sampled once annually.

3.1.6 Tagging

Researchers will apply a variety of tags and marks to animals. Researchers will apply tags as a method to mark animals for short- and long-term identification of individual animals. This is critical for the population monitoring database. Researchers will try to tag as many pups as possible during the nursing season to compute age-specific vital rates (survival and reproductive rates). However, most pups are not tagged until after they wean, so as not to disturb mother-pup pairs. Without tagging it is impossible to associate the identities of unmarked juveniles with individual pups born in the previous year, so failure to tag each pup reduces the ability to track the fate of pups born at particular islets or to individual females. These concerns, when compounded over time, may severely reduce understanding of the life history dynamics for Hawaiian monk seals. Types of tags used during the proposed action are presented in Table 2 and are discussed further below.

Table 2. Types of instruments used for tagging endangered Hawaiian monk seals.

Instrument Type	Specifications (Length by Width by Height, unless Otherwise Specified)	Application	Approximate Duration of Deployments	Number Deployed Per Year
		Flipper Tag Attachment		
LAT 1800 TDR, Single Post (Lotek)	4.2 cm by 1.7 cm by 1.7 cm 11 g in-air plus flipper tag	Dive Behavior	Up to Two Years	Up to 20

MiniGPS, Single Post (iGotU)	4.4 cm by 2.8 cm by 1.3 cm 20 g in-air plus flipper tag	GPS Location	One to Four Weeks	Up to 20
SPOT 6 Finmount, Double Post (Wildlife Computers)	8.7 cm by 3.7 cm by 1.9 cm 57 g in-air	Argos Satellite Location	Up to Two Years	Up to 20
Bluetooth Identification Tag, Single or Dual Post (TBD)	Under Development	Real-Time Detection based on Bluetooth Signal	Up to Five Years	Up to 40
Other Flipper-Mounted Instruments	Up to 10 cm by 4 cm by 2 cm 75 g in-air	May Vary	May Vary	Up to 40
Dorsal Fur Attachment				
VHF Radio Tags	6.5 cm by 3.2 cm by 1 cm	Real Time Detection based on Radio Signal	Up to One Year	Up to 40
MK9 TDR (Wildlife Computers)	8.5 cm by 1.8 cm by 1.7 cm 34 g in-air	Dive Behavior	Up to Ten Months	Up to 20
SPOT 6 (Wildlife Computers)	7 cm by 4.1 cm by 2.3 cm 72 g in-air to 8.6 cm by 1.7 cm by 1.8 cm 38 g in-air	Argos Satellite Location	Three to Nine Months	Up to 20
MK10 GPS Recorder (Wildlife Computers)	8.6 cm by 5.5 cm by 2.6 cm 130 g in-air	GPS Location, Argos Satellite Location, Dive Behavior	Three to Nine Months	Up to 40
GPS/GSM Tags (SMRU)	10 cm by 7 cm by 4 cm 370 g in-air	GPS Location and Dive Behavior Transmitted through Cell Phone Network	Three to Six Months	Up to 20
Crittercam Video System (National Geographic)	7 cm by 20 cm 1 kg in-air	Video Recording of Underwater Behaviors, Sound	Three Days to Two Weeks	Up to 20

Multi-Sensor Video Camera System (CATS)	11.3 cm by 8.3 cm by 5.6 cm 500 g in-air	Video Recording of Underwater Behaviors, GPS Location, Dive Behavior, Pressure, Speed, Bearing, Temperature, Light, Acceleration, Sound	Two Weeks	Up to 20
Remote Release Device (for use with Additional Instruments) (Wildlife Computers)	10.9 cm by 6.6 cm by 2.9 cm 400 g in-air	Platform that Allows the Remote Release of Other Instruments	Up to One Year	Up to 20
Other Dorsal Fur Attachment Instruments	Up to 20 cm by 10 cm by 9 cm 1 kg in-air	May Vary	May Vary	Up to 40

cm=centimeter
GPS=Global Positioning System
g=grams
kg=kilograms

As refinements in manufacturing of tagging technologies progress, new diagnostic tests are developed, and improvements in research methods are made, researchers at NMFS PIFSC propose to incorporate such improvements to research and enhancement activities in the field as long as impacts to the animals remain the same or are reduced. The NMFS PIFSC will notify the NMFS Permits and Conservation Division of any implementation of new tagging technologies.

3.1.6.1 Flipper and Passive Integrated Transponder Tagging

Researchers will annually tag or retag Hawaiian monk seals (approximately 400 animals) of any size or sex (except lactating females) within the Hawaiian Archipelago and Johnston Atoll. Flipper tags will be applied to both hind flippers of weaned pups and to older animals that may have not been previously tagged.

Flipper tags will include Temple, Roto, and monel tags. Lettered and numbered flipper tags will be the most commonly applied marking tag. In order to maintain identities of individuals, flipper tags will be reapplied to animals with tags that have become lost, broken, or excessively worn. Temple tags will be applied to weaned pups and older animals. Roto or monel tags will be applied to animals when standard capture and restraint is not possible or warranted (e.g., nursing pups or adults in some cases).

As stated, most pups are not tagged until after they wean so as not to disturb mother-pup pairs. Towards the end of the field season when not all of the pups have weaned, nursing pups that are handled during interventions to reunite them with their mother or to place them with a foster mother will be tagged in order to facilitate identification the following year. Nursing pups may be tagged very rapidly and with minimal restraint using a single metal or plastic tag with a piercing side that attaches to a second element. Researchers will do this when pups have not and will not wean prior to the end of the field season (otherwise, researchers will wait until weaning as usual to apply tags). Researchers will use tags fitted into purpose-designed pliers that pierce and attach or crimp (e.g., monel steel or plastic tags such as All-Flex, Dalton, or Roto) in a single rapid motion. These tags are less durable than Temple tags, but surviving pups may be recaptured when older and retagged with longer-lasting Temple tags. Juvenile and adult animals may also be tagged using piercing tags for long-term identification when full capture and restraint is not safe or practical.

Animals are typically restrained by hand, stretcher, hoop, or net and tagged with two plastic Temple tags. Temple tags are 4 by 2 centimeters (1.6 by 0.8 inches) and are inserted through holes punched in the webbing between two digits for each rear flipper. The flipper plugs resulting from punching the webbing of hind flippers are retained for deoxyribonucleic acid analysis. Plugs of tissue will be placed in dimethyl sulfoxide, returned to the laboratory in liquid nitrogen, and stored in ultra-cold freezers. Restraint time for tagging animals averages less than five minutes and will rarely exceed ten minutes.

After flipper tags are applied and the animal is still under restraint, researchers will inject a single passive integrated transponder (PIT) tag. Researchers generally inject PIT tags bellow the blubber in the lumbar area, approximately 12.7 centimeters (5 inches) lateral to the dorsal midline and approximately 12.7 centimeters (5 inches) anterior to the bae of the tail. However, alternate sites on the animal’s posterior may be used. Each “microchip” has a unique identification code that can be determined using portable, hand-held readers and provide long-term identity of individuals (even if flipper tags are lost).

Researchers will apply tags by approaching a resting pup when it is relatively far from its mother. A single rear flipper will be quickly held and the tag will be applied between two digits along the trailing edge of flipper. Tagging will be completed in less than ten seconds (typically one to two seconds). The researcher will then immediately vacate the area to minimize disturbance, but will observe the mother-pup pair to confirm they remain together. A second researcher may accompany the other researcher for safety reasons in order to distract the mother if she moves rapidly toward the pup and tagger. During tagging, researchers will measure the length and girth of animals using a flexible tape measure.

3.1.7 Population Assessment and Monitoring

Research activities for population assessment and monitoring are conducted to evaluate the vital (survival and reproductive) rates and abundance trends of Hawaiian monk seal subpopulations, identify the threats to recovery, provide data that may be used to formulate recovery strategies for implementation, and evaluate the effectiveness of implemented recovery actions. Population assessment and monitoring will include a combination of aerial surveys, vessel surveys, and land surveys. Population monitoring is almost exclusively conducted by human observation. Researchers on the shore adjacent to animals will conduct most observations. Researchers will use binoculars and digital cameras with telephoto lenses to document animals. In some cases, researchers are right next to the animals (0 meters) while they sleep to read a tag or get a photo when these things cannot be accomplished from further away. Researchers will conduct annual population assessment and monitoring year-round, but most is typically done during the March through September field season. Depending on objectives of the observation and context, including the seal’s position and behavior, ground observations may be conducted in minutes or hours.

Extensive population assessments and monitoring is conducted at six subpopulations in the Northwestern Hawaiian Islands. Field camps are deployed for up to five months annually. Less frequent population assessments and monitoring is conducted at Necker and Nihoa Islands and Ni’ihau. A volunteer sighting network also gathers information on animals year-round in the remaining Main Hawaiian Islands.

Objectives at each monitoring site include:

- Conducting regular systematic surveys to count and identify all individuals on the beach at any given time (“beach counts”);
- Enumerating (through individual identification), to the degree possible, all the animals observed at each subpopulation;
- Tagging and measuring pups and other animals for permanent identification and monitoring body condition, and retagging animals to maintain identification;
- Obtaining digital photographs to maintain an updated photographic identification database;
- Collecting tissue for genetic analysis;
- Documenting births, identifying parturient mothers, and determining duration of nursing period;
- Documenting and mitigating any factors that may affect the survival of individual animals, including wounds (from sharks, aggressive males), entanglement in marine debris, hookings, emaciation, etc.
- Identifying and evaluating candidates for rehabilitation, which will be conducted under the authority of the Marine Mammal Health and Stranding Response Program;
- Documenting any deaths or disappearances of animals;
- Documenting “association” data that may be used to identify aggressive male animals that cause injury or death to other animals; and
- Surveillance for evidence of disease and/or poor health.

Another objective of the population assessment and monitoring is to provide a better understanding of the ecology of Hawaiian monk seals. Trends in parameters such as survival, body condition, and abundance will be analyzed to establish inks with climate-ocean dynamics in order to better understand the drivers of population trends.

The population assessment and monitoring of the Hawaiian monk seal is a long-term (35-year), consistent, and very detailed demographic study that is integral to the conservation and management of the species (NMFS 2019). Annual data from the field is entered into a relational database, from which output is analyzed to estimate the following parameters:

- Subpopulation and range wide abundance;
- Subpopulation age-sex composition;
- Age-specific survival;
- Gross and age-specific reproductive rates; and
- Movement among subpopulations.

These standard datasets, information on causes of injury and mortality, as well as genetic analysis from individuals and populations, are used to track the status and trends of the species, identify threats to recovery, and evaluate recovery actions. Annual monitoring of the subpopulations in the Northwestern Hawaiian Islands has been identified as a priority research action in the Hawaiian Monk Seal Recovery Plan (NMFS 2007d) as well as by the Marine Mammal Commission and through a series of external reviews of the HMSRP.

3.1.8 Bleach and Dye Marking

Researchers will mark animals with bleach or dye to identify animals. A commercially available cosmetic hair lightener will be used and applied from a squeeze applicator. Researchers will mark animals by carefully approaching a sleeping animal and applying a unique identifier consisting of an alpha/number, shape, or combination to the animal’s pelage on the back or side. A bleach “girdle” is also applied over the animal’s circumference near the tail. The purpose of the girdle is for subsequent detection by researchers that the animal has been bleached, even if the animal is lying on the previously applied mark. Most animals with bleach and dye marks will have been previously tagged and have an identity assigned. The presence of a highly visible marking allows researchers to identify an animal from a much greater distance than normal and lessens the need to closely approach (and thus reduces disturbance). Animals are often marked annually to support the monitoring of subpopulations. Each animal may be bleach marked up four times per year. Multiple bleach or dye markings may occur in order to mark the left and right sides (in case the animal is lying on one side), if the marking fails, or if the animal molts and sheds the previously applied mark. The bleach or dye mark usually remains until the annual molt, with a maximum duration of one year.

3.1.9 Health Studies and Treatments

Health studies objectives include:

- Baseline health assessment to establish normal values for morphometric, hematologic, and biochemical parameters within age and gender classes;
- Monitor hormones to establish normal values and assess individual condition and reproduction;
- Monitor and document infectious disease exposure and pathogenesis to help understand its influence on past, current, and potential future population trends;
- Develop prevention and control strategies to mitigate the effects of suboptimal health;
- Develop contingency plans for high risk unforeseen circumstances (e.g., oil spills); and
- Provide guidance and protocols where there is a nexus between health issues and enhancement activities (e.g., translocations between subpopulations).

Health screening will include collections from (1) animals displaying debilitation, malnutrition, or wounds, which may be symptomatic of a disease or a disease process; and (2) apparently healthy animals. Health studies may occur year-round during planned efforts or on an ad hoc basis (e.g., unusual mortality event). In the event of an adverse reaction during health studies and treatments, researchers will follow the HMSRP Emergency Resuscitation Protocol, and refresher training on the protocol will be provided to researchers annually.

The types of samples collected from injured, ill, or debilitated animals, as well as the decision on site whether to use sedation on an animal, is at the discretion of the attending veterinarian who will always be present when sedation is involved. Samples collected will include blood (no more than one percent of body weight; typically 96 milliliters or less), dry swabs from all body orifices and wounds, blubber biopsies, ultrasound, morphometrics (girth and length), and weight. Samples collected by researchers will depend upon the condition of the animal, clinical signs it is displaying, and an assessment of the animal’s tolerance to restraint. Animals will be flipper and/or PIT tagged, if they have not been previously tagged or if the tag becomes lost, broken, or excessively worn. Animals may be recaptured for subsequent health studies and treatment per the recommendation of the veterinarian.

Researchers sometimes observe weaned pups and juvenile animals with large dorsal lumps. These abscesses are thought to result from infection of scratches or puncture wounds inflicted by conspecifics. These abscesses may resolve without treatment, but sometimes grow large enough to cause debilitation and possibly even lead to systemic infection. Treatment may involve manual lancing and flushing with dilute betadine, hydrogen peroxide, or similar disinfectant. Researchers may collect swabs of abscess material during lancing in order to do diagnostic testing (e.g., culture, Polymerase chain reaction) to identify the organisms involved in causing the abscess. Animals are often observed with wounds inflicted by sharks, which may require debridement, flushing, and treatment. Researchers may use long-acting antibiotics (e.g., Ceftiofur, Defovecin) to treat abscesses and wounds if prescribed by an attending or consulting veterinarian (See Table 3). More details are included in Appendix F of NMFS PIFSC’s application (See Section 16.6).

Table 3. The drugs proposed for use by the National Marine Fisheries Service's Pacific Islands Fisheries Science Center for sedation, anesthesia, resuscitation, and veterinary medical treatments.

Drug Name	Dosage/Route of Administration	Use in Hawaiian Monk Seals
Atropine Sulfate	0.02 to 0.04 mg/kg SC, IM, IV (Plumb 2008; Simone C. A. and Stoskopf 2018)	Anticholinergic used to treat bradycardia (slowed heart rate) or cardiac arrest; may be used as a pre-anesthetic to reduce respiratory secretions and block vagal mediated dive reflex.
Butorphanol	0.05 to 0.2 mg/kg PO, SQ, IV, IM (Haulena and Schmitt 2018)	Opiate partial agonist/antagonist. Used in combination with midazolam or diazepam to aid in deeper sedation, as necessary (e.g., for in-water capture and/or transport of large animals when cage are not feasible/available); mildly analgesic.
Ceftiofur crystalline free acid	6.6 mg/kg IM (Meegan et al. 2010)	Long-acting cephalosporin antibiotic for prophylactic treatment of injuries and treatment of infections.
Cefovecin	4 to 8 mg/kg IM, SC (Garcia-Parraga et al. 2016; Simone C. A. and Stoskopf 2018)	Long-acting antibiotic (3rd generation cephalosporin).
Cimetidine (Tagamet)	5 mg/kg PO	H2 (histamine) – receptor blocker used to reduce gastric acid production; used in treatment of gastric ulcers.
Dexamethasone	Anti-inflammatory 0.1 to 0.2 mg/kg IM q24h Treatment of shock: 2.2 mg/kg IV, IM (Simone C. A. and Stoskopf 2018)	A glucocorticoid used for treatment of shock; may be used to treat adrenal insufficiency, inflammation, and other maladies.
Diazepam	0.1 to 0.3 mg/kg IV	A benzodiazepine used as a sedative (anxiolytic, muscle

	(Up to 0.5 mg/kg IV for heavy sedation prior to euthanasia or lethal removal (Plumb 2008; Haulena and Schmitt 2018)	relaxant, hypnotic) for capture events; may be used as an appetite stimulant or anti-convulsant.
Doxapram HCL	2 to 4 mg/kg IV	A CNS/respirator stimulant used to treat respiratory arrest; may also be administered during/after anesthesia.
Epinephrine	0.05 to 0.5 mg/kg IV, IM, SC, intracardiac, intratracheal.	Treatment for cardiac arrest with resuscitation; may also be used to treat anaphylaxis.
Famotidine (Pepcid)	0.5 to 1 mg/kg PO, SC, IM, IV every 12 to 24 hours	H2 (histamine) – receptor antagonist for reducing gastric acid production, commonly used in supportive care.
Fenbendazole	10 to 50 mg/kg PO (Simone C. A. and Stoskopf 2018)	An antiparasitic agent for treating intestinal roundworms.
Flumazenil	0.05 to 0.1 mg/kg IV, IM	A benzodiazepine antagonist used to reverse effects of sedative overdose (diazepam or midazolam).
Furosemide	2 to 4 mg/kg PO, SQ, IM, IV (Dierauf et al. 2018)	A diuretic used to treat congestive heart failure or pulmonary edema.
Lidocaine HCL	2 to 6 mg/kg SQ4 Mg/kg SQ	A local anesthetic used to create nerve blocks to reduce pain from skin incisions such as blubber biopsies.
Midazolam	0.15 to 0.3 mg/kg IV, IM	An injectable benzodiazepine used as a sedative for capture events or as a preanesthetic.
Naloxone	0.002 to 0.02 mg/kg IV, IM	Opiate antagonist (reverses effects of butorphanol).
Praziquantel	10 to 15 mg/kg PO, IM	An anticestodal antiparasitic used to treat intestinal tapeworms.
Prednisolone sodium succinate (Solu-delta-cortef)	5 to 10 mg/kg IM, IV	A glucocorticoid used for treatment of shock; may be used to treat adrenal

		insufficiency and other maladies.
Sodium pentobarbital	60 to 120 mg/kg (Dierauf et al. 2018)	Humane euthanasia by attending veterinarian of moribund animals, or as a last resort to remove aggressive male animals.
Tiletamine/Zolazepam (Telazol)	1 mg/kg IM, IV	Anesthetic/tranquilizer will be used for pre-medication to make animal removal that is more amenable to handling for euthanasia /lethal. Not proposed for routine sedation for research and enhancement activities.

kg=kilogram
mg=milligram
IM= Intermuscular
IV= Intravascular
PO= Oral; Administration by mouth
SC or SQ= Subcutaneous

More details can be found in Appendix G (Section 16.7) and Appendix H (Section 16.8) of the NMFS PIFSC's application, which provides protocols for treating abscesses and for administering injectable medications in the field, respectively.

Procedures for sampling healthy animals will typically occur under sedation and are paired with other research activities such as biological sampling and tagging. Sedation, if appropriate, will typically be accomplished with benzodiazepines (midazolam or diazepam) and a top-up dose will be given at the discretion of veterinarians based on the status of the sedated animal. After the animals are sedated, researchers may collect blood from the extradural intervertebral vein. Dry swabs may be collected from eyes, nares, mouth, anus, genital orifice, and external lesions. Two blubber core samples (through the full depth of the blubber layer) will be collected from the dorsal pelvic region using a sterile 6-millimeter (0.2 inches) biopsy punch and forceps. Topical anesthetics may be used at the biopsy punch site prior to collecting the blubber sample. Animals may be weighed, morphometrics and ultrasound taken, vaccinated, and flipper and/or PIT tagged (if not done previously). The total handling time of animals depends upon the number of concurrent research activities, but will typically range from 15 to 60 minutes. Research activities will cease immediately in the event that the animal becomes unstable, and researchers will focus on sedative reversal and resuscitation.

A portable imaging ultrasound (SonoVet Universal Imaging or similar) will be used for blubber depth measurements. Researchers will collect blubber depth measurements by applying light pressure to the skin to obtain images along the lateral side and dorsum of the animal. Blubber depth measurements may occur during health assessment studies, instrumentation, flipper tagging, wound or other medical treatment, and deworming. Measuring blubber depth will provide information on body condition and reflect changes in fat deposition and growth via lean mass.

Researchers may opportunistically collect milk from lactating females during health assessment studies. Milk collection will be conducted in rare occurrences when a female has lost or abandoned her pup (and the pup cannot be reunited). Oxytocin may also be administered to animals to facilitate milk letdown at a dose of 20 United States Pharmacopeia units intramuscularly (Dierauf et al. 2018). Milk will be collected by manual expression of the teat and frozen at negative 20 degrees Fahrenheit. Analyses of the milk will include, but not be limited to, proximate analysis of fat, protein, water, and ash. Oxytocin may also be administered for agalactia. Post-partum adult females that do not appear to be producing milk and have a dependent pup, may be given oxytocin intramuscularly by hand injection or pole syringe. Administration of oxytocin may be repeated up to four times in a 48-hour period, with additional dosing at the discretion of the attending veterinarian.

All samples will be labeled with the identity of the animal being sampled, as well as standard collection data. Swab samples will be preserved using standard methods appropriate to the microorganism being detected. Whole blood will be centrifuged and blood fractions (i.e., plasma, serum, buffy coat) will be divided into aliquots and frozen in liquid nitrogen. Blubber biopsies will also be frozen in liquid nitrogen. Samples may be submitted to contract laboratories, research institutions, or collaborators for analyses including but not limited to tests for *Brucella* spp., protozoa, *Leptospira* spp., morbillivirus (including canine and phocine distemper virus), herpesvirus, biotoxins, environmental contaminants (heavy metals and hydrocarbons), and fatty acid composition. The HMSRP or a permitted partner (e.g., National Institute of Standards and Technology) will retain any samples not consumed or destroyed during analyses in ultra-cold storage. More details regarding protocols for sample collection are described in Appendix I of NMFS PIFSC’s application (see Section 16.9).

3.1.9.1 Baseline Health Assessments

The purpose of the research activities is to continue to collect data either on pathogens that might affect animals, individually or as a zoonotic or unusual mortality event. Screening debilitated animals will help to diagnose disease or other conditions which may be affecting a single animal, or, in the event of an outbreak or unusual mortality event, a large number of animals. Sampling ill or moribund animals is critical for detecting, and potentially mitigating, a disease or other threat to the broad population. Researchers will selectively screen healthy animals to help gain a basic understanding of disease exposure to the population, and to augment normal baseline values for hematologic and biochemical parameters.

3.1.9.2 Contaminant Studies

Contaminants such as persistent organic pollutants are often measured in blubber, liver, and blood of animals because these are tissues in which contaminants concentrate or which are relatively easy to obtain from live animals. Hawaiian monk seals accumulate persistent organic pollutants such as polychlorinated biphenyls, dichlorodiphenyltrichloroethane, and polybrominated diphenyl ethers in their tissues through nursing when young and through their diet later in life.

Research and enhancement activities will be done to collect samples for contaminant analysis to monitor for changes in tissue contaminant levels and better characterize the potential influence of substances on the health and recovery of Hawaiian monk seals. Contaminants are considered a moderate threat to Hawaiian monk seals. The Hawaiian Monk Seal Recovery Plan recommends to “continue collection of samples from seal and prey species and banking of samples for potential contaminant monitoring” and “examine data for association between reproductive failure and exposure to contaminants and conduct a risk assessment for monk seals” (NMFS 2007d).

3.1.9.3 Disease Studies

Researchers will monitor the exposure, incidence, and prevalence of infectious disease in various subpopulations of Hawaiian monk seals. The species is rare, has very low genetic diversity and may have been buffered from exposure to many mammalian diseases due to its isolation in the Hawaiian Archipelago for millions of years. These factors raise great concern that outbreaks of disease to which animals have not been previously exposed can have devastating impacts (Baker et al. 2017).

Land-to-sea transfer of *Toxoplasma gondii*, a protozoal parasite shed in the feces of cats, is of growing concern. Impacts from *Toxoplasma gondii* are further discussed in Section 7.5. In addition, certain pathogens, such as morbillivirus and West Nile virus, are of special concern in that they have not yet been detected in wild animals, but can have devastating effects on the species if an introduction occurs. There is especially heightened concern about the risk of new disease exposure in the Main Hawaiian Islands where animals encounter land mammals to which they have not been exposed due to their isolated evolutionary history in Hawaii. One of the enhancement activities the researchers propose to continue involves translocation of animals between subpopulations. Proper population-level surveillance as well as individual screenings is required to ensure that spread of disease is not facilitated by human interventions. The Hawaiian Monk Seal Recovery Plan lists “reduce the probability of the introduction diseases into the Hawaiian monk seal population” as one of the “four key actions required to alter the trajectory of the Hawaiian monk seal population and to move the species towards recovery” (NMFS 2007d).

Routine health monitoring sample collection and processing protocols have been developed to screen a variety of pathogens in live and dead animals and to archive samples for future surveillance or research needs. Samples are collected from animals requiring rehabilitation, opportunistically from healthy animals during research and enhancement activities, and all dead animals that are detected are necropsied as best as possible based on the condition of the body. Archives will be maintained using an extensive barcoding system and database.

Efforts are being implemented to reduce infectious disease outbreak risks. An unusual mortality event contingency plan has been published by the HMSRP (Yochem 2004). A vaccination program has been instituted throughout the Hawaiian Archipelago to prevent morbillivirus outbreaks. Researchers propose to maintain authorization for safety and efficacy studies of vaccines against specific pathogens considered most likely to spread to Hawaiian monk seals. This may be necessary if the vaccine currently used to protect against morbillivirus becomes unavailable or if new morbillivirus or other potentially relevant vaccines become available. Captive studies will include Hawaiian monk seals and surrogate species, and potentially free-ranging animals. If research activities indicate that such vaccines are safe and effective, they may be administered as enhancement activities.

3.1.9.4 Hormone Studies

Researchers will measure hormones to provide novel, sensitive information about an individual's condition and reproduction. For example, measures of glucocorticoids, thyroid hormone (triiodothyronine), and reproductive steroid hormones from free-ranging wildlife have been used to monitor individual responses to disturbance, changes in metabolism during food shortages, and reproductive activity.

The hormones that have been measured and studied in Hawaiian monk seal serum in the past, and validated and analyzed to different degrees include: testosterone, cortisol and thyroid, and progesterone (measured but not analyzed). During the proposed activities, researchers plan to continue these studies by extracting hormones from serum, plasma, feces, blubber, or vibrissae from any age class, gender, or location. Captive animals may be sampled for hormone analysis. Procedures for storage, hormone extraction, and laboratory analysis will be standardized for samples of each type (such as serum and feces) to allow for comparison of measures across future studies. Current characterization of the female reproductive cycle is limited due to limited sample availability throughout the cycle. Opportunistic samples taken during emergency response or necropsy seldom cover estrus or pregnancy. Remote biopsy (without restraint and sedation) is a potential tool for filling gaps in blubber sampling from breeding-aged females for health, hormone, and diet studies.

3.1.9.5 Deworming Studies and Treatment Methods

A variety of gastrointestinal parasites (i.e., nematodes and cestodes) are common in Hawaiian monk seals. To reduce parasite burden, anthelmintic treatment of wild and rehabilitated animals has been conducted by the HMSRP using oral, injectable, and topical pharmaceutical agents including praziquantel (oral and injectable), fenbendazole (oral), and praziquantel/emodepside (topical). The goal of developing deworming treatment is to reduce parasite burden in order to relieve pressure on struggling animals and improve their overall nutritional condition, which will hopefully lead to better health outcomes. Deworming studies may occur year-round, and follow-up assessments will be carried out between treatments. Due to past uses and studies of deworming treatment on Hawaiian monk seals and given an improved understanding on the reliability and dose of oral anthelmintics, the HMSRP will continue using oral deworming treatments in order to enhance survival of animals with high parasite burdens. This will occur until a suitable injectable deworming protocol is developed.

Research studies have shown a lack of definitive outcomes on the safety and efficacy of deworming drugs and left researchers without a clear direction in mitigating parasite infection. The research activities will continue to seek effective means for treating parasite infections in free-ranging animals and to determine if this treatment can help improve survival and body condition. The primary drug being considered is praziquantel, targeting cestodes, as it is available in multiple formulations (oral, injectable, and compounded injectable) that may lend itself to use on wild animals in the field. If so, this can be a tool implemented for enhancement activities. The first goal is to evaluate the safety of a compounded, highly concentrated injectable form of praziquantel and administer it to animals at a higher dose (15 milligrams per kilogram [33 milligrams per pound]) than that used in prior studies. If safe, the second goal will be to evaluate the efficacy of this injectable form relative to oral praziquantel administration.

3.1.10 Foraging Studies

Foraging studies will be comprised of instrumentation studies and diet studies. Foraging success of juvenile animals is a key element affecting survival, body condition, and growth of Hawaiian monk seals. The data from foraging studies will serve recovery goals to "use diet analysis, foraging studies, nutritional status, and ecosystem monitoring to evaluate possible competition with fisheries" in the Hawaiian Monk Seal Recovery Plan (NMFS 2007d). The data gathered to track foraging ecology will serve to track the survival and success of animals translocated or rehabilitated in an effort to improve survival. Foraging studies will improve understanding of important foraging habitat and inform management to conserve habitat. Foraging studies may occur year-round.

3.1.10.1 Instrumentation Studies

Instrumentation studies will focus on recording movements, habitat use, and foraging behaviors of animals. Hawaiian monk seal dive behavior, geographic dispersion, and habitat use will be studied by testing hypotheses including:

- Foraging patterns of animals in the Northwestern Hawaiian Islands and Main Hawaiian Islands vary consistently with differences in demography and body condition;
- Animals foraging habitat use in the Main Hawaiian Islands overlaps spatially with commercial, recreational, and subsistence fishing;
- By identifying key foraging habitats in the Main Hawaiian Islands, researchers can better understand the frequency and spatial dynamics of Hawaiian monk seal interactions with fishers and fishing gear;
- Foraging behavior of juvenile animals in the Northwestern Hawaiian Islands is correlated with variable oceanographic conditions;

- Foraging behaviors and/or strategies of juvenile animals differ from those of mature animals (potentially in terms of distances traveled, dive depth, prey search or capture behaviors);
- Breeding females exhibit more seasonal variability in foraging behaviors than males (associated with varied nutritional needs during pregnancy, nursing, etc.); and
- Foraging behaviors of animals rehabilitated and released back to their natural habitat will not differ from animals that remained in their habitat (without intervention).

A variety of integrated technologies and sensors will be used to detail characterization of geographic and vertical habitat use as well as foraging behavior of animals including:

- Location – Satellite telemetry technology provides excellent data from tracking animal movements. Some instruments record data at a broad scale (i.e., within kilometers or nautical miles) and are ideal for tracking regional movements (e.g., Argos). Many monk seals forage in complex habitats or in regions where habitat (depth, substrate, etc.) can change substantially over short distances. Proposed research activities will also incorporate technologies (e.g., Global Positioning System) that can provide fine scale spatial resolution (i.e., within meters or feet).
- Depth – Depth sensors provide detailed information on diving patterns (i.e., use of vertical foraging habitat). When paired with fine scale location data, it is possible to describe an animal's three dimensional habitat use. Research activities will incorporate depth sensors either independently or integrated into telemetry tags.
- Body Movement – The use of movement and body position sensors (three dimensional accelerometers or speed meters) has great potential for enabling researchers to understand specific behaviors, foraging strategies, and the effort output in foraging. These sensors are beginning to be incorporated into some telemetry tags and other instruments and are expected to yield valuable data.
- Video – Animal-borne video systems (e.g., Crittercam and Customized Animal Tracking Solutions cameras) offer an invaluable view from the animal's perspective. Research activities will use animal-mounted cameras to obtain visual data on the characteristics of habitats used, foraging behaviors, and identification of prey encountered. Such video data will also be valuable in identifying incidents of competition with conspecifics or other predators as well as interactions with fisheries/fishing gear.
- Environmental Sensors – Many instruments integrate sensors including temperature, salinity, chlorophyll, or other factors that can help assess the oceanographic conditions of the habitat used by animals.

Researchers will determine the number of animals to be instrumented by the number of individuals of suitable age available at a particular site.

3.1.10.2 Diet Studies

Diet studies will focus on animals' dietary needs, nutritional status, and types of targeted and consumed prey. Researchers will recover parts from animal feces and vomitus for diet analyses. Researchers will use quantitative fatty acid signature analysis to determine the species that comprise of their diet. Blubber samples will be used because fatty acid composition of blubber provides insights into prey species assimilated into the predator's tissues. The skin and hair collected from biopsy samples can be useful in stable isotope analysis, which is valuable for diet studies at broad ecological scales.

The HMSRP will use serial sections of animal whiskers (vibrissae) to study long-term foraging patterns by identifying temporal changes in diet via analysis of stable isotope ratios. Whiskers grow continuously and shed annually (Greaves et al. 2004), so each section represents diet during the period of growth (Hirons et al. 2001b; Kurle and Worthy 2002). Stable isotope ratios calculated from different sections of the whiskers can be used to interpret the diet or trophic position of animals (Hobson and Welch 1992; Hobson et al. 1996; Zhao and Schell 2004).

In addition to the samples above, researchers will take part in diet studies using opportunistic diet sample collection. Researchers will collect specimens that can provide important biological information. For example, researchers will gather fecal material (scats) and vomitus (spews) from beaches as the primary source of information for diet studies. Shed molt samples found on the beach will provide genetic material, and placentae will provide material for health and disease analysis.

3.1.11 Vocalization Studies

The main goal of vocalization studies is to characterize the vocal repertoire to determine detectable differences in vocalizations from individuals that may be used in different social situations. Information from recorded animals can be included in such analysis to track the effect of gender, body condition, stress level, and age class on the characteristics of vocalizations. This is because acoustic signals can convey different types of information such as species, group and individual identify, age, gender, physiological and emotional state, body condition, and social status. If differences in vocalizations by age are detected during research activities, this can help to determine relative age of unknown aged animals. For example, the existence of individual vocal signatures can be investigated to determine the role of vocalization in male-male competition or mother-pup recognition. Various species of pinnipeds use vocalizations to organize their social activities and to serve vital biological functions such as territorial defense, mate selection, pup attendance, and conspecific protection (Riedman 1990; Insley et al. 2003).

During vocalization studies, researchers will acoustically assess vocalizations of Hawaiian monk seals both in-air and underwater in the Northwestern Hawaiian Islands and Main Hawaiian Islands. Animals can be of any age and sex, and include mother-pup pairs. In the Northwestern Hawaiian Islands, researchers will conduct recordings during deployments at field camps or during cruises. In the Main Hawaiian Islands, recordings will be conducted opportunistically. Researchers will not conduct active acoustic playbacks.

Target pups will be recorded at different ages to follow vocal development during the course of lactation. Data from target animals such as age, sex, body condition, and health condition will be collected when possible to link acoustic characteristics to these traits. Agonistics vocalizations will be recorded opportunistically when mothers or pups are approached by other animals and may involve aggressive interactions.

Vocalization studies from acoustic recordings may occur on captive animals, such as on animals in human care for health concerns, and animals during relocations or while being captured for tagging and disentanglements. These opportunistic acoustic recordings will help assess if emotional state, stress level, and health conditions can be encoded in vocalizations, and if some acoustic features can be good indicators of health and/or stress.

Researchers will conduct vocalization studies by deploying acoustic recording instruments on an animal, as well as attach other instruments to provide social and environmental context. This approach will be useful for characterizing an animal's acoustic environment and the level of sound exposure experienced by different animals and in different locations. More information about instruments deployed directly on animals will be discussed in the *Tagging* section (Section 3.1.6).

In-air vocalization recordings may be collected using a Beyer Dynamic M69 microphone or similar instrument mounted on a 4 meter (13.1 feet) long boom and connected to a digital recorder Marantz PMD 661 (Sampling Frequency: 44.100 Hertz) or similar by an approximately 9.1 meter (30 feet) long cable. The boom will allow researchers to record the vocalizing animal at distance and limit disturbance. The microphone will be approximately 1 meter (3.3 feet) from the animal being recorded. A microphone windshield will be used to limit the noise generated by the wind.

Underwater vocalization recordings may be collected in the following ways:

(1) Opportunistic vocal recordings using a hydrophone connected to a digital recorder in areas where Hawaiian monk seals are known to be present.
(2) Longer-term passive recording may occur using an autonomous acoustic recorder deployed in a location where animals are likely to occur and vocalize. The recording station will be checked periodically to retrieve recordings and change batteries.
(3) Acoustic recording tags may be deployed on an animal when being handled and tagged for other purposes (e.g., diet and foraging studies). Acoustic recording tags that are deployed to measure variables such as time, depth, acceleration, location, or temperature will allow a match of vocalization activity to other behavior and provide context.

Researchers will conduct acoustic analysis on the recordings to assess differences among individuals (or age class or sex) by measuring different acoustic features in time and frequency domains including duration, spectral characteristics, frequency modulation, amplitude modulation, and fundamental frequency.

3.1.12 Translocations

Translocation has proven to be one of several useful tools in conservation efforts for Hawaiian monk seals. Researchers may conduct four types of translocation activities. Translocation methods include (1) establish/re-establish maternal association; (2) risk alleviation; (3) survival enhancement (one-way translocation or first stage of two-stage translocation); and (4) survival enhancement.

- Establish/Re-establish Maternal Association – As warranted, researchers may conduct translocations of nursing pups of either sex that have become prematurely separated from their mothers to either reunite them with their mother or place them with lactating adult female that has lost her pup. This will primarily occur in the Northwestern Hawaiian Islands, but as necessary at any location in the Hawaiian Archipelago. Unpaired nursing or prematurely weaned pups are captured by hand or with a hoop net or stretcher net without sedation, and carried to a parturient female. The transport distance will generally be no more than several hundred meters, so transport time seldom exceeds 30 minutes. In rare instances, intra-atoll transport using small research vessels may be necessary if the lactating female is located on a different islet from where the pup was abandoned or separated from its mother. In such cases, the pup is secured in the net while being transported in the research vessel. Similar methods will be used to reverse a pup exchange that has disadvantaged a female pup in favor of a male pup. The difference will be that the two pups will be captured from the nursing mothers and returned to their previous pairing. If a pup exchange severely disadvantages one pup and the pups are the same sex, the same methods may be used to reverse the exchange to return the disadvantaged pup to its birth mother. Intervention in such “same-sex” pup exchanges will only be undertaken if the circumstances and available data on the relationship between weaning condition and survival indicate the action will maximize the chances of one or both pups surviving in the long term. For example, if a very small pup is switched with a very large one near weaning, intervention may be warranted if the smaller pup’s mother appears to have sufficient resources to bring her pup to a sufficient weaning size to improve its chance to survive to the subsequent year. If, on the other hand, the two pups are similar in size, or the smaller pup’s mother is not likely to wean it in survivable condition, no intervention will occur. In the case where a previously weaned male pup has usurped the nursing position of a female pup, the male will be captured, carried a sufficient distance away, and placed in a safe position. Finally, where two pups are nursing from one mother, if an unpaired mother is still present, her pup will be reunited with her. If there is no unpaired mother present but one pup is a male, the male pup may be removed from the nursing association. In some cases, reuniting mother and pups is fraught because both animals appear anxious or stressed for several possible reasons. The pup will be handled and carried by humans, the mother may see the humans moving about the area and both animals may be stressed due to having lost their mother or offspring, respectively. Researchers propose to improve success of reuniting attempts by rapidly constructing two adjacent beach pens (conjoined on one side), one enclosing the mother (typically without herding her) and the other for the pup. The pup will be carried and placed into the adjacent shelter. Beach pens will adhere to the designs and methods described in Appendix J of the NMFS PIFSC's application (See Section 16.10). Researchers will then retreat out of sight of the animals so that the pair may relax and interact safely through their adjoining pen structure. If the pair appears to be interacting positively, the adjoining panel will be removed (or the pup lace inside the mother's pen). If the pair continues to bond, the pen structure will be opened and removed. Animals will be held for a maximum of approximately 24 hours. In association with efforts to reunite mothers and pups (whether or not penning is involved), oxytocin may be administered to adult females by pole syringe in the gluteal muscle. Oxytocin will be administered within 20 minutes (before or after) the separated pup is reintroduced to the mother. A repeat dose (20 United States Pharmacopeia units) can be administered as soon as one to two hours after the first dose, or any time thereafter. If attempts to reunite a mother and pup fail, the next step would be to take the pup to rehabilitation (under the MMHSRP permit), if that is an available option. Otherwise, the pup would be released and monitored.

- Risk Alleviation –
  - Pups – As warranted, researchers may conduct translocations of pups of either sex that have weaned or are determined to be very close to weaning (e.g., a few days prior to weaning) in locations where there is a severely reduced chance of survival. Pups will be moved to other beaches or islets which present less risk (i.e., risks from shark predation). Pups born within the Northwestern Hawaiian Islands are moved to other sites within the same island or atoll, and pups born within the Main Hawaiian Islands are moved to other beaches or islands in the Main Hawaiian Islands. Weaned pups in high-risk areas will be captured using a hoop net or stretcher net, without sedation. In the Northwestern Hawaiian Islands, weaned pups in high-risk areas (i.e, areas with high shark predation risks) are captured with a net and transported using a small research vessel directly from the weaning site to the release site within the same atoll or on the same island (e.g., French Frigate Shoals). In the Main Hawaiian Islands, weaned pups in danger of high human contact will be transported in a cage on a vehicle (e.g., truck), research vessel, aircraft (airplane or helicopter), and the duration of transport will not generally exceed eight hours. Pups will be transported immediately after capture. Pups will not be held in a pen unless deemed necessary by an attending veterinarian (e.g., for health screening). Weaned pups translocated in the Main Hawaiian Islands may be health screened by an attending veterinarian, and may be dewormed and instrumented (using devices presented in Section 3.1.10.1) to

monitor the animal's movements and foraging behavior post-release. Most animals transported in the Northwestern Hawaiian Islands for risk alleviation will not be health screened because the translocations will be of short duration, and a veterinarian is routinely not present at any Northwestern Hawaiian Islands site.

- o Unmanageable behavioral patterns[3] – Translocation of animals with unmanageable behavioral patterns has typically involved weaned pups, juveniles, or subadult animals. In the case of weaned pups, capture and transport procedures will be similar to those involved in one-way translocation. For juveniles or subadults, the procedures will be similar to those involved in the second stage of two-stage translocation (Baker et al. 2013). Other activities include, but are not limited to, cutting an umbilicus from a neonate that is being encumbered by a placenta (especially near high surf or rising tide), hazing animals of any age or sex away from other harmful situations (e.g., roads or boat ramps), and removing animals of any age or sex from behind the Tern Island seawall at French Frigate Shoals where they can become trapped.

- Survival Enhancement (one-way translocation or first stage of two-stage translocation) – Researchers may conduct translocations within the Northwest Hawaiian Islands, from the Main Hawaiian Islands to the Northwestern Hawaiian Islands, but not from the Northwestern Hawaiian Islands to the Main Hawaiian Islands. One-way translocations, which are where animals are moved to a different subpopulation and left there for the remainder of their lives, are conducted identically to the first stage of two-stage translocation. The only distinction is whether the option to conduct the second stage return translocation is exercised. Two-stage translocation is to translocate animals back to their natal or other suitable subpopulations once they have reached an age when survival probability is universally quite high (Baker et al. 2013). Baker et al. (2013) described a decision framework for determining whether a one-way or two-stage translocation is needed. This framework factors in the source subpopulation, number of weaned pups, and recipient subpopulations. Many of the inputs to the decision framework rely on direct observation of key indicators such as population status, juvenile survival rates, and outcomes from previous translocation actions. Also, at various points in the decision framework, researchers may use a computer model (called a stochastic simulation model) updated with the most recent population data to estimate the likely range of benefits associated with different choices. Two decision trees, one for each of the two stages of the translocation strategy, have been developed to support decision-making and assessment as translocation projects progress. The stage-one decision tree addresses translocation of weaned pups from areas of lower survival to areas of higher survival.

[3] Unmanageable behavioral patterns include unmitigable seal-human interactions. Occasionally, individual seals in the Main Hawaiian Islands develop habitual patterns of seeking out humans and interacting with them, sometimes in ways that constitute a risk to the individual seal as well as a public safety risk

The stage-two decision tree addresses returning previously translocated animals from the recipient site to their donor sites. The decision framework is designed to structure the decision making process to maximize the benefits and reduce the risks associated with the translocation projects. For example, the donor and recipient sites will be carefully chosen to achieve the greatest possible benefit (in terms of increasing juvenile survival and enhancing population welfare), while ensuring that the capacity of a site to support additional animals is not exceeded. This will be determined from observations of juvenile survival at each site, supplemented by simulation modeling to better quantify the probable benefit. There are provisions within the framework to adjust translocation actions in response to a variety of conditions or developments. For example, additional translocations of pups may be suspended if previously translocated animals are not being returned to their natal site or region once they reach the stipulated age to be returned. This is intended to both avoid overloading a host site with immigrants and prevent over-depletion and sex ratio imbalance at source sites that are not being replenished. While animals are at the recipient site, they will be monitored (sometimes initially with satellite transmitters, and later visually through the regular population assessment and monitoring activities of the HMSRP) so that researchers know as much as possible about their location, activities, and welfare. The HMSRP will follow procedures to ensure take proper care and safe transport of animals as well as mitigate the risk of transmitting disease via translocations. More details on the measures involved in the selection, health screen, care in temporary captivity, quarantine, and unforeseen contingencies are addressed in Appendix K of the NMFS PIFSC's application (See Section 16.11), which includes best practices developed to date for handling and transporting animals.

- Survival Enhancement (second stage of two-stage translocation) – Researchers will conduct survival enhancement, this is the second stage of two-stage translocation and methods are congruent with those described in the first stage (Baker et al. 2013). The return translocation may occur any time after surviving animals from the first stage have reached two or three years of age. If some animals are not captured and returned by three years of age, they will be subject to return in subsequent years. The number of animals eligible for return translocation may accrue over time. More information on this proposed action is included in Appendix K of the NMFS PIFSC's application (See Section 16.11). Baker et al. (2013) presents scenarios that include translocating weaned pups from the Northwestern Hawaiian Islands to the Main Hawaiian Islands for demonstration purposes only. The principles and concepts of two-stage translocation are consistent regardless of which specific source and host sites are involved. Permission to translocate animals from the Northwestern Hawaiian Islands to the Main Hawaiian Islands is not being requested. Also, no second stage translocations have been conducted to date. Authorization of two-stage translocation is being requested in case juvenile survival patterns, which have varied greatly in the past warrant this action during the term of the scientific research and enhancement permit.

Nursing or prematurely weaned pups separated from their mothers may be captured, and relocated to their natural mother or a prospective foster mother. Young pups that are prematurely weaned or otherwise separated from their mother suffer high rates of mortality. In these cases, intervention to restore nursing can enhance the pup's survival. Pup switching, whereby two adult females exchange the pups they are nursing, either temporarily or for the duration of lactation, is relatively common in Hawaiian monk seals. Sometimes these situations compromise the survival of one of the pups. For example, if a young pup is switched to a mother who has nearly completed her lactation period, that pup will wean prematurely and likely starve. In related cases, a previously weaned pup may displace a young pup from its mother or nurse alongside the younger pup. In cases where the disadvantaged pup is a female and the other pup is a male, field researchers may remove the male pup to a safe distance and, if they are separated, reunite the female pup with its mother. There may be cases involving exchanges of two pups of the same sex that warrant intervention, if such action will likely maximize the chances of long-term survival of one or both pups. During these handling events, pups may also be tagged.

Weaned (or nearly weaned) pups in locations where there is a severely reduced chance of survival, such as areas of high shark predation (e.g., some islets at French Frigate Shoals), disease or contaminant exposure, or likelihood of human interaction (for example, hooking, entanglement, socialization, disturbance in the Main Hawaiian Islands), may be moved to locations which present less risk. In such cases, pups born within the Northwestern Hawaiian Islands are moved to other sites within the same Northwestern Hawaiian Islands atoll, and pups born within the Main Hawaiian Islands are moved to other beaches or islands in the Main Hawaiian Islands. In some cases, translocations to alleviate risk may involve animals older than pups.

Hawaiian monk seals of any size and either sex can be translocated if they exhibit or are subject to unmanageable human interactions. Occasionally, individual animals in the Main Hawaiian Islands develop habitual patterns of seeking out humans and interacting with them, sometimes in ways that constitute a risk to the individual animal as well as a public safety risk. Research to develop tools to prevent and mitigate human interactions with individuals is proposed (see *Behavioral Modifications*; section 3.1.13) as part of the action under consultation. However, there are likely to be cases in the future, as there have been in the past, where despite all efforts to alter animal or human behavior, the interactions persist. In such cases, unmanageable animals may be translocated within the Main Hawaiian Islands or from the Main Hawaiian Islands to the Northwestern Hawaiian Islands, were they can continue to live in a wild population that is isolated from human contact. In past cases, managing some animals involved permanent captivity or translocation to Johnston Atoll where there are only occasionally other animals. Those solutions resolve the public safety concerns but do not benefit the individual animal or any population. Translocation to the Northwestern Hawaiian Islands will constitute enhancement activities as the animals will have an opportunity to continue living wild and contribute to recovery.

Weaned pups and juvenile animals in subpopulations where juvenile survival is low may be translocated to subpopulations with higher rates of juvenile survival. Survival at the original site may be relatively low due to insufficient prey availability (thought to be a primary cause of juvenile mortality), but may also be affected by other factors.

Researchers may make multiple attempts to unite unpaired nursing pups with a prospective foster mother. Translocations may be conducted on animals away from hazardous areas if an animal subsequently moves to hazardous sites, which can occur more than once. Translocations may occur year-round, but those involving weaned pups typically occur in summer to autumn. Adult males removed from the wild or translocated may be held in temporary quarantine facilities.

3.1.12.1 Adult Male Relocation

Aggressive male animals may be translocated as one option to mitigate their effects on other animals. Adult males will be treated identically to those taken for permanent captivity except for their final destination. Animals will be transported to Johnston Atoll or elsewhere in the Hawaiian Islands for release. Animals may be health screened if a veterinarian is present. Prior to release, animals will typically be sedated and fitted with a satellite transmitter so that they can be tracked. This will provide information on the fate and location of animals if they move away from the release site. The transmitter will be operational for up to one year, although likely shorter due to the animal's annual molt. Animals may be relocated more than once if they return to the site from which they were removed and resume aggressive behavior against immature animals.

3.1.12.2 Use of Oxytocin

The reason for pup switching or maternal separation are not well understood, but may occur due in part to a weak maternal bond. In the post-partum period, the neuropeptide oxytocin is produced to support lactation, uterine contraction, and has been demonstrated as a key component of maternal bond formation and maintenance (Kendrick 2000; Strathearn et al. 2009). As a result, during the proposed activities, oxytocin may be used to treat agalactia in post-partum animals. Candidate females will be those that do not appear to be providing nursing opportunities to their pups (i.e., not presenting teats) or those whose pups do not appear to be gaining any weight despite repeated suckling behavior. Administration of oxytocin might improve outcomes of starving pups with minimally invasive intramuscular injection. To support maternal-pup bonds, oxytocin may be administered at a dose of 20 United States Pharmacopeia units intramuscularly by pole syringe in the gluteal muscle (Dierauf et al. 2018). This may be repeated up to four times in 48 hours, with additional dosing at the discretion of the attending veterinarian.

Injectable oxytocin is used commonly in animals to induce or facilitate uterine contractions during birth or induced abortion (Plumb 2008). In post-partum animals, it is administered to treat retained placentas, uterine prolapse and metritis. It also facilitates milk let-down and can be used to treat agalactia (Plumb 2008). Its applied use in supporting maternal bonding has not been evaluated in pinnipeds. However, given the low risk when administered to post-partum animals

(Plumb 2008) the HMSRP proposes to administer injections of oxytocin to animals intramuscularly during interventions to establish/re-establish maternal association in hopes that it will improve outcomes by promoting bonding.

3.1.12.3 Permanent Captivity

To address issues of adult male aggression or unnamable behavioral patterns (i.e., unmitigable human-seal interactions), seals may be placed into permanent captivity. For permanent captivity, animals will be moved into a transport cage. If biomedical samples are needed prior to transport, animals will be handled or sedated following established handling and health sampling protocols. If the preferred method of transport cannot be used due to location or other logistical challenges, animals may be transported using stretchers, stretcher nets, or boards. Sedation may be administered at veterinary discretion to make animals more tractable and to reduce stress and anxiety for the animal. All appropriate resuscitative and supportive medications (e.g., atropine, epinephrine, fluids) will be available for use at veterinary discretion during transport. Animals will then be transported either to a temporary holding pen on the beach or directly to a transport vessel or vehicle. Local transport will be via either small research vessel or over land, as appropriate to the location, and will generally not exceed two hours. Ideally, the animal will be captured at a beach that is accessible by a small research vessel. After an animal is caged or otherwise contained, it will be carried by hand, usually requiring at least six people, to the nearby small research vessel. For larger animals, some form of wheeled conveyance (e.g., a cart) may be used. If transport over land is not feasible, an animal will not be captured unless it is on a beach accessible by a small research vessel for transport. The animals will be kept wet as needed for thermoregulation.

Animals placed in a temporary holding pen in the Northwestern Hawaiian Islands will remain there until a research vessel is available to transport them to the Main Hawaiian Islands. No food will be offered to animals. The duration that animals will be in a holding pen will vary based on animal condition and behavior, and will be assessed in communication with a veterinarian, but will not exceed five days. If a research vessel is either not available or does not arrive within five days, animals will not be captured and captured animals will be released. In such cases, other options for removal (such as lethal removal) may be considered.

During transport by the research vessel, animals will be maintained in individual cages and kept wet during daylight hours. During transport to the Main Hawaiian Islands aboard the research vessel, animals will be offered thawed frozen herring at least once daily. Upon arrival in the Main Hawaiian Islands, animals will be placed in approved temporary holding facilities (e.g., NMFS Inouye Regional Center, Waikiki Aquarium, or The Marine Mammal Center’s Ke Kai Ola rehabilitation facility on Hawaii Island). If other animals are being held in these facilities at the same time, strict quarantine procedures will be followed. Animals will remain in temporary holding until arrangements are made to transfer them to a permanent facility. Animals will not be brought to the Main Hawaiian Islands unless a facility has been identified that is willing and able to obtain the necessary permits to accommodate them.

3.1.13 Behavioral Modifications

Research and enhancement activities to develop and apply effective means to displace animals from out-of-habitat or dangerous areas, and to disrupt or prevent interactions with humans or anthropogenic food sources (e.g., fishing gear) and aggressive interactions with other animals are part of the proposed action. Research and enhancement activities have two specific goals. In the short term, immediate displacement or behavior change can enhance survival by removing an animal from an imminently threatening situation. In the long term, research may identify methods to condition animals to avoid dangerous areas or activities. Hazing aggressive adult males is another behavioral modification activity, and is considered an enhancement activity. Overall, the research and enhancement activities will identify effective tools in an adaptive management context. Researchers will use behavioral modification in the form of displacement, as well as efficacy trials of aversive tools for understanding and mitigating high-risk behaviors of animals. The efficacy of tools and techniques will be examined in an experimental fashion, and if demonstrated safe and effective, applied as appropriate. In addition to aversive stimuli, positive reinforcement may be researched and developed to replace the reinforcement of interacting with humans or utilizing undesirable areas. Researchers will discuss using novel procedures with the NMFS Permits and Conservation Division before applying them in the field on free-ranging animals.

Candidates for behavioral modification will be animals observed engaging in behaviors that are actually or potentially harmful. Researchers will conduct behavioral modification with animals that are out of their natural habitat (e.g., hauled out on boat ramps or nearshore roads) and/or in a dangerous area (e.g., waterway with high vessel traffic). Undesirable interactions between Hawaiian monk seals and humans (e.g., biting, grasping, mounting) may result in a potentially harmful situation and is considered a primary challenge to the management and recovery of the species. Aggressive adult males can pose a substantial threat to vulnerable individuals such as pups, juveniles, and adult females that may have population-level impacts. The Hawaiian Monk Seal Recovery Plan’s priority action is to “reduce male aggression toward pups/immature seals and adult females” (NMFS 2007d). Methods and tools to move animals will be essential to mitigate imminent threats to the safety of animals themselves, as well as humans.

Researchers will use techniques involving aversive stimuli, where animals behaving in an undesirable fashion are exposed to unpleasant experiences that are not harmful. The primary use of aversive stimuli is to immediately displace the animal from a dangerous situation, though some methods may also be effective in discouraging the undesired behavior. A variety of aversive and disruptive stimuli may be considered for behavioral modification.

Researchers will assess the area for safety concerns for animals and humans prior to conducting behavioral modification. An animal will only be displaced if it has safe egress and avoids causing interactions with humans (i.e., there is no danger of the animal injuring itself on rocks or other material in the vicinity, and there is no danger of flushing the animal into humans on the beach or in the water).

Researchers will conduct outreach with humans in the vicinity before displacing animals. Humans will be informed of the intent of the research and enhancement activities to allay public concerns, and will be asked to maintain a safe distance from the animal before, during, and after it is displaced. If displacement occurs at a beach park with lifeguards, the lifeguards will be requested to call swimmers out of the water near where the animal may enter. If swimmers do not follow the lifeguard's guidance, displacement will not occur while humans are swimming in the area.

Data regarding the animal's position and behavior will be recorded prior to and after displacement. The animal will be observed until it leaves the vicinity.

Displacement methods will include the following general categories:

- Visual and Aural Disruptive Stimuli – These are intended to stop an animal from its current behavior. This could involve various types of stimuli (shouting, noise making, and waving large objects near animals) that disrupt a behavior or displace an animal from the area. Researchers will move toward an animal carrying or waving large objects to gain attention. This may include approaching an animal while carrying a crowding board and shouting, waving palm fronds to create visual cues as to well as to make noise, and slapping the water to make noise.
- Tactile Harassment – This includes any technique that repels animals or stops a behavior by direct contact, including prodding with blunt objectives (e.g., poles), crowding boards, or low-velocity objects tossed or projected at the animal or in its vicinity.
    - Prodding – The most typical method of displacement (in the Main Hawaiian Islands) involves approaching an animal carrying a crowding board (also adding the visual and aural stimuli), and prodding the animal's flippers or posterior with the board upon approach.
    - Projectiles – When it is unsafe to approach an animal, typically because footing is unstable or the animal is in the water, then blunt, low-velocity projectiles may be used to distract the animal's attention and frighten it from an area. Projectiles typically include items readily available on the beach such as tree nuts or coral rubble. Pointed objects will be avoided, with the rare exception of testing remote biopsy methods, which are discussed in Section 3.1.5.1. Projectiles will be tossed gently toward the animal, always avoiding the head.
    - Remote Devices – Animals in the water can be particularly difficult to approach safely, yet there is sometimes the need to displace animals from dangerous water bodies (such as canals or boat harbors). In such cases remote devices (such as remote control boats) may be used to approach, harass, and gently prod an animal

to encourage it leave an area. The remotely-operated aquatic vehicles described in the population assessment methods may be used for this purpose (Section 3.1.2.1).

- Acoustic Harassment and Deterrents – Acoustic deterrents for animals are designed to cause temporary annoyance, discomfort, or frightened animals to displace them from specific locations. All acoustic deterrents fall within the NMFS Revised Marine Mammal Acoustic Technical Guidance (NOAA 2018). Acoustic deterrents will be played on an underwater speaker or other devices, no closer than one meter to an animal. Volume will be adjusted to safe and effective levels according to the distance from the speaker to the animal (based on the sound source level and attenuation curves). Sounds will be played at or above the behavioral response thresholds while remaining safely below the temporary threshold shift (TTS) and permanent threshold shift (PTS) levels, cumulative sound exposure level not to exceed 181 decibels. More information and detailed protocol is included in Appendix L of NMFS PIFSC's application (See Section 16.12).

Additional tools may be established including novel aversive stimuli which may be developed as needed. Additionally, positive reinforcements may also be researched and developed to replace the reinforcement of interacting with humans or fishing gear. Tools and techniques will be developed in a careful fashion and will be tested on live seals. If proven safe and effective, applied as appropriate as an enhancement tool.

Animals will be excluded from aversive testing if they are nursing, compromised by significant injury or emaciation, or if they are pregnant, lactating, or molting. The selected stimulus will be applied multiple (typically three) times to each individual animal to evaluate consistency in induced responses and any habituation. Testing may occur on land or in the water.

Each trial will involve first observing and recording the behavior of the animal without any stimulus. The animal will then be approached with the application of the aversive tool. The technique will be repeated or continuously applied, if applicable, until the animal departs the immediate area or until 15 minutes has passed, whichever occurs first. The animal's response will be recorded. Follow-up monitoring of the general area will be considered to determine if the study subject returns to the area or relocates to another area.

Statistical analyses will be conducted to assess categorized responses of animals to no stimulus, and aversive stimuli. Sex, age, habitat (land or water), category of undesirable behavior and the trial sequence (first, second, third, etc.) will be examined as covariates. Aversive techniques demonstrated to be effective in modifying undesirable behavior over time will continue to be applied as needed and animal responses will be recorded. Multiple trials following this standardized design may be conducted within the constraints specified in the take table (Table 1) in order to evaluate novel or refined aversive tools.

Aggressive adult male animals may be hazed away from conspecific victims. The methods used are similar to those described above, but because this is utilized in cases where the targeted males are likely to injure or kill other animals, less emphasis is placed on the safety of the adult males. Hazing aggressive males may occur under two circumstances:

(1) When the victim (typically a weaned pup) is in imminent danger of serious injury or death. For example, males may exhibit aggression towards pups but the pup may escape or the male may not act overly aggressive. However, at times, males mount and hold ups underwater until they are at risk of drowning, or they may bite them severely. In such cases, researchers in the field may haze the male away from the victim.
(2) When the aggressor has previously been observed to harm or kill a conspecific. For example, a male may have met the criteria for removal, yet logistics and cost constraints may delay that action. In the interim, the repeat aggressor may be hazed away from any potential victim (typically a pup or juvenile) the adult male is approaching or attacking.

Hazing aggressive adult male animals may be accomplished by approaching, vocalizing, or otherwise making noise, prodding with a long pole, or throwing objects (e.g., rocks, coral, sticks, debris). Care will be taken not to harm or cause severe pain to the adult male animal. The objective is to distract the target animal and frighten away rather than to cause harm or pain. However, the risk of death to a conspecific outweighs any risk of injury to the adult male animal.

3.1.14 Lethal Take

Researchers may lethally take animals by adult male removal and euthanasia.

3.1.14.1 Adult Male Removal

Aggressive adult male animals, either acting singly or in groups, can severely injure or kill other Hawaiian monk seals of any age or sex, but typically their victims are either weaned pups or adult females. Adult male animals will be removed in cases where individuals are known or strongly suspected of causing serious injury or mortality of conspecifics as a result of single or multiple adult male aggression events. Removal may include translocations to sites within the Hawaiian Islands or Johnston Atoll, capture for permanent maintenance in captivity, or lethal removal via humane euthanasia as a last resort. In some cases, researchers may be able to interrupt observed attacks and treat injured animals, but the aberrant behavior continues. Euthanasia will be considered in cases where the identity of adult male aggressors is certain or circumstantial evidence overwhelmingly indicates direct participation in such attacks. Adult male animals will be taken by capture, restraint, sedation, biological sampling, tagging or instrumentation, and transport, or euthanasia. Adult male removal has proven to be a very effective tool to reduce mortality and has been used to rebalance male-biased sex ratios.

When adult male aggression appears to be occurring as indicated by disappearance of weaned pups, or wounding or death of animals with injuries consistent with male attacks, field researchers focus observation effort in order to identify the males involved. Because single male aggression tends to be directed at weaned pups, which spend much time on the beach, identifying the males involved is somewhat tractable. Even so, there are cases where males are documented habitually behaving aggressively towards pups but unequivocal documentation of an aggressive act that causes a death or severe wound are lacking.

It is far more difficult to ascertain perpetrators of multiple male aggression. Most mating behavior occurs at sea and is thus rarely observed. Males compete over the right to lie next to, and maintain exclusive access to females on shore. It seems likely that males that are successful maintaining exclusive access to females on shore are also more successful maintaining exclusive access to females during mating events at sea. To reduce the risk of increasing aggression by inadvertently removing males that maintain social control, the relationship between aggression and apparent dominance was investigated prior to undertaking the male removal efforts during 1984 through 1994 (Johanos et al. 2010). The HMSRP continues to collect behavioral data relevant to this question. Most males are never seen on the beach beside a female who is in, or near, estrus. However, a small subset of males commonly associate with these females (i.e., lie next to them on the beach), successfully defend them from other males, and are considered dominant. At Laysan and Lisianski Islands, where multiple male aggression has been most common historically, field researchers document the identities of paired adult males and females.

All adult male animals in a population can be ranked according to the proportion of observed pairing of males with adult females at or near estrus in which each male was involved (Johanos et al. 2010). For example, a male who accounts for ten percent of all observed pairing with adult females near estrus is considered higher rank than a male that accounts for two percent of these pairings. This dominance ranking is informative because past analysis has shown that subordinate males are most likely to be involved in multiple male aggression. Although identified aggressors are typically subordinate, there is usually at least one dominant male present in an aggressive aggregation. Typically, that male will have been already paired with the female when the aggressive incident began. Anecdotal observations suggest that the risk of aggression may be higher for females paired with lower-ranking males within the dominant group than for females paired with the highest-ranking males (Johanos et al. 2010).

When there is evidence that multiple male aggression is occurring (typically due to observation of severely wounded or killed adult female animals), researchers in the field increase effort to observe actual aggressive interactions or aggregations of many males with a wounded female.

Three types of cases will result in a decision to remove some adult male animals:

(1) If an attack by multiple males is observed in which a victim is seriously wounded, and the males involved are identified, these males may be removed. However, the highest dominance-ranked males, especially those previously observed attending the victim on the beach, will most likely not be considered for removal unless they were specifically observed causing a serious injury to a female animal.

(2) If an aggregation of several identified males is observed either (a) associated with a freshly wounded victim (i.e., the aggression is not observed but it is clear that it very recently occurred); (b) involved in competition for a victim but the victim is not seriously

harmed (i.e., sustains only normal mating injuries), but this observation occurs during a period when other animals have been observed with male aggression injuries, then the identified males may be removed. Again, the highest rank males identified in such an aggregation (or the previously observed attending male) will not be removed.

(3) Finally, if unusually high levels of male aggression are occurring yet no males can be confirmed as aggressors nor suspected based upon observations such as those described above (2), then some low ranking males that are observed consistently in the same beach areas as victims may be considered for removal.

If the HMSRP decides to remove adult male animals, the arrangements for the disposition of the animals in question will be completed before the action is taken. Transport via aircraft or vessel will only occur the final disposition at a permanent captivity site, translocation destination, or through lethal removal has been determined.

3.1.14.2 Euthanasia

Euthanasia may occur if an experienced onsite veterinarian determines that there is a high probability of death of the animal due to the injury or disease. In addition, in rare instances euthanasia may also occur for aggressive adult males. In such instances, animals will be captured, sedated, and biologically sampled for health assessments.

Animals will be humanely killed in such a manner as to minimize distress to this animal to the maximum extent possible. At veterinary discretion, a higher dose of sedative than typically used for research restraint may be used. Sedatives may be combined with each other and with analgesics to achieve deep sedation and thus provide for the best welfare by minimizing stress, pain, and anxiety. Drugs that may be used include midazolam, diazepam, tiletamine/zolazepam, and butorphanol. Once heavily sedated, animals will be injected with a lethal dose of Beuthanasia (sodium pentobarbital) at a dose of one milliliter per ten pounds into the extradural vein. The subclavian vein or an intracardiac injection may also be used, in whole or in part, provided that the animal is deeply sedated. Immediately after the animal has succumbed, a complete necropsy will be conducted according to HMSRP necropsy protocols. Samples from all major organs will be saved. In some instances, the entire carcass may be collected and preserved for necropsy and sample collection later. Because of the presence of barbiturates in the carcass and risk of toxicity to scavengers, all parts not retained will be collected in plastic bags for subsequent environmentally safe disposal (e.g., incineration). The carcass will be removed from the environment.

In addition to the injectable sodium pentobarbital, the HMSRP requests permission to have additional modes of euthanasia available (penetrating captive bolt and gunshot). These methods will only be used if an overdose of sodium pentobarbital was not feasible, for example if there was no mechanism available to remove the carcass from the environment.

3.1.15 Disentanglement and Dehooking

Disentanglement and dehooking is a form of mitigation to prevent serious injury and death to Hawaiian monk seals. The removal of entanglement hazards, marine debris, and derelict fishing gear from the Northwestern Hawaiian Islands is a major management objective of the HMSRP.

Animals observed to be entangled in nets, lines, or other marine debris will be freed via two possible methods including (1) capture with a hoop net or a stretcher net, restraint, and disentanglement (by hand or using a cutting implement), and release; or (2) removal of the entangled item using a cutting implement attached to a long pole, with no attempted restraint of the animal. The use of each method will be at the discretion of personnel in the field performing the rescue. If a line or net fragment has become embedded in the tissue of the animal, the entangled item will be removed as carefully as possible to avoid further injury. This may require cutting the item at several sites to avoid pulling net knots out through tissue. Betadine or similar disinfectants may be applied if warranted and available on site. Antibiotics may be administered at veterinary discretion. Animals will be released on the beach or nearshore reef. If restraint or sedation is necessary for disentanglement and dehooking, animals will be cooled with water as appropriate.

Hooks will be removed from animals by restraining the animal in a hoop net or stretcher net and removing the hook by hand. Radiographs may be collected to aid in evaluation of hooked animals. The animals may be sedated to ensure the safety of responding personnel and ease collection of radiographs for assessment. Sedation procedures will be identical to those described for health screening (Section 3.1.9) and will be conducted by a veterinarian. For occasional and more invasive stranding response procedures (such as hook removal) requiring a longer duration or deeper plane of anesthesia than can be achieved with injectable drugs, animals may be anesthetized using gas anesthesia. Animals requiring gas anesthesia may be pre-medicated with sedatives (typically benzodiazepines) at veterinary discretion and then gas anesthesia induced by mask. Animals will be intubated with an appropriately sized endotracheal tube (typically ranging from size five to 14, the cuff inflated, and then attached to fresh gas flow of isoflurane (zero to five percent) and oxygen (10 to 20 milligrams per kilogram a minute) on a rebreathing circuit. If hooks are ingested and cannot be removed on site, animals may be transported to a rehabilitation facility for further diagnostic evaluation (e.g., radiographs, endoscopy) and treatment (e.g., anesthesia, endoscopic removal, surgery). Any dehookings or entanglements in the Main Hawaiian Islands to which researchers respond will be coordinated with the stranding coordinator at NMFS Pacific Islands Regional Office.

At field camps where research vessels are present, animals entangled offshore may be located and disentangled. All occurrences of entangled animals will be recorded, including animals with fresh entanglement scars that were not previously observed. The entangling gear, or a sample, thereof, is collected and catalogued. Data will be provided to the stranding coordinator at NMFS Pacific Islands Regional Office.

3.1.16 Vaccinations

The Hawaiian monk seal is rare, has very low genetic diversity, and been buffered from exposure to many mammalian diseases due to its isolation in the Hawaiian Archipelago; therefore, researchers are concerned about outbreaks of disease that could have devastating impacts to the population. Infectious diseases, especially those that are newly introduced to naïve populations of animals, can cause mass illness and mortality. Vaccinations are the best method for preventing the spread of infectious diseases among animals. Vaccines for morbillivirus (e.g., canine distemper virus and phocine distemper virus) and West Nile virus are currently available and these infectious diseases have been identified as high risk for the population of Hawaiian monk seals.

Research activities involving vaccinations that will be performed as part of the proposed action include vaccine research, surveillance, prophylactic vaccination against morbillivirus, assess the safety and efficacy of recombinant canine distemper virus, outbreak response, and vaccination against West Nile virus.

3.1.16.1 Vaccine Research

The HMSRP and collaborating researchers will study the susceptibility of the Hawaiian monk seal to morbilliviruses due to the devastating effects these viruses have had on other phocid populations, in order to understand and prepare if an outbreak occurs in the Hawaiian Archipelago. Researchers will characterize how morbillivirus outbreaks may proceed and determine preventative and effective mitigation measures.

Vaccinations will be used for research, surveillance, and as a prophylactic vaccination against morbillivirus and Purevax, as well as to respond to outbreaks. Vaccinations will be used to prevent and respond to an epizootic caused by morbilliviruses, West Nile virus, or other pathogens to Hawaiian monk seals. Vaccinations may occur year-round.

3.1.16.2 Surveillance

The population of Hawaiian monk seals will be routinely and actively monitored to enable early detection of unintentionally introduced infections, especially those with the potential to cause rapid and severe outbreaks. The greatest concern of potential outbreaks are from morbilliviruses (canine distemper virus), phocine distemper virus, and West Nile virus. Monitoring wild animals for these viruses and other pathogens may include tests for antibodies in blood (e.g., enzyme linked immunosorbent assays), tests for actual virus in blood, feces, tissues, or nasal swabs (e.g., polymerase catalyzed reaction assays), necropsy, histopathology, and syndrome-based surveillance. Health assessment studies will collect samples and data for these tests. Because the HMSRP has an active program to vaccinate animals against morbillivirus, surveillance for morbillivirus will account for animals that have been vaccinated and are expected to have antibodies present in blood samples.

3.1.16.3 Prophylactic Vaccination against Morbillivirus

Purevax is a recombinant vaccine to canine distemper virus recommended by the American Association of Zoological Veterinarians for use in non-domestic carnivores and has been used on wild Hawaiian monk seals from 2016 through the present by the HMSRP (Permit No. 16632). Recombinant virus vaccines use a vector virus that does not typically infect the target host but expresses antigens from the pathogen of interest to stimulate an immune response against it. In late 2015, the HMSRP decided to implement a prophylactic vaccination strategy to protect Hawaiian monk seals from a morbillivirus outbreak and a vaccination trial program was completed in 2016.

The vaccination of wild animals requires a time series of two (initial and booster) one-milliliter Purevax vaccines administered three to five weeks apart (to the greatest extent possible). Some additional parameters have been established because wild animals are not predictably available and not all field administrations of vaccine are complete. Animals that do not receive a booster within a maximum of eight weeks from the initial vaccination are treated as if unvaccinated and subject to restarting the vaccination series. In the event, that a vaccine is only partially administered and a sufficient portion of the dose may not have been given, researchers will vaccinate animals again in three weeks with a subsequent dose three to five weeks later. This ensures that animals will receive two full doses within the appropriate timeframe.

Animals will only be vaccinated if they are readily identifiable by flipper tags or other permanent markings so that each individual animal’s vaccination status can be tracked. Animals that are not considered candidates include adult females that appear likely to imminently give birth, nursing pups, prematurely weaned pups, and injured, sick, or malnourished animals. Researchers will conduct no more than four injection attempts per an animal per calendar year.

Purevax vaccines will be administered intramuscularly in the gluteal region. The injections may be given by hand or via pole syringe. Hand injections will be given opportunistically when the animals are already being handled for another purpose (e.g., flipper tagging, biomedical sampling, disentanglement). Pole syringe injections allow for one researcher to approach the animal without handling it, which minimizes disturbance and risks associated with restraint.

Vaccinating animals prior to population-wide exposure is a very effective method to protect animals against a morbillivirus outbreak (Baker et al. 2017). A safe vaccine is available and modeling indicates that in the event of an outbreak, many animals will likely become infected either before they can be vaccinated, or during the extended period between vaccination (including booster) and acquiring immunity. Nevertheless, if a morbillivirus outbreak did occur, animals may still be vaccinated in response as this may protect some individuals. For other pathogens, it may be appropriate either to use a prophylactic approach or to vaccinate only in response to pathogen detection. The approach to vaccination will be carefully evaluated based on attributes of the pathogen of concern, risk of exposure, safety of the vaccine, and expected lag time between vaccination and immunity.

3.1.16.4 Assess the Safety and Efficacy of Recombinant Canine Distemper Virus

While the effectiveness cannot be truly assessed without exposing vaccinated animals to the virus, researchers intend to evaluate serum antibody titers as a way to gauge whether vaccinated animals' immune systems mount a response consistent with immunity. Blood samples will be collected from vaccinated wild animals according to the methods described for health sampling. This may be directed or occur opportunistically during research and enhancement activities. In addition, vaccination of and serum collection from animals brought into rehabilitation under the MMHSRP permit may occur, provided that the animals are deemed suitably healthy by a veterinarian at the time of vaccination.

The HMSRP has been archiving samples from select animals to better understand the persistence of serum antibodies in the years following vaccination as it relates to outbreak preparedness. Serum samples will be archived (per health screening protocols) until all post-vaccination time points are collected so that samples from the same individual can be analyzed in a single assay for appropriate comparison. These data will guide the researchers' understanding of how frequently animals may need to receive boosters in the future. Therefore, animals may be vaccinated multiple times during their lives, either in response to an outbreak or prophylactically as future research on serum antibody titers suggests.

3.1.16.5 Vaccination against West Nile Virus

The West Nile virus vaccine used by the HMSRP is a product made by Fort Dodge of inactivated West Nile virus, which cannot be shed and does not pose risk to other wildlife. In response to a detected case of West Nile virus, all accessible animals in the Main Hawaiian Islands will be vaccinated, starting with the island on which the case was identified. The vaccine will then be used in the Northwestern Hawaiian Islands at the earliest possible opportunity.

3.1.17 Supplemental Feeding

Researchers will provide supplemental food to Hawaiian monk seals in the wild that are in need of medical attention (e.g., stranded, injured, prematurely weaned, or emaciated). Hawaiian monk seals receiving supplemental feeding following rehabilitation under the MMHSRP's permit will be provided with individually quick frozen herring in quantities of up to five percent of body weight as frequently as once per day for as long as one year. The training to take food from humans in captivity will be bridged to a wild context, such that released animals can be gradually "weaned" from human support rather than making an abrupt transition. Much will depend on the animal's behavior, as they will need to make themselves available to be fed. In order to "wean" the animal while keeping it in good body shape, feeding may be more regular (daily) and involve higher rations at the outset that would be gradually reduced. Supplemental feeding will provide a gradual transition from captivity to independence, which will improve the survival of animals following rehabilitation.

Animals receiving supplemental feedings will be pre-trained to approach on cue for feeding, thus non-target animals will likely not try to obtain provisions. Any uneaten portion of herring offered to an animal will be collected and disposed properly to keep waste out of the natural environment. The HMSRP permit will complement rehabilitation with supplemental feeding of animals after they are released in the Northwestern Hawaiian Islands. Supplemental feeding of wild animals will occur only in the Northwestern Hawaiian Islands where human presence is minimal. It will not be conducted in the Main Hawaiian Islands, to avoid the problem of these animals approaching members of the public as a food source.

3.1.18 Necropsy

NMFS PIFSC will conduct necropsies of Hawaiian monk seals that are found dead in the Hawaiian Archipelago and seals euthanized due to poor health or male seals due to aggressive behavior. Responses to dead animals in the Main Hawaiian Islands will be coordinated with the stranding coordinator at the NMFS Pacific Islands Regional Office. The number of necropsies to be conducted is unlimited (i.e., as warranted). Carcasses of animals are necropsied in a normal manner for phocids and specific to Hawaiian monk seals and the protocols are described in Appendix M of NMFS (2019) (See Section 16.13). The analysis of specimens may evolve as new tests are developed and disease risk are encountered. Specimens are retained according to the condition of the carcass[4]. If the animal has recently died and the carcass is in good condition, samples from all major organs are retained and data for life history and morphometrics is recorded. If the carcass is in poor condition, a limited set of data are collected, which includes size (measurements), sex, and general description. The skulls may be retained for subsequent measurement and additional skeletal material may be retained by the PIFSC using a variety of storage means discussed in the Section below (Section 3.1.19). Data will be provided to the stranding coordinator at the NMFS Pacific Islands Regional Office. Animal parts (tissue) salvaged during necropsies may be used as bait for permitted shark removals to enhance survival of Hawaiian monk seal pups. This is discussed further in the subsection below (See Section 3.1.18.1)

The HMSRP recognizes the value of examining dead Hawaiian monk seals, and has routinely collected samples from carcasses as part of health studies and treatment. Tissue samples of appropriate quality are routinely evaluated by histopathology, the results of which are used to guide choices in ancillary diagnostic tests (e.g., polymerase chain reaction, culture, immunohistochemistry). This high level monitoring serves as an early warning system for detection of new disease concerns. Some tests are directed at specifically monitoring baseline exposure to known pathogens (e.g., herpesvirus) in the population, which provides context for interpreting new findings. Examination and sampling of dead animals also will provide

[4] Tissue quality is evaluated by the PIFSC using a condition coding system. Codes 1 and 2 designate that the specimen is fresh and in good quality whiles codes 3,4, and 5 designate that the specimen is fairly decomposed and tissue is not in good condition.

information on the physiology and ecology of the species. Examination of tissue samples can reveal infectious and non-infectious disease processes that were directly related to morbidity or mortality, or were incidental findings. Determination of parasite load will provide information on the impacts of parasite burden on growth and survival. Samples of muscle, organs, blubber, can be examined for presence of environmental contaminants. Dietary information can be obtained from necropsies through examination of gastrointestinal contents, blubber samples for fatty acid analysis, and a variety of tissues for stable isotope analysis. Skeletal remains will provide valuable reference materials.

3.1.18.1 Use of Monk Bait for permitted shark removals

To capture large adult Galapagos sharks, hooks are primarily baited with large tuna heads and shark remains. However, when monk seal flesh from dead animals (after necropsy procedures and sampling) is available, the PIFSC seeks permission to be able to use this tissue as bait. Relatively large pieces of tissue of skin/blubber/muscle from dead monk seal pups or other deceased older individuals would be used. Typically, when dead monk seals are found on the beach at French Frigate Shoals, the PIFSC HMSRP conducts a necropsy, samples tissues, takes photographs and then buries the remains. Using such tissue for bait instead of burying it is intended to help protect remaining live pups from shark predation.

3.1.19 Sample Collection and Import/Export of Samples

Biological samples (all hard and soft parts collected under the proposed permit or from carcasses found opportunistically) from Hawaiian monk seals may be imported/exported for analysis with cooperating agencies. The cooperating agencies include ANTECH Diagnostics, U.S. Department of Agriculture’s Animal Parasitic Diseases Lab, University of Georgia’s Athens Diagnostic Laboratory, Institute of Molecular and Cellular Biology Siberian Branch of the Russian Academy of Sciences, Bishop Museum, University of California-Davis’ CAHFS Thurman Laboratory, Clinical Laboratories of Hawaii, Colorado State University’s Diagnostic Laboratory, Cornell Stable Isotope Laboratory, Dalhousie University, IDEXX Veterinary Services, John Hopkins School of Medicine, Marine Ecosystem Health Diagnostic and Surveillance Laboratory, The Marine Mammal Center (California and Hawaii), Minnesota Zoo, National Institutes of Allergy and Infectious Diseases’ Molecular Parasitology Unit, Mote Marine Laboratory, Mystic Aquarium, NOAA’s National Ocean Service, National Institute of Science and Technology’s Hollings Marine Laboratory, National Veterinary Service Laboratory, NMFS Northwest Fisheries Science Center, Sackler Institute of Comparative Genomics, Smithsonian Institution’s National Museum of Natural History, NMFS Southwest Fisheries Science Center, University of Florida’s College of Veterinary Medicine, University of Illinois’ Zoological Pathology Program, United States Geological Survey-National Wildlife Health Center-Honolulu Field Station, University of Washington. Currently, the only non-U.S. cooperators are in Canada and Russia, but any country worldwide may be included if additional cooperators are identified to conduct analyses. Convention on International Trade in Endangered Species of Wild Fauna and Flora permits will be obtained as necessary for all import/export of samples. The HMSRP maintains the samples and a database that documents their provenance, analysis, and current location

The HMSRP opportunistically collects specimens including molted fur, placentae, scats, skins, and spews at haulout sites of Hawaiian monk seals. Molted fur and skin are collected for deoxyribonucleic acid isolation. In addition to being collected from live pups for risk prevention (as discussed in Section 3.1.12), placentae are collected to be examined for possible causes of perinatal death. Scats and spews are collected for dietary analyses.

Collection of most molt fur, scats, or spew samples will occur after animals have departed the beach to forage at sea, and leave behind a sample of interest to researchers. In some cases, the identity of the animal that left the sample will be determined if tracks are evident between an animal still on the beach and the sample to be collected. Placentae are collected from stillborn pups, or pups, which experience perinatal death during necropsy. Many of these placentae are still attached to the carcass of the pups and will be collected as part of the necropsy, but some may be separated from the pup, particularly if the pup was alive for a short time after birth or if the pup carcass has been washed to sea.

Samples are processed and preserved in various ways by researchers. Necropsy samples and subsamples of placentae are fixed in formalin for histopathological analyses and frozen. Molt fur samples are collected and kept dry. Scat samples are stored in a solution of detergent/seawater, although fresh scat subsamples will be preserved in polyvinyl alcohol to be examined for parasite eggs. Whole parasites from scats and spews are preserved in alcohol, formalin, and acetic acid for cestodes and trematodes or alcohol and glycerin for nematodes. Other spew samples (i.e., bones, otoliths, scales, beaks, etc.) are preserved in ethanol, although fresh flesh from spews may be frozen for biotoxin analyses. Some necropsy samples are frozen in liquid nitrogen.

3.1.20 Unintentional Disturbance

Researchers may unintentionally disturb animals up to three times a year during research and enhancement activities (e.g., when retrieving carcasses or biological sampling) on Hawaiian monk seals. Animals hauled out on beaches may react to human presence at field camps (i.e., living in tents), operations of small research vessels (i.e., transits and landings to support field work and camps), and installation and maintenance of remote video cameras.

3.1.21 Conservation Measures

The mitigation measures in the NMFS PIFSC's application and the permit include:

- Using controlled approaches during population monitoring;
- Avoiding tagging lactating females with dependent pups;
- Pelage marking using bleach or dye outside the range of foreflippers;
- Conducting risk assessment and capture planning before capturing animals;
- Conducting follow-ups for deworming treatment;
- Attaching no more than two flipper-mounted instruments at a time;

- Limiting serial biopsies to five times per year;
- Conducting telemetry and visual follow-ups of translocated animals;
- Conducting supplemental feeding only at locations without additional human presence; and
- Using a step-wise approach to risk analysis before vaccine administration.

Measures to minimize potential adverse effects of the research and enhancement activities include:

- Approaching animals with care so as not to unduly stress the animals, and terminating approaches if animals exhibit avoidance behaviors;
- Only animals that are asleep will be bleached or dye-marked. Moreover during marking activities, molting animals, which are more restless and subject to disturbance, will be avoided;
- Not marking animals when other Hawaiian monk seals or green turtles are in the immediate vicinity, where they might be startled;
- Prior to any animal capture, a thorough risk assessment will be conducted using a Green-Amber-Red model;
- In the event that an animal has an adverse reaction to the PIFSC's proposed activities, emergency procedures will be initiated under the advice of an on-site veterinarian;
- If an animal is captured for instrumentation but is not sedated within eight to ten minutes, instrumentation will be discontinued and will release the animal immediately;
- For translocations, whenever possible, animals will not be collected when other animals are in the immediate vicinity;
- For adult male removals, during all restraint procedures, animals will be sedated to reduce stress during handling;
- If animals are euthanized or humanely killed, methods approved by the American Veterinary Medical Association will be used;
- Researchers will attempt to remove entangling items without restraint (i.e., by using a long-handled cutting implement) whenever possible;
- Animals are observed for a minimum of five minutes after being barked, disentangled, vaccinated, or handled for any reason (tagging, sampling, instrumentation involving sedation) to ensure they resume normal behavior (either going into water or resuming normal respiration rates on land). Animals going into the water will be observed until they are out of sight of researchers; and
- At least a subset of translocated animals will be instrumented with tracking devices that will allow for a period of post-release assessment of location, behavior, and survival.

3.1.21.1 Mitigation for Remote Biopsy Sampling

Researchers will target the rear of the animal during remote biopsy sampling (and biopsy punches). Before working in the field, researchers will have to demonstrate accuracy with biopsy darts or poles to within a 10.2 centimeter (4 inch) area to mitigate risk of injury with non-target strikes. The dart/punch stopper will help to ensure that penetration of the biopsy dart or pole does not penetrate beyond the blubber layer of the animal. Researchers will visually monitor the biopsy sample location to ensure proper healing. In the case of serial biopsy sampling (as when biopsy sampling reproductive females across their cycle), researchers will allow an area to heal, then shift the target of the next biopsy sample (other side, slightly higher/lower) to ensure that tissue is not damaged by repeating. Serial biopsy sampling can occur up to five times per year for an animal. Subsequent serial biopsy sampling will occur no sooner than one month following a preceding biopsy sample. Biopsy sampling multiple time points is needed to characterize female reproductive cycles while minimizing the stress of handling animals to draw blood or take blubber biopsies. The biopsy sampling objective will be to measure multiple time points in the estrus cycle including follicular and luteal phases, as well as early pregnancy. Given the current lack of knowledge regarding timing or duration of each stage of the reproductive cycle, multiple biopsy samples throughout a year will be required to characterize the cycle.

Researchers will biopsy sample animals at least three times per year to characterize patterns in hormone levels. If three serial biopsy samples are successfully obtained from a female animal and the results suggest that additional time points will prove informative, the PIFSC will consider increasing the frequency of serial biopsy sampling to five times per year, but only if monitoring demonstrates no ill effects of this method of remote biopsy sampling.

3.1.21.2 Mitigation for Tagging and Measuring

Researchers will never tag lactating females during the suckling period in order to avoid disrupting mothers with pups. Nursing pups may be tagged if they have been separated from their mother and researchers were handling the pups to reunite them. Some nursing pups may be rapidly tagged with minimal restraint. Tagging of nursing pups will occur when (1) the pup will clearly not wean prior to the researchers departure from the field site; and (2) the pup and mother can be approached safely and with minimal disturbance (both resting and separated some distance). Researchers will avoid tagging molting animals due to the higher physiological demands to animals that are shedding and regrowing their entire epidermis.

For routine tagging which entails short restraint times, administering sedatives presents more of a risk to animals than the stress that sedative will relieve, and the procedure will add significantly to the restraint time. Similarly, a local anesthetic such as lidocaine can be administered to relieve the transitory pain experienced by animals when a tag is applied, but given the time to effect, this will add to the restraint time and present a higher risk.

3.1.21.3 Mitigation for Population Assessment and Monitoring

Aerial Surveys – If an animal reacts to the presence of an aircraft, researchers will increase its altitude until the animal settles down. The HMSRP will assess responses of animals to overflights of aircraft and adjust altitude as needed to minimize disturbance.

Vessel Surveys – Research vessels transiting lagoons will not divert from straight-line paths necessary to transit between the islands, and research vessels will avoid landing on beach areas where animals are in the immediate vicinity.

Land Surveys – Researchers will remain as far away as possible from animals during population monitoring to obtain the necessary data, using binoculars and telephoto lenses as necessary for documentation. All researchers in the field are trained to be unobtrusive and to remain low to the ground whenever animals may alert to the presence of humans. Animals are specifically given a wide berth when they are especially susceptible to disturbance, such as lactating females or molting individuals. Researchers will record observations and level of disturbance.

During installation, maintenance, and repair of camera systems, at least one researcher will accompany technicians to monitor the response of animals at all times. Researchers will minimize disturbance of animals by skirting the edge of the beach. Animals present on the beach during these research activities will be continuously monitored.

Researchers will use binoculars and telephoto lenses on cameras for documentation and remain as far away as possible from animals during population assessment and monitoring to obtain the necessary data. Researchers will be trained to be unobtrusive and remain as low to the ground as possible if animals may be alerted to human presence. Animals that are especially susceptible to disturbance, such as lactating females or molting animals, will be given a wide birth.

3.1.21.4 Mitigation for Bleach and Dye Marking

Researchers will not apply bleach to a part of the pelage that the animal can reach with a fore flipper to ensure that the animal cannot rub any bleach on its face or in its eyes. Researchers will only apply bleach to sleeping animals in order to reduce the chance for disturbance. Molting animals will also be avoided, as they are more restless and subject to disturbance. Researchers will also avoid applying bleach to animals that are in close proximity to basking sea turtles, or if extrinsic factors exist that can threaten their welfare if startled (e.g., nearby rocks).

Animals that are swimming in the nearshore area sometimes approach another animal when the other is being marked with bleach or dye. In such instances, the swimming animal may notice the researcher and vocalize, which can alert nearby animals. Researchers will avoid marking animals when other animals are in the immediate vicinity, where they might be startled, in order to minimize disturbance.

Bleach markings will be photographed by researchers just after application for re-identification and animals are observed for five minutes after being bleach marked to monitor their behavior and assess the likely efficacy of the mark. Bleach marking may not be effective if an animal goes into the water shortly after being marked or if the animal rolls onto the mark before the bleach takes effect, rendering the mark illegible). Researchers will maintain follow-up sighting records throughout the field season.

3.1.21.5 Mitigation for Health Screening

Mitigation measures describe for capture and restraint activities will apply to any capture activities associated with health studies and treatment (screening). The team of researchers capturing animals always has a risk assessment and capture planning briefing prior to the event to discuss roles of each team member and contingencies and responsibilities in the event of unanticipated results or action by the animal. Procedures requiring longer restraint such as biological sampling and instrumentation will involve the use of sedatives to calm the animal and reduce stress. Restraint times for normal handling without sedation are usually less than ten minutes. Because of this, if an animal is captured for health assessment (or instrument that requires sedation) but is not sedated within eight to ten minutes, researchers will discontinue efforts and will release the animal immediately.

When sedation is involved, a veterinarian is always present. During sedation, vital signs will be monitored, including alertness of eyes, respiratory rate and depth of respiration, and heart rate. In the event of an adverse reaction, emergency procedures will be initiated under the advice of an on-site veterinarian and consistent with HMSRP Emergency Resuscitation Protocol. These procedures may vary depending upon the condition of the subject animal, but can proceed in the following order:

(1) Reversal drugs may be administered to reverse the effects of sedatives (e.g., flumazenil is the reversal agent for benzodiazepines).
(2) If the respiratory arrest occurs, manual stimulation to restore breather, including, as necessary, stimulation to face, chest compressions, intubation, and administration of atropine and/or doxapram hydrochloridat (Dopram).
(3) If cardio-vascular arrest occurs, administration of epinephrine by the most effective means (intravenous, intermuscular, pericardial, and/or via airway). Corticosteroids such as dexamethasone or prednisolone injectable (e.g., Solu-delta Cortef) may be administered after arrest to reduce shock.
(4) At the discretion of the veterinarian, other medications may be administered, including but not limited to sodium bicarbonate, physiological saline, aqueous dextrose solution, and Lactated Ringer’s solution.

3.1.21.6 Mitigation for Vocalization Studies

Researchers will minimize disturbance to animals by obtaining passive acoustic monitoring recordings during vocalization studies by:

(1) All personnel performing these recordings will be trained and follow already established best practices for surveying Hawaiian monk seals to prevent disturbance.
(2) Vegetation or other cover or visual obstructions will be used whenever possible by researchers to collect recordings to avoid detection by the Hawaiian monk seals.
(3) If a microphone and boom can be placed near a sleeping animal without waking it, the researcher will remain on site while recordings are being performed and will monitor the

animals and equipment to ensure the Hawaiian monk seals do not become entangled in the microphone cable.

(4) If a researcher feels that their presence has disturbed the animal, the recording session will end and a "take" will be recorded and reported in the annual permit report.

(5) Animals will not be captured solely for attachment of acoustic recorders. Rather, such instruments will be attached only in conjunction with other instrumentation, thereby resulting in no increase in number of takes.

3.1.21.7 Mitigation for Deworming Treatment

Animals will be monitored by follow-up assessments as described to determine the effects (positive or negative) of worming treatments. If there is any indication that the welfare of the subject animals has been compromised by handling, treatment, or any other artifact of the study, the HMSRP will cease treatments. Previous testing of injectable praziquantel resulted in three cases of swelling at the injection site (all of which resolved) and one case of an abscess at the injection site (which as treated by field staff and resolved. This may have been a reaction to the drug itself, a result of contamination of the injection site, or a side effect of a large volume of administration. Improved handling methods, re-doubled vigilance in cleaning the injection sites, and maintaining the cleanliness of needles, syringes, medicine, and splitting doses of praziquantel were subsequently employed, after which no further swellings or injections occurred. The proposed use of compounded praziquantel is aimed at eliminating the volume of administration issue. Since 2016, the HMSRP has successfully administered over 1,000 injections (of 1 milliLiter volume vaccines) to Hawaiian monk seals using pole syringes and hand injections without any ill effects. Thus, the applicant's injection practices, tools, skills, and training modules have been greatly improved. These practices will be followed in the future and field staff will be prepared to treat any abscesses if they appear.

3.1.21.8 Mitigation for Tagging

NMFS Permits and Conservation Division will also include mitigation measures to minimize adverse impacts from the research and enhancement activities, which are considered standard mitigation measures used by all marine mammal researchers. New mitigation measures in the permit will require that biopsy sampling tips and tags are sterile prior to deployment following the Institutional Animal Care and Use Committee approved protocol described in the NMFS PIFSC's application, and require post-tag monitoring and reporting.

Researchers will use (single post/Temple tag) flipper-mounted tags to reduce capture time and need for sedation, which also reduces risk. For multi-post tags that will remain attached to animals for longer periods of time, animals will be monitored for the life of the tag, and tags removed if signs of irritation or infection develop. Animals will not be given more than two flipper-mounted instruments at one time (only one in most cases). In selecting animals for applying tags, researchers will consider both body condition and any known behavioral patterns (i.e., habitual interaction with fishing gear) that might increase the risk of becoming entangled.

The smallest, least impactful, instruments available to obtain the desired data will be used by researchers. The maximum total tag package will not exceed one percent of the animal's body mass.

3.1.21.9 Mitigation for Behavioral Modification

Behavioral modification techniques will be applied only in situations where wild animals are beginning to regularly demonstrate behaviors that put themselves or humans at risk. Aversive stimuli that may be used will be tested carefully and while they may cause discomfort or annoyance, will not cause physical harm to animals.

3.1.21.10 Mitigation for Translocations

Baker et al. (2013) described full two-stage translocation, and one-way translocation between subpopulations is identical to the first stage of two-stage translocation. The decision framework and protocols for mitigation and are designed to avoid (but are not limited to) include the following:

- Harm or illness to animals in capture or transport;
- Introduction or spread of infectious disease;
- Reduced chance of survival of translocated animals;
- Reduced fitness of individuals in the recipient subpopulation;
- Imbalanced population sex ratios; and
- Depletion of donor subpopulations.

Follow-up monitoring of individuals (i.e., translocated animal via telemetry and visual surveys) as well as of subpopulations provides information for project evaluation and helps to continually improve translocation decision making. At least a subset of translocated animals will be instrumented with tags to track them for a period to assess post-release behavior, location, and survival.

Researchers will not capture animals when other animals are in the immediate vicinity. In some instances, when an abandoned nursing pup is being sought, researchers will not capture the pup if it is in the vicinity of other animals, particularly mother-pups pairs. To introduce the pup to a parturient female, researchers will approach close to the female to place the pup in close proximity to the female. Generally, this placement will be done quickly by a single human.

3.1.21.11 Mitigation for Adult Male Removal

For translocation and permanent captivity, animals will be captured, temporarily held, and transported using the methods and restrictions to minimize stress and risk to the animal's safety. Sedation will be used to reduce stress during handling. During transport, animals will be kept wet throughout all daylight hours, but will be otherwise undisturbed. Procedures for responding to emergencies to mitigate negative impacts from restraint to sedation will be followed as described for health assessment sampling. If animals are euthanized, American Veterinary

Medical Association-approved methods will be used in consultation with an attending or consulting veterinarian. The least intrusive alternative will be used. This proposed action will be submitted to the University of Hawaii and NMFS Institutional Animal Care and Use Committee for review and approval.

3.1.21.12 Mitigation for Disentanglement

Researchers will attempt to remove entangled items without restraint (i.e., by using a long-handled cutting element) whenever possible. If restraint is necessary, animals will be cooled with water if restraint is not near the waterline and is during midday times.

3.1.21.13 Mitigation for Necropsy

The condition of carcasses and placentae deteriorate rapidly in the warm Hawaiian climate, so researchers will retrieve these tissues in a timely manner in order to diagnose cause of death. In some cases, animals may be unintentionally disturbed in the vicinity of a carcass may occur, but researchers will make an effort to obtain the carcass surreptitiously. Mothers sometimes remain agitated and near their pup’s carcass for some time after the pup has died. To maximize the probability of learning the pup’s cause of death, a researcher may distract the mother while another researcher rapidly retrieves the carcass. In all cases, prior to necropsy, carcasses will be moved away from other animals to avoid disturbance.

3.1.21.14 Mitigation for Sample Collection

Biological samples (e.g., molt, scat, and spew samples) will not be collected when animals are in the immediate vicinity and may be disturbed by the research and enhancement activities.

3.1.21.15 Mitigation for Predation at French Frigate Shoals

Dead flesh from Hawaiian monk seals may be used for bait for predation mitigation at French Frigate Shoals. This mitigation may lead to increased protection and survivorship of the pup cohort. Predation mitigation is deemed necessary for the recovery of animals part of the subpopulation at French Frigate Shoals and recommended in the Hawaiian Monk Seal Recovery Plan (NMFS 2007d). In an effort to mitigate predation of pups at French Frigate Shoals, researchers may attempt to remove (cull) Galapagos sharks (*Carcharhinus galapagensis*) at select islets in the atoll during the breeding season. This proposed action will be conducted under a permit issued by the Papahānaumokuākea Marine National Monument.

In addition to tuna heads and shark remains, flesh from dead Hawaiian monk seals may be used to target and capture large adult Galapagos sharks. The flesh from dead Hawaiian monk seals are available after a necropsy has been conducted. Researchers will use large pieces of tissue that includes skin, blubber, and muscle. From 2001 through 2006, fishing with flesh from Hawaiian monk seals resulted in a higher catch per unit effort than using fish as bait. The flesh will be attached to a hook and line, and not used as chum. Any Galapagos sharks that ingest the bait and are captured will be killed and not pose a threat to Hawaiian monk seals. While it has not been used in recent years, the HMSRP will keep this as an option for removing large sharks at French Frigate Shoals.

3.1.21.16 Mitigation for Unintentional Disturbance

Researchers will remain as far away as possible from animals during monitoring to obtain data. Researchers will use binoculars and telephoto lenses for documentation. All researchers in the field will be trained to be unobtrusive and to remain low to the ground whenever animals may alert to human presence. Animals will be given a wide birth when they are especially susceptible to unintentional disturbance, such as lactating females or molting animals.

4 ACTION AREA

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02). The NMFS Permits and Conservation Division proposes to issue MMPA Section 104 and ESA Section 10(a)(1)(A) permits for scientific research and enhancement activities on Hawaiian monk seals in the Pacific Ocean. The action area for Permit No. 22677 encompass the range where the Hawaiian monk seal occurs throughout the Hawaiian Archipelago and Johnston Atoll (a National Wildlife Refuge managed by the U.S. Fish and Wildlife Service and part of the Pacific Remote Islands Marine National Monument) including the Northwestern Hawaiian Islands and Main Hawaiian Islands (Figure 1). More specifically, the research and enhancement activities will include portions of the open ocean, beaches, and nearshore environment where Hawaiian monk seals may be found as well as the shore zone of the islands, islets, and atolls that make up the Hawaiian Archipelago and Johnston Atoll. The shore zone includes terrestrial habitat 5 meters (16.4 feet) inland from the upper reaches of the wash of the waves, at high tide during the season in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth or the upper limit of debris. Research and enhancement activities will generally occur on the beach or nearshore lava beach areas of all specified locations. The action area also includes captive facilities housing Hawaiian monk seals. A map of the action area for Permit No. 22677 is shown in Figure 1.

The majority of NMFS PIFSC's research and enhancement activities will occur in protected areas such as the Papahānaumokuākea Marine National Monument, Hawaiian Islands National Wildlife Refuge, Midway Atoll National Wildlife Refuge, Battle of Midway National Memorial, Northwestern Hawaiian Islands State Marine Refuge, Kure Atoll Hawaii State Seabird Sanctuary, and the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve.

In the Northwest Hawaiian Islands, Hawaiian monk seals have eight reproductive sites including Kure Atoll, Midway Atoll, Pearl and Hermes Reef, Lisianski Island, Laysan Island, French Frigate Shoals, Necker Island, and Nihoa Islands. Small numbers of Hawaiian monk seals have been observed at Gardner Pinnacles and Maro Reef, but those sites are rarely surveyed. Hawaiian monk seals are also found throughout the Main Hawaiian Islands.

In the Main Hawaiian Islands, research and enhancement activities will occur in military areas including Kaneohe Marine Corps Base on Hawaii and Pacific Missile Range Facility on Kauai (including Kaula Rock); as well as state of Hawaii areas including Manana (Rabbit) Island, Mokolua Islands, and Kaena Point Natura Area Reserve.

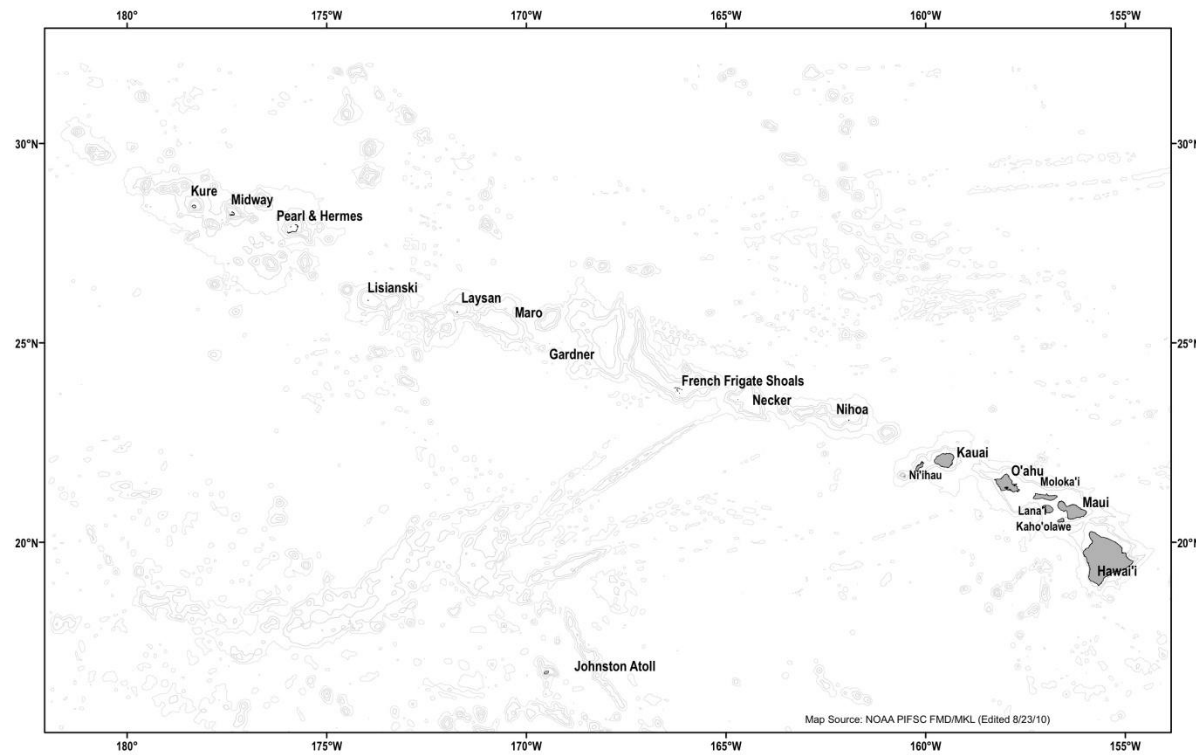


Figure 1. Map of the Hawaiian Archipelago and Johnston Atoll representing the National Marine Fisheries Service Pacific Islands Fisheries Science Center's proposed action area.

5 POTENTIAL STRESSORS

The proposed action involves multiple research and enhancement activities, each of which can create potential stressors to ESA-listed species in the action area. Stressors are any physical, chemical, or biological entity that may directly or indirectly induce an adverse response either in ESA-listed species or their designated critical habitat. During consultation, we identified stressors associated with each proposed activity that are reasonably certain to occur. The following lists presents each of the PIFSC's proposed activities with their associated stressor/s in parentheses:

- Aerial surveys (visual and audio disturbance);
- Vessel activities (vessel pollution, vessel strike, visual and auditory disturbance from close approach, and entanglement);
- Non-invasive research activities (entanglement and close approach);
- Capture and restraint (close approach, direct human contact, and entanglement);
- Remote chemical capture (close approach, needle injection, chemical immobilization, and direct human contact);
- Sedation/anesthesia (direct human contact and chemical immobilization);
- Specimen collection and health screening (direct human contact, blood collection, biopsy, swab/fecal sampling, milk sampling, hair/vibrissae sampling, and morphometrics);
- Marking (close approach and skin contact);
- Tagging (capture and restraint and skin piercing);
- External instrument attachment (capture and restraint and instrument disturbance);
- Behavioral modification (aversive audio and projectiles);
- Translocation (capture and restraint, temporary captivity and temporary habitat removal);
- Temporary Captivity (capture and restraint and temporary habitat removal);
- Euthanasia (needle injection, captive bolt, and gunshot);
- Permanent captivity (capture and restraint and permanent habitat removal);
- Disentanglement/Dehooking (capture and restraint and veterinary medical procedures);
- Deworming/administration of drugs (close approach, needle injection, and drug treatment);
- Supplemental feeding (close approach and human disturbance);
- Vaccination (close approach, needle injection, and drug treatment);

- Treatment of wounds (close approach and veterinary medical procedures); and
- Administration of oxytocin (close approach, needle injection, and drug treatment)

To appropriately categorize these stressors, we grouped them into two classifications: 1.) Stressors that may affect target species (Hawaiian monk seals) and non-target ESA-listed species and designated critical habitat in the action area; and 2.) Stressors that may affect only target species and their designated critical habitat. These categories are presented in the subsections below.

5.1 Stressors that May Affect Target and Non-Target ESA-Listed Species and Designated Critical Habitat in the Action Area

5.1.1 Visual and Audio Disturbance from Aerial Surveys

Aerial surveys using helicopters, fixed-wing aircrafts and unmanned aerial systems are proposed to census Hawaiian monk seals. Responses to aerial surveys directed at Hawaiian monk seals consist only of behavioral responses, which vary by species and aircraft type. Manned aerial surveys that will be authorized under the proposed action may cause visual disturbance and/or auditory disturbance (i.e., noise. Species responses to aircraft depend on the animals' behavioral state at the time of exposure (e.g., resting, socializing, foraging, or traveling) as well as the altitude and lateral distance of the aircraft to the animals (Luksenburg and Parsons 2009).

Unmanned aerial surveys that will be authorized under the proposed action may also cause visual and/or auditory disturbances to ESA-listed cetaceans, pinnipeds, sea turtles, and fishes. Despite being conducted at much lower altitudes than manned aerial surveys, the aircraft used to conduct unmanned aerial surveys will be much smaller and quieter, so less of a behavioral response might be expected. While the use of unmanned aerial systems to study marine mammals is in its infancy, current data support the notion that disturbance from the activity is minimal (Acevedo-Whitehouse et al. 2010; Koski et al. 2015; Sweeney et al. 2016).

5.1.2 Vessel Activities/Surveys

Vessel surveys/surveys will expose ESA-listed species within the action area to potential vessel strike, visual and/or auditory disturbances from close approach, and entanglement.

5.1.2.1 Vessel Pollution

The operation of the research vessels permitted under Permit No. 22677 may result in pollution from exhaust, fuel, oil, trash, and other debris. Air and water quality are the basis of a healthy environment for all species. Emissions pollute the air, which could be harmful to air-breathing organisms and lead to ocean pollution (Duce et al. 1991; Chance et al. 2015). Emissions also cause increased greenhouse gases (carbon dioxide, methane, nitrous oxide, and other fluorinated gases) that can deplete the ozone, affect natural earth cycles, and ultimately contribute to climate change (see https://www.epa.gov/ghgemissions/overview-greenhouse-gases for additional information). The release of marine debris such as paper, plastic, wood, glass, and metal associated with vessel operations can also have adverse effects on marine species most commonly through entanglement or ingestion (Gall and Thompson 2015). While lethal and non-lethal effects to air breathing marine animals such marine mammals and sea turtles are well documented, marine debris also adversely affects marine fish (Gall and Thompson 2015).

Many of the research vessels permitted as a result of the proposed action have spill-prevention plans, which will allow a rapid response to a spill in the event one occurs. Discharges from research vessels in the form of leakages of fuel or oil are possible, though likely to be minimal, if they occur at all. The potential for fuel or oil leakages is extremely unlikely. During vessel surveys, NOAA research vessels conform to the requirements of 33 C.F.R. §151, the Federal Water Pollution Control Act, International Maritime Organization ballast water guidelines, and MOC Environmental Guideline ENV 09. If a discharge does occur, the amount of leakage will be small, and would be expected to disperse quickly in the water and not affect ESA-listed species directly.

5.1.2.2 Vessel Strike

Vessel surveys necessarily involve transit within the marine environment, and the transit of any research vessel in waters inhabited by ESA-listed species carries the risk of striking an animal. The majority of vessel strikes of marine mammals occur when vessels are traveling at speeds greater than approximately 18.5 kilometers per hour (10 knots), with vessels traveling faster, especially large vessels (80 meters [262.5 feet] or greater), being more likely to cause serious injury or death (Laist et al. 2001; Jensen and Silber 2004; Vanderlaan and Taggart 2007; Conn and Silber 2013). Vessel strike risk for sea turtles is less studied than for marine mammals, but it is considered an important injury and mortality risk. Moreover, interactions with ESA-listed fishes in the action area can potentially involve vessel strikes due to these species spending a portion of their time in the upper water column.

5.1.2.3 Visual and Auditory Disturbance from Close Approach

Close approaches by research vessels or remotely operated aquatic vehicles used during vessel surveys may cause visual or auditory disturbances to ESA-listed species. Vessel noise is generated primarily by the machinery used to propel the vessel with the amount of noise related to the size of the vessel. Visual and noise disturbance of the research vessel may last up to the entire duration a haulout site is circled. Further, Kayaks and remotely operated vehicles could cause visual disturbance and may approach very close to animals due to no minimum approach distance to haulouts for these vessels.

5.1.2.4 Entanglement

The use of remotely operated vehicles presents an entanglement risk for ESA-listed species. An example of the type of platform used during vessel surveys conducted with remotely operated vehicles can be found at https://www.powervision.me/en/product/powerray. This platform contains a 70 meter (230 feet) communication cable that will travel with the vehicle as it traverses through the water. Further, marine debris such as paper, plastic, wood, glass, and metal associated with vessel operations may also present entanglement risks.

5.1.3 Non-Invasive Research Activities

Non-invasive research activities include land surveys for population monitoring, photography, videography, passive acoustic monitoring, and opportunistic sampling. The stressors from these activities include disturbance from close approaches by researchers and entanglement from passive acoustic monitoring. For researchers to conduct activities such as terrestrial population monitoring, it will be necessary for them to be close enough to visually detect, count animals, and read tags. As a result, researchers may need to position themselves right next to target ESA-listed species while they are asleep which can cause visual disturbance. Further, researchers will use microphone cables to conduct passive acoustic monitoring which may present an entanglement risk.

5.1.4 Capture and Restraint

The stressors involved with capture and restraint include close approaches by researchers, direct human contact, and entanglement. As researchers perform close approach to manually capture and restrain target species, researchers will visually disturb target species and non-target species that may be in the close vicinity of the activity. Also, an entanglement risk is presented to target species when researcher use nets during capture. Further discussion on the impacts of direct human contact to target species during capture and restraint is presented in Section 8.2.2.1.

5.1.5 Remote Chemical Capture

The stressors involved with remote chemical capture include close approaches by researchers, needle injection, chemical immobilization, and direct human contact). As researchers perform close approach to chemically capture and restrain target species, researchers will visually disturb target species and non-target species that may be in the close vicinity of the activity. Further discussion on the impacts of direct human contact to target species during capture and restraint is presented in Section 8.2.2.1.

5.2 Stressors that May Affect Only Target ESA-Listed Species and Designated Critical Habitat in the Action Area

The activities that may affect only target ESA-listed species during the proposed research and enhancement activities are sedation/anesthesia, specimen collection and health screening, marking, tagging, external instrument attachment, behavioral modification, translocation, temporary captivity, euthanasia, permanent captivity, disentanglement/dehooking, deworming/administration of drugs, supplemental feeding, vaccination, treatment of wounds, and administration of oxytocin. The stressors for each of these activities are stated in the list above (See Section 5). A detailed analysis on the effects of these activities and their associated stressors are presented in Section 8.

6 Species and Critical Habitat In the Action Area

This section identifies the ESA-listed species and designated critical habitat that potentially occur within the action area (Table 4) that may be affected by stressors from the proposed research and enhancement activities. Section 6.1 identifies the species and designated critical habitats in the action area that may be affected, but are not likely to be adversely affected by the PIFSC's proposed action. The remaining species deemed likely to be adversely affected by stressors resulting from the PIFSC's proposed action are carried forward through the remainder of this Opinion. Table 5 provides an illustrative summary of our determinations by proposed activity for each of the ESA-listed species and designated critical habitats considered in this consultation.

Table 4. Endangered Species Act-listed threatened and endangered species that are not likely to be adversely affected by the National Marine Fisheries Service's Permits and Conservation Division's proposed action of issuance of scientific research and enhancement permit for Permit No. 22677.

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue Whale (*Balaenoptera musculus)*	E – 35 FR 18319	-- --	07/1998 10/2018 - Draft
False Killer Whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular DPS	E – 77 FR 70915	83 FR 35062	-- --
Fin Whale (*Balaenoptera physalus)*	E – 35 FR 18319	-- --	75 FR 47538 07/2010
North Pacific Right Whale (*Eubalaena japonica*)	E – 73 FR 12024	73 FR 19000	78 FR 34347 06/2013
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584 12/2010
Marine Mammals – Pinnipeds			
Hawaiian Monk Seal (*Neomonachus schauinslandi*)	E – 41 FR 51611	80 FR 50925	72 FR 46966 2007
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – Central North Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359 01/1998

Species	ESA Status	Critical Habitat	Recovery Plan
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	57 FR 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359 05/1998 – U.S. Pacific
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359 05/1998 – U.S. Pacific
Loggerhead Turtle (*Caretta caretta*) – North Pacific Ocean DPS	E – 76 FR 58868	-- --	63 FR 28359
Olive Ridley Turtle (*Lepidochelys olivacea*) – All Other Areas/Not Mexico's Pacific Coast Breeding Colonies	T – 43 FR 32800	-- --	-- --
Fishes			
Giant Manta Ray (*Manta birostris*)	T – 83 FR 2916	-- --	-- --
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --	9/2018- Outline

Table 5. ESA-listed species that may be affected by the proposed action and effects determination by activity for ESA-listed species expected to be encountered during Permit No. 22677

ESA-listed Species in the action area	Overall Determination	Proposed Activities																			
		Vessel Activities/Surveys	Aerial Surveys	Non-Invasive Research Activities	Capture and Restraint	Remote Chemical Capture	Sedation/Anesthesia	Specimen Collection/Health Screening	Marking	Tagging	External Instrument Attachment	Behavioral Modification	Translocation	Temporary Captivity	Euthanasia	Permanent Captivity	Disentanglement/ Dehooking	Deworming/Administration of Drugs and Supportive Fluids	Vaccination	Treatment of Wounds	Administration of Oxytocin and Supplemental Feeding
Blue Whale	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
False Killer Whale	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Fin Whale	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
North Pacific Right Whale	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Sei Whale	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Sperm Whale	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Hawaiian Monk Seal	LA	NL	NL	NL	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA

ESA-listed Species in the action area	Overall Determination	Proposed Activities																			
		Vessel Activities/Surveys	Aerial Surveys	Non-Invasive Research Activities	Capture and Restraint	Remote Chemical Capture	Sedation/Anesthesia	Specimen Collection/Health Screening	Marking	Tagging	External Instrument Attachment	Behavioral Modification	Translocation	Temporary Captivity	Euthanasia	Permanent Captivity	Disentanglement/ Dehooking	Deworming/Administration of Drugs and Supportive Fluids	Vaccination	Treatment of Wounds	Administration of Oxytocin and Supplemental Feeding
Green Turtle- Central North Pacific DPS	NL	NL	NL	NL	NL	NL	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Hawksbill Turtle	NL	NL	NL	NL	NL	NL	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Leatherback Turtle	NL	NL	NL	NL	NL	NL	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Olive Ridley Turtle– All Other Areas/Not Mexico's Pacific Coast Breeding Colonies	NL	NL	NL	NL	NL	NL	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Giant Manta Ray	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Oceanic Whitetip Shark	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE

ESA-listed Species in the action area	Overall Determination	Proposed Activities																			
		Vessel Activities/Surveys	Aerial Surveys	Non-Invasive Research Activities	Capture and Restraint	Remote Chemical Capture	Sedation/Anesthesia	Specimen Collection/Health Screening	Marking	Tagging	External Instrument Attachment	Behavioral Modification	Translocation	Temporary Captivity	Euthanasia	Permanent Captivity	Disentanglement/ Dehooking	Deworming/Administration of Drugs and Supportive Fluids	Vaccination	Treatment of Wounds	Administration of Oxytocin and Supplemental Feeding
Main Hawaiian Islands Insular DPS of False Killer Whale Critical Habitat	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE
Hawaiian Monk Seal Critical Habitat	NL	NL	NL	NL	NE	NE	NE	NE	NE	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE

NL=Not Likely to Adversely Affect
LA=Likely to Adversely Affect
NE=No Effect

6.1 Species and Designated Critical Habitat Not Likely to be Adversely Affected

This section identifies the ESA-listed species and designated critical habitat under NMFS jurisdiction that may occur within the action area (as described in Table 4) that are not likely to be adversely affected by the proposed action. NMFS uses two criteria to identify the ESA-listed species or designated critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities consequential to the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that are exposed to a potential stressor but is likely to be unaffected by the exposure are also not likely to be adversely affected by the proposed action. We applied these criteria to the species ESA-listed in Table 4 and we summarize our results below.

The probability of an effect on a species or designated critical habitat is a function of exposure intensity and susceptibility of a species to a stressor's effects (i.e., probability of response). An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly beneficial, insignificant or discountable. Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is very unlikely to occur.

In this section, we evaluate the effects of the proposed action on several ESA-listed species and designated critical habitats that may be affected, but are not likely to be adversely affected. For these ESA listed species and critical habitat, we focus specifically on stressors that are associated with the NMFS Permits and Conservation Division's proposed issuance of Permit Nos. 22677. The species potentially occurring within the action area that may be affected, but are not likely to be adversely affected are listed in Table 4, along with their regulatory status, designated critical habitat, and recovery plan.

6.1.1 Endangered Species Act-Listed Cetaceans

Vessel activities/surveys, aerial surveys, underwater passive acoustic monitoring from non-invasive research activities, and aversive audio from behavioral modification used during the proposed activities have the potential to affect cetaceans whose ranges spatially overlap with the action area including blue whales, Main Hawaiian Island false killer whales, fin whales, North Pacific right whales, sei whales, and sperm whales.

Vessel Activities/Surveys

As discussed in Section 3.1.2, during vessel activities/surveys, NOAA research vessels conform to the requirements of 33 C.F.R. §151, the Federal Water Pollution Control Act, International Maritime Organization ballast water guidelines, and MOC Environmental Guideline ENV 09. Furthermore, to our knowledge, no leakages have occurred during Hawaiian monk seal research and enhancement activities. An oil or fuel leak could pose a significant risk to the vessel and its crew should begin actions to correct a leak immediately to the furthest extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the research vessel is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the research vessel). If a discharge occurs, the amount of leakage will be small, and would be expected to disperse quickly in the water and not affect ESA-listed species directly. Further, entanglement risks during vessel activities/surveys associated with pollution and remotely operated vehicles (See Section 5.1.2) is unlikely to occur. For example, due to the short length of the cord attached to the remotely operated vehicle and the presence of researchers controlling it, the chance for an entanglement event as a result of the remotely operated vehicle would be small. Also, due to NOAA’s conformance to pollution control standards mentioned above, the potential for discharge of marine debris that could cause entanglement would be minimal. Therefore, the effects on ESA-listed cetaceans associated with vessel pollution and entanglement during vessel activities/surveys throughout the proposed research and enhancement activities are anticipated to be discountable.

Vessel activities/surveys may occur year-round and will be conducted from vessels ranging in size from remote controlled boats, kayaks, small boats (i.e., a Boston Whaler [5.5 meters or 18 feet]) and larger research vessels. If cetaceans are encountered by boat, researchers would maintain a distance of 45.75 meters (150 feet) from the animals. As a result, any vessel strike or noise/visual disturbance to ESA-listed cetaceans from vessel surveys is expected to be brief and so small in scale as to be negligible. Therefore, the effects on ESA-listed cetaceans associated with vessel strikes are anticipated to be discountable and the effects of vessel noise/visual disturbance are expected to be insignificant.

Aerial Surveys

Aerial surveys may take place year-round. Thus, aerial surveys may occur during periods when cetaceans may be concentrated in their feeding grounds within and around the action area. In the event cetaceans are encountered near shore where aerial surveys would take place, researchers would fly to an altitude of 304 meters (1,000 feet) to avoid harassment of animals. In addition, manned aircraft and unmanned aircraft will avoid flying over non-target species, such as the ESA-listed cetaceans provided in Table 4 above. Any noise or visual disturbance associated with the surveys is expected to be a short duration (i.e., the time needed to spot the whale and alter course or increase the altitude of the airplane, helicopter, or unmanned aerial system). Therefore, the effects from research area surveys on ESA-listed cetaceans is expected to be discountable.

Non-Invasive Research Activities (Underwater Passive Acoustic Monitoring)

As discussed in the *Description of the Proposed Action* (Section 3), NMFS PIFSC researchers propose to conduct underwater passive acoustic monitoring of Hawaiian monk seals through the use of a hydrophones and autonomous passive recording devices. These devices will not be towed from vessels, preventing any form of entanglement risk for ESA-listed cetaceans. Furthermore, aside from a small potential for ESA-listed cetaceans to be visually alerted by the devices as they are hand-dipped or remotely installed in the water by researchers , there will be little to no disturbance risk from underwater passive acoustic monitoring as no active acoustics will be deployed during the activity. As a result, any visual disturbance of cetaceans from underwater passive acoustic monitoring is expected to be brief and so small in scale as to be negligible. Therefore, the effects on ESA-listed cetaceans associated with underwater passive acoustic monitoring during the proposed research activities is anticipated to be insignificant.

Behavioral Modification (Aversive Audio)

Aversive audio during behavioral modification may affect ESA-listed cetaceans exposed to noise resulting from the research and enhancement activities. Aversive audio from behavioral modification activities usually occurs in the shallow nearshore areas where cetaceans are not likely to occur. Before aversive audio will be used, a visual survey will be conducted for the presence of any other protected species other than Hawaiian monk seals prior to application of audio aversive devices. If protected species are detected at close range, then playbacks will not occur. If protected species appear at close range during playback then the noise will be halted and behavior will be observed and recorded. As a result, any noise disturbance of cetaceans from aversive audio during behavioral modification activities is expected to be brief and so small in scale as to be negligible. Therefore, the effects from aversive audio from behavioral modification are anticipated to be discountable.

In summary, the effects from pollution, aerial surveys, vessel surveys, non-invasive research activities, and behavioral modification are not likely to adversely affect ESA-listed cetaceans. Thus, we conclude that the NMFS Permits and Conservation Division's issuance of Permit No. 22677 may affect, but is not likely to adversely affect ESA-listed blue whales, Main Hawaiian Island insular DPS of false killer whales, fin whales, North Pacific right whales, sei whales, and sperm whales.

6.1.2 Endangered Species Act-Listed Sea Turtles

The proposed action spatially overlaps with several ESA-listed sea turtle species and DPSs including the Central North Pacific DPS of green turtles, hawksbill turtles, leatherback turtles, the North Pacific DPS of loggerhead turtle, and non-Mexico Pacific Coast breeding colony areas of olive ridley turtles. Pollution, aerial surveys, vessel surveys, non-invasive terrestrial research activities, capture/restraint activities, and aversive audio from behavioral modification used during the proposed activities have the potential to affect the ESA-listed sea turtles whose ranges spatially overlap with the action area.

Vessel Activities/Surveys

As discussed in Section 3.1.2, during vessel activities/surveys, NOAA research vessels conform to the requirements of 33 C.F.R. §151, the Federal Water Pollution Control Act, International Maritime Organization ballast water guidelines, and MOC Environmental Guideline ENV 09. Furthermore, to our knowledge, no leakages have occurred during Hawaiian monk seal research and enhancement activities. An oil or fuel leak could pose a significant risk to the vessel and its crew should begin actions to correct a leak immediately to the furthest extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the research vessel is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the research vessel). If a discharge occurs, the amount of leakage will be small, and would be expected to disperse quickly in the water and not affect ESA-listed species directly. Further, entanglement risks during vessel activities/surveys associated with pollution and remotely operated vehicles (See Section 5.1.2) is unlikely to occur. For example, due to the short length of the cord attached to the remotely operated vehicle and the presence of researchers controlling it, the chance for an entanglement event as a result of the remotely operated vehicle would be small. Also, due to NOAA's conformance to pollution control standards mentioned above, the potential for discharge of marine debris that could cause entanglement would be minimal. Therefore, the effects on ESA-listed sea turtles associated with vessel pollution and entanglement during the proposed research and enhancement activities are anticipated to be discountable.

Vessel activities/surveys may occur year-round and will be conducted from vessels ranging in size from kayaks, small boats (i.e., a Boston Whaler [5.5 meters or 18 feet]) and larger research vessels. To avoid contact with ESA-listed sea turtles, vessels will maintain straight-line paths while transiting between survey islands. Small boats will maintain a moderate speed and watch for objects in the water including turtles to reduce the threat of boat strikes or disturbance to sea turtles in the water. Furthermore, caution will be exercised in shallower waters within the atolls to avoid any disturbance to swimming sea turtles. Boats will also avoid landing on beach areas where turtles are in the immediate vicinity. As a result, any vessel strike or noise/visual disturbance of sea turtles from vessel surveys is expected to be brief and so small in scale as to be negligible. Therefore, the effects on ESA-listed sea turtles associated with vessel strikes are anticipated to be discountable and the effects of vessel noise/visual disturbance are expected to be insignificant.

Aerial Surveys

NMFS PIFSC researchers propose to only conduct aerial surveys near areas where Hawaiian monk seals are located. If a sea turtle or other non-target species is sighted during flights, the aircraft will alter course or increase altitude whether it is an airplane, helicopter, or unmanned aerial system in order to avoid flying over non-target species as much as possible. As a result, any noise or visual disturbance associated with the surveys would be of short duration (the time needed to spot the sea turtle and change course or altitude). Therefore, the effects associated with aerial surveys conducted as part of the proposed research activities on sea turtles will be insignificant.

Non-Invasive Research Activities, Capture/Restraint, and Remote Chemical Capture

Non-invasive research activities, capture/restraint, and remote chemical capture of monk seals may affect ESA-listed sea turtles during the NMFS PIFSC's proposed research and enhancement activities. Researchers will only conduct these activities in daylight hours to prevent disturbance of sea turtles, which nest at night. In addition, field camps for the proposed research and enhancement activities will not be established in the immediate vicinity of turtle nesting areas, so emerging hatchlings will not be exposed to lights or human disturbance.

The NMFS PIFSC researchers will use Best Management Practices for the Papahānaumokuākea Marine National Monument which will also decrease potential adverse effects on turtles (Papahānaumokuākea Marine National Monument 2008). Furthermore, any entanglement risk from microphone cables during passive acoustic monitoring used during vocalization studies (as discussed in Section 3.1.11) will be averted as researchers on land are instructed to be visually alert to prevent any form of entanglement risk. As a result, any disturbance of sea turtles from non-invasive terrestrial research activities and capture/restraint of monk seals is expected to be brief and so small in scale as to be negligible. Therefore, the effects on ESA-listed sea turtles associated with non-invasive terrestrial research activities and capture/restraint of monk seals is anticipated to be discountable.

Behavioral Modification (Aversive Audio and Projectiles)

Aversive audio and the use of projectiles during behavioral modification may affect ESA-listed sea turtles. Before aversive audio will be used, a visual survey will be conducted for the presence of any other protected species other than Hawaiian monk seals prior to application of audio aversive devices. If sea turtles are detected at close range, then playbacks will not occur. Furthermore, if protected species appear at close range during playback then the noise will be halted and behavior will be observed and recorded. As a result, any noise disturbance of sea turtles from aversive audio during behavioral modification activities is expected to be brief and so small in scale as to be negligible.

Projectiles used during Hawaiian monk seal behavior modification typically include items readily available on the beach such as tree nuts or coral rubble. Pointed objects will be avoided and projectiles will be tossed gently toward the seal, always avoiding the head. NMFS PIFSC researchers will try to prevent any disturbance sea turtles. It is highly unlikely that a researchers will strike or disrupt ESA-listed sea turtles while using projectiles for behavioral modification as monk seals would only be targeted and sea turtles will be avoided. Therefore, impacts to ESA-listed sea turtles from the use of projectiles during the proposed action is discountable.

In summary, the effects from pollution, aerial surveys, vessel surveys, non-invasive research activities, capture/restraint, remote chemical capture, and behavioral modification are not likely to adversely affect ESA-listed sea turtles. Thus, we conclude that the NMFS Permits and Conservation Division's issuance of Permit No. 22677 is not likely to adversely affect the Central North Pacific DPS of green turtles, hawksbill turtles, leatherback turtles, the North Pacific DPS of loggerhead turtle, and non-Mexico Pacific Coast breeding colony areas of olive ridley turtles.

6.1.3 Endangered Species Act-Listed Fishes

Pollution, aerial surveys, vessel surveys, passive acoustic monitoring from non-invasive research activities, and aversive audio from behavioral modification used during the proposed activities have the potential to affect ESA-listed giant manta ray and oceanic whitetip shark, whose ranges spatially overlap with the action area.

Vessel Activities/Surveys

As discussed in Section 3.1.2, during vessel activities/surveys, NOAA research vessels conform to the requirements of 33 C.F.R. §151, the Federal Water Pollution Control Act, International Maritime Organization ballast water guidelines, and MOC Environmental Guideline ENV 09. Furthermore, to our knowledge, no leakages have occurred during Hawaiian monk seal research and enhancement activities. An oil or fuel leak could pose a significant risk to the vessel and its crew should begin actions to correct a leak immediately to the furthest extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the research vessel is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the research vessel). If a discharge occurs, the amount of leakage will be small, and would be expected to disperse quickly in the water and not affect ESA-listed species directly. Further, entanglement risks during vessel activities/surveys associated with pollution and remotely operated vehicles (See Section 5.1.2) is unlikely to occur. For example, due to the short length of the cord attached to the remotely operated vehicle and the presence of researchers controlling it, the chance for an entanglement event as a result of the remotely operated vehicle would be small. Also, due to NOAA's conformance to pollution control standards mentioned above, the potential for discharge of marine debris that could cause entanglement would be minimal. Therefore, the effects on ESA-listed fishes associated with pollution and entanglement during the proposed research and enhancement activities are anticipated to be discountable.

Vessel activities/surveys may occur year-round and will be conducted from vessels ranging in size from kayaks, small boats (i.e., a Boston Whaler [5.5 meters or 18 feet]) and larger research vessels. To avoid contact with ESA-listed fishes, vessels will maintain straight-line paths while transiting between survey islands. Small boats will maintain a moderate speed and watch for objects in the water including fishes to reduce the threat of boat strikes or disturbance to fishes in the water. Furthermore, no vessel strike or entanglement events of fishes have occurred during the PIFSC's past and current research and enhancement activities. As a result, any vessel strike or noise/visual disturbance of fishes from vessel surveys is expected to be brief and so small in scale as to be negligible. Therefore, the effects on ESA-listed fishes associated with vessel strikes are anticipated to be discountable and the effects of vessel noise/visual disturbance are expected to be insignificant.

Aerial Surveys

NMFS PIFSC researchers propose to only conduct aerial surveys near areas where Hawaiian monk seals are located. If ESA-listed fishes or other non-target species are sighted during flights, the aircraft will alter course or increase altitude whether it is an airplane, helicopter, or unmanned aerial system in order to avoid flying over non-target species as much as possible. As a result, any noise or visual disturbance associated with the surveys would be of short duration (the time needed to spot the fish and change course or altitude). Therefore, the effects associated with aerial surveys conducted as part of the proposed research activities on fishes will be insignificant.

Non-Invasive Research Activities (Underwater Passive Acoustic Monitoring)

As discussed in the *Description of the Proposed Action* (Section 3), NMFS PIFSC researchers propose to conduct underwater passive acoustic monitoring of Hawaiian monk seals through the use of a hydrophones and autonomous passive recording devices. These devices will not be towed from vessels, preventing any form of entanglement risk. Aside from a small potential for ESA-listed fishes to be visually alerted by underwater recording devices as they are hand-dipped or remotely installed in the water by researchers, there will be little to know disturbance risk from underwater passive acoustic monitoring. As a result, any visual disturbance of fishes from recording devices entering the water during underwater passive acoustic monitoring is expected to be brief and so small in scale as to be negligible. Therefore, the effects on ESA-listed fishes associated with underwater passive acoustic monitoring during the proposed research activities is anticipated to be insignificant.

Behavioral Modification (Aversive Audio)

Aversive audio during behavioral modification of monk seals may affect ESA-listed fishes exposed to noise resulting from the activities. Before aversive audio will be used, a visual survey will be conducted for the presence of any other protected species other than Hawaiian monk seals prior to application of audio aversive devices. If protected species are detected at close range, then playbacks will not occur. Furthermore, if ESA-listed fishes appear at close range during playback then the noise will be halted and behavior will be observed and recorded. As a result, any noise disturbance of fishes from aversive audio during behavioral modification of monk seals activities is expected to be brief and so small in scale as to be negligible.

In summary, the effects from pollution, aerial surveys, vessel surveys, non-invasive research activities, and behavioral modification are not likely to adversely affect ESA-listed fishes. Thus, we conclude that the NMFS Permits and Conservation Division's issuance of Permit No. 22677 is not likely to adversely affect ESA-listed giant manta ray and oceanic whitetip shark.

6.1.4 Designated Critical Habitat

The proposed action will take place in areas that encompass the range where the Hawaiian monk seal occurs throughout the Hawaiian Archipelago and Johnston Atoll. The action area includes designated critical habitat for the Main Hawaiian Islands Insular DPS of false killer whale and Hawaiian monk seal (Table 4).

6.1.4.1 False Killer Whale – Main Hawaiian Islands Insular Distinct Population Segment Critical Habitat

In 2018 (83 FR 35062), NMFS designated critical habitat for the Main Hawaiian Islands Insular DPS of false killer whale, which includes waters from the 45 meter (147.6 feet) to the 3,200 meter (10,498.7 feet) depth contour around the Main Hawaiian Islands from Niihau east to the island of Hawaii (Figure 2). The area designated as critical habitat includes approximately 45,504 square kilometers (13,266.8 square nautical miles) surrounding the Main Hawaiian Islands within the geographical area presently occupied by Main Hawaiian Islands Insular DPS of false killer whales. Due to the unique ecology of this island-associated population, habitat use is largely driven by depth. Thus, the features essential to the species' conservation are found in those depths that allow the false killer whales to travel throughout a majority of their range seeking food and opportunities to socialize and reproduce. The final rule excludes from the designation certain areas where they overlap with the 45 meter (147.6 feet) to the 3,200 meter (10,498.7 feet) depth contour around the Main Hawaiian Islands from Niihau east to the island of Hawaii including (1) the Bureau of Ocean Energy Management's Call Area offshore of the Island of Oahu (which includes two sites, one off Kaena Point and one off the south shore); (2) the U.S. Navy Pacific Missile Range Facilities Offshore ranges (including the Shallow Water Training Range, the Barking Sands Tactical Underwater Range, and the Barking Sands Underwater Range Extension (west of Kauai); (3) the U.S. Navy Kingfisher Range (northeast of Niihau); (4) Warning Area 188 (west of Kauai); (5) Kaula Island and Warning Area 187 (surrounding Kaula Island); (6) the U.S. Navy Fleet Operational Readiness Accuracy Check Site (west of Oahu); (7) the U.S. Navy Shipboard Electronic Systems Evaluation Facility (west of Oahu); (8) Warning Areas 196 and 191 (south of Oahu); (9) Warning Areas 193 and 194 (south of Oahu); (10) the Kaulakahi Channel portion of Warning Area 186 (the channel between Niihau and Kauai and extending east); (11) the area north of Molokai; (12) the Alenuihaha Channel; (13) Hawaii Area Tracking System; and (14) the Kahoolawe Training Minefield. In addition, the

Ewa Training Minefield and the Naval Defensive Sea Area are precluded from designation under section 4(a)(3) of the ESA because they are managed under the Joint Base Pearl Harbor-Hickam Integrated Natural Resource Management Plan that NMFS found provides a benefit to the Main Hawaiian Islands Insular DPS of false killer whale.

The physical and biological features essential for the conservation of the Main Hawaiian Islands Insular DPS of false killer whales includes island-associated marine habitat for the Main Hawaiian Islands Insular DPS of false killer whales. The following characteristics of this habitat support the Main Hawaiian Islands insular DPS of false killer whales' ability to travel, forage, communicate, and move freely around and among the waters surrounding the Main Hawaiian Islands: (1) adequate space for movement and use within shelf and slope habitat; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; (3) waters free of pollutants of a type and amount harmful to Main Hawaiian Islands Insular DPS of false killer whales; and (4) sound levels that will not significantly impair false killer whales' use or occupancy.

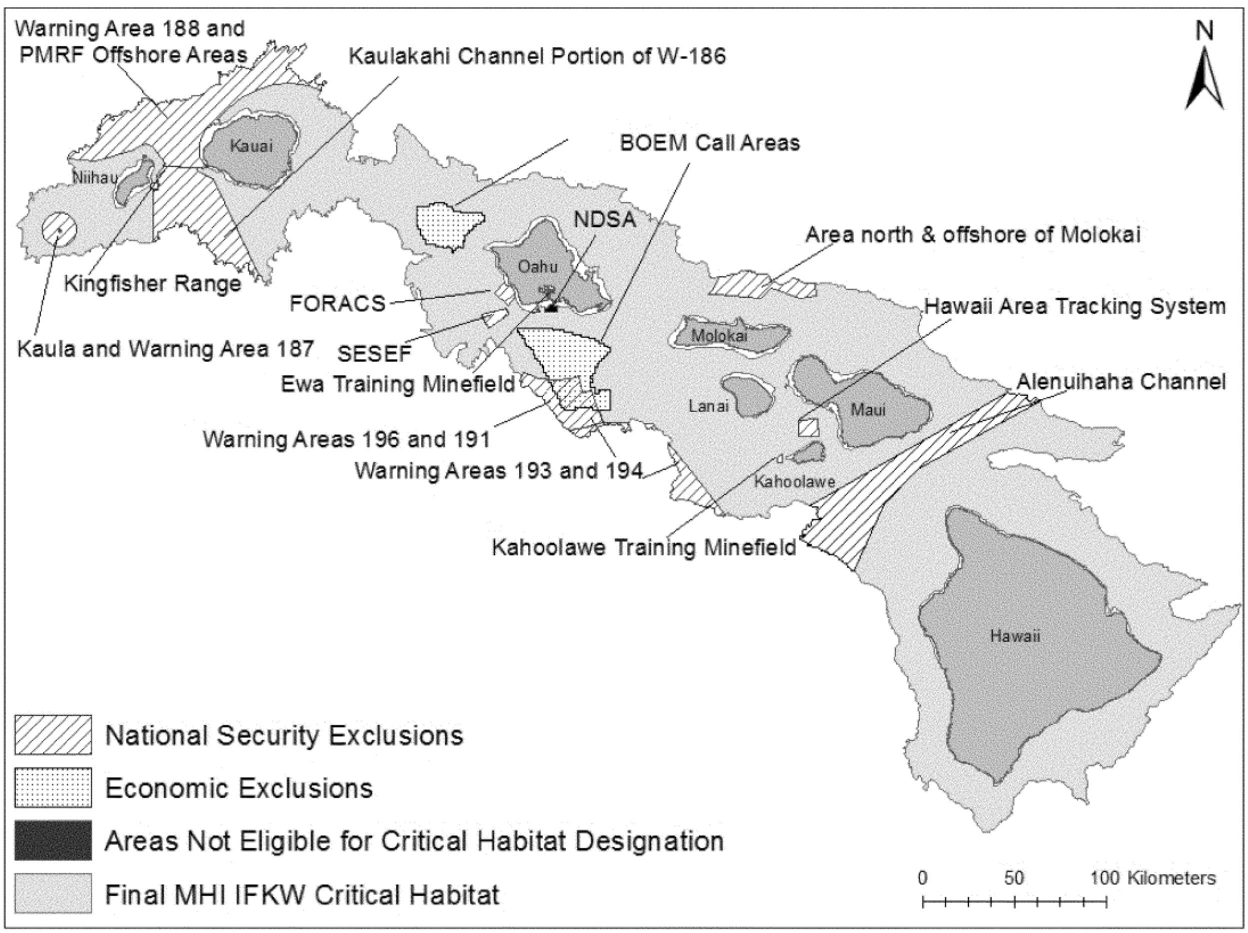


Figure 2. Map identifying designated critical habitat for the endangered Main Hawaiian Islands insular distinct population segment of false killer whale (83 FR 36062).

6.1.4.2 Hawaiian Monk Seal Critical Habitat

In 1986, NMFS designated critical habitat for the Hawaiian monk seal (51 FR 16047). The area of designated critical habitat was extended on May 26, 1988. It includes all beach areas, sand spits, and islets (including all beach crest vegetation to its deepest extent inland), lagoon waters, inner reef waters, and ocean waters out to a depth of 37 meters (121.4 feet) around the Northwestern Hawaiian Islands breeding atolls and islands. The marine component of this habitat serves as foraging areas, while terrestrial habitat provides resting, pupping, and nursing habitat (Figure 3).

In 2015, NMFS published a final rule to revise designated critical habitat for Hawaiian monk seals (80 FR 50925) that extended the current designation in the Northwestern Hawaiian Islands out to the 200 meter (656.2 feet) depth contour (including Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island). NMFS also designated six new areas in the Main Hawaiian Islands (i.e., terrestrial and marine habitat from 5 meters [15.4 feet] inland from the shoreline extending seaward to the 200 meter [656.2 feet] depth contour around Kaula, Niihau, Kauai, Oahu, Maui, Nui, and Hawaii) (Figure 3).

The physical and biological features identified for this area include (1) terrestrial areas and adjacent shallow, sheltered aquatic areas with characteristics preferred by Hawaiian monk seals for pupping and nursing; (2) marine areas from 0 to 200 meters (0 to 656.2 feet) in depth that support adequate prey quality and quantity for juvenile and adult Hawaiian monk seal foraging; and (3) significant areas used by Hawaiian monk seals for hauling-out, resting, or molting (80 FR 50925).

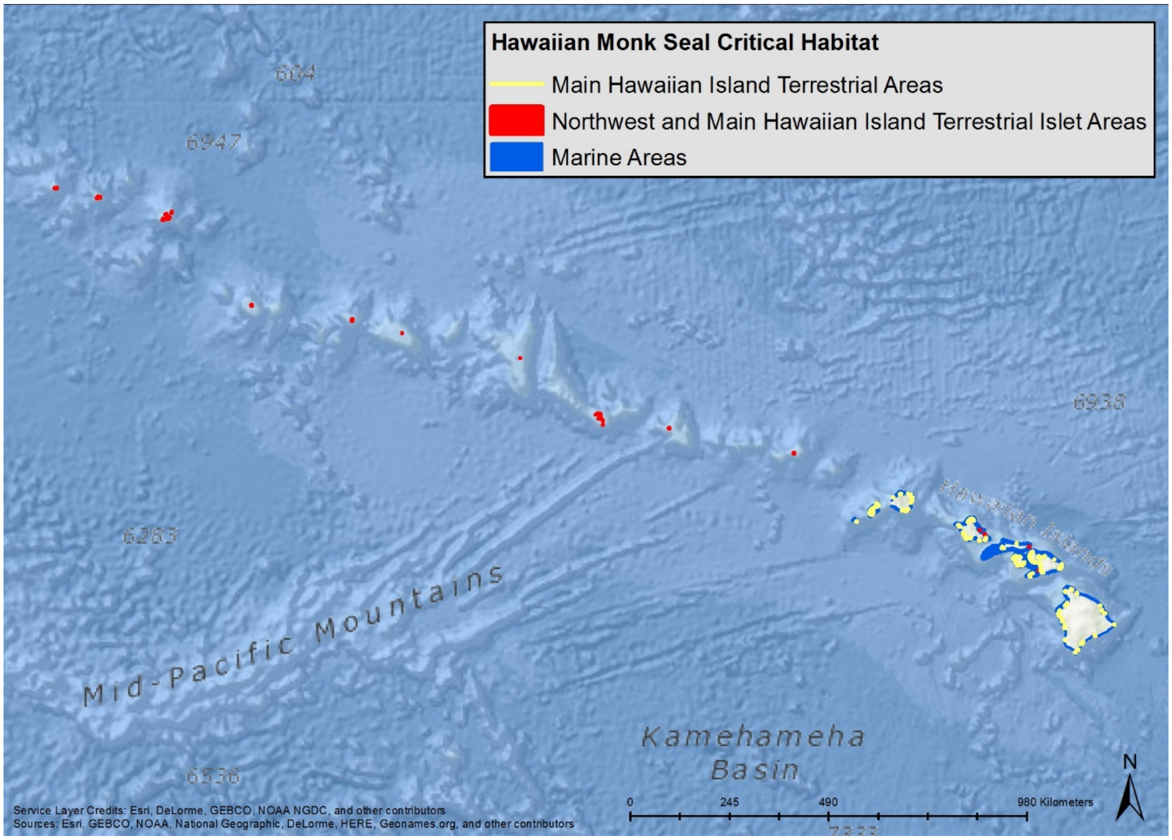


Figure 3. Map identifying designated critical habitat in the Northwest Hawaiian Islands and Main Hawaiian Islands for the endangered Hawaiian monk seal.

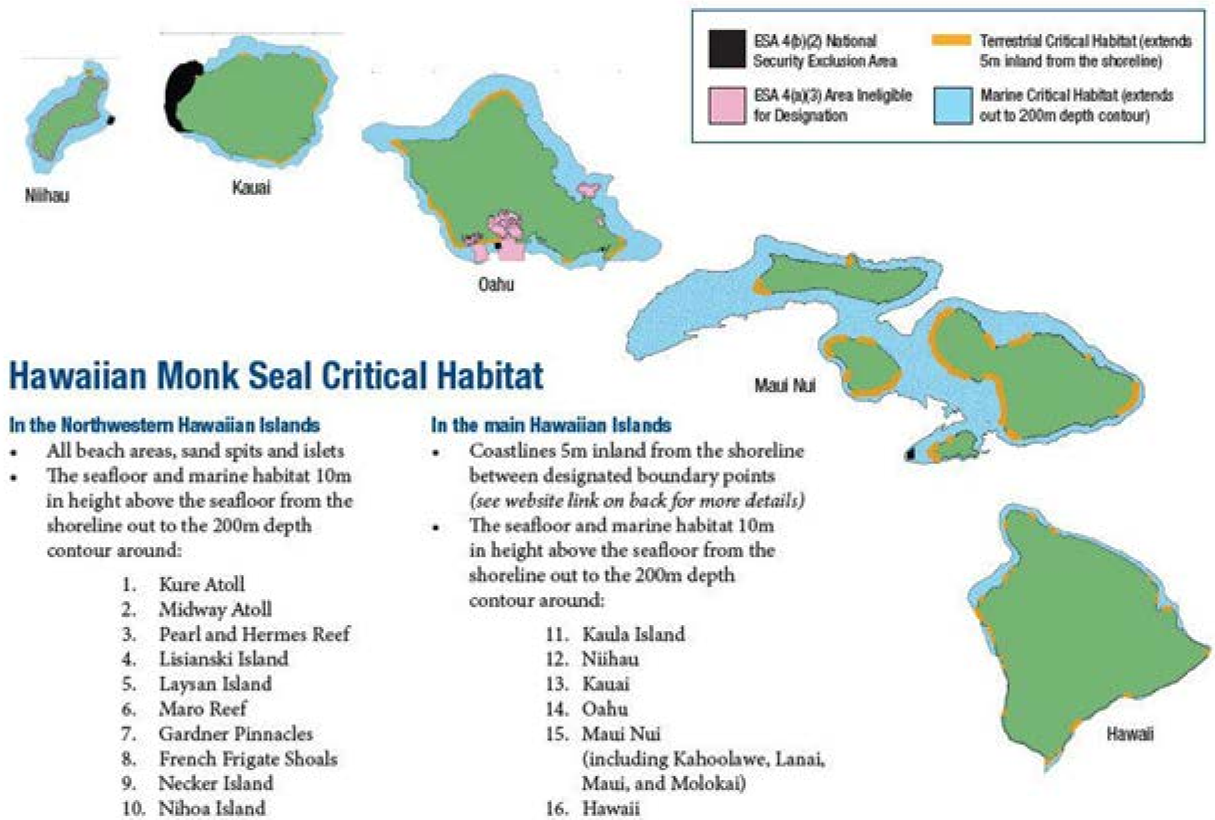


Figure 4. Map identifying designated critical habitat in the Main Hawaiian Islands for the endangered Hawaiian monk seal.

6.1.4.3 Effects to Designated Critical Habitat

False Killer Whale – Main Hawaiian Islands Insular Distinct Population Segment Critical Habitat

Marine areas of Main Hawaiian Islands Insular DPS of false killer whale designated critical habitat may be affected by the NMFS PIFSC's research and enhancement activities under Permit No. 22677. The designated critical habitat encompasses depths of 45 meters (147.6 feet) to over 3,000 meters (9,842.5 feet), which are not water depths typically used by Hawaiian monk seals and are not water depths conducive to research and enhancement activities, especially capture, of animals. Potential stressors on designated critical habitat for Main Hawaiian Islands Insular DPS of false killer whale associated with the proposed action include vessel traffic (physical disturbance and strike), vessel noise, underwater acoustic deterrents, discharge and pollution, and entanglement.

Small and occasionally large research vessels are proposed for use during research and enhancement activities under Permit No. 22677. Vessel movements involve transit to and from ports to various locations, vessel surveys, and use of research vessels during translocations within the action area. Research and enhancement activities involving vessel movements occur intermittently and are variable in duration. Operation of research vessels will result in a temporary increase of vessel traffic within designated critical habitat. This increase in vessel traffic is likely to consist of only one research vessel operating within a particular area of critical habitat. The action area often has a lot of commercial and recreational vessel traffic, and the addition of a single research vessel may not even be measurable. The physical transit of research vessels may result in brief obstruction of surface waters due to the presence of a research vessel and slight changes in dissolved oxygen levels, water temperature, and currents due to the research vessels displacement and mixing of water, but is not expected to have any effects on contaminant levels, depth, benthic habitat, and sea state. The brief physical transit of research vessels will still allow for adequate space for movement and use within shelf and slope habitat. The slight changes to water quality will still allow for waters free of pollutants of a type and amount harmful to Main Hawaiian Islands Insular DPS of false killer whales.

Prey species of Main Hawaiian Islands Insular DPS of false killer whales, including some fish, may to be susceptible to physical disturbance and strike from vessels. We anticipate that prey species (e.g., tuna, marlin, jack, mahi mahi, wahoo, moonfish, and squid) of Main Hawaiian Islands Insular DPS of false killer whales will be able to detect vessels and avoid them. Fish are able to use a combination of sensory cues to detect approaching vessels, such as sight, hearing, and their lateral line (for nearby changes in water motion). These prey species are not generally considered vulnerable to vessel strike as they are considered faster moving and do not occur regularly at the water's surface. For these reasons, it is extremely unlikely that a research vessel will strike prey of Main Hawaiian Islands insular DPS of false killer whales.

Vessel presence may also cause a slight change in distribution of prey due to behavior or physical disturbance. Prey species may exhibit a temporary behavioral response to oncoming vessels and regardless of the response, there is the potential for some type of stress or energetic cost as an individual fish must stop its current activity and divert its physiological and cognitive attention to responding to the vessel (Heffman et al. 2009). Behavioral avoidance and associated stress responses from detection of research vessels is not expected to result in impacts to the quantity, quality, or availability of prey species of Main Hawaiian Islands Insular DPS of false killer whales. These effects will be highly localized, occurring only within close proximity to the transiting research vessel, and temporary, with habitat conditions quickly returning to pre-exposure values once the research vessel leaves the area. Given the localized and short-term nature of operation of research vessels in critical habitat, is it expected to have an insignificant effect on the physical and biological features of designated critical habitats.

Transiting vessels also produce a variety of underwater sounds characterized as low-frequency, continuous, or tonal, with sound pressure levels at a source varying according to speed, burden, capacity, and length (Richardson et al. 1995b; Kipple and Gabriele 2007; Mckenna et al. 2012). The exact level of noise produced varies by vessel type. While such vessel noise will not physically obstruct water passage or affect water properties, depth, sea state, or oceanographic, benthic and algal features, it may affect prey in designated critical habitat. Prey in designated critical habitat of Main Hawaiian Islands Insular DPS of false killer whale are likely to be exposed to and detect sounds emitted from research vessels. All fish species can detect vessel noise due to its low-frequency content and their hearing capabilities. Similarly, available information indicates that aquatic invertebrates, such as squid, which are prey for false killer whales, are primarily sensitive to low-frequency sounds. Most cephalopods (e.g., octopus and squid) likely sense low-frequency sound below one kilohertz, with best sensitivities at lower frequencies (Packard et al. 1990; Budelmann 1992; Mooney et al. 2010). The vast majority of fishes do not show strong responses to low frequency sound. Because of the characteristics of vessel noise, sound produced by research vessels is unlikely to result in direct injury, hearing impairment, or other trauma to fishes or squid. Behavioral and/or physiological responses can occur. Impacts from vessel noise will be intermittent, temporary, and localized, and such responses are not expected to compromise the general health or condition of individuals. The only impacts expected from exposure to vessel noise for fishes and squid may include temporary auditory masking, short-term physiological stress, or minor changes in behavior. These effects will be highly localized and temporary. For these reasons, exposure to vessel noise is not expected to result in detectable impacts to the quantity, quality, or availability of prey for Main Hawaiian Islands Insular DPS of false killer whale.

We do not expect invertebrates to respond strongly to vessel sound (Bennet et al. 1994; Albert 2011). A study on the effects of vessel noise on sea hare (*Stylocheilus striatus*) found that chronic exposure to vessel noise may affect some invertebrates' development and lead to increased mortality (Nedelec et al. 2014). However, the experimental conditions of the study are drastically different than the brief exposure to vessel noise that will result from research vessel operations in the action areas. Another recent study examining the effects of broadband sounds, including recorded continuous vessel noise, on three representative benthic invertebrates (the clam, *Ruditapes philippinarum*; the decapod, *Nephrops norvegicus*; and, the brittlestar, *Amphiura filiformis*) indicated that continued exposure to broadband sounds may affect benthic invertebrate behavior in ways that alter nutrient cycling (Solan et al. 2016). However, this study found no significant effects on invertebrate tissue biochemistry, and behavioral responses including avoidance behavior, were mixed (Solan et al. 2016). Importantly, this study examined time integrated effects, which differ from those that would result from the brief exposure to noise from a single, transiting vessel. While avoidance behavior in prey may lead to a change in distribution, any such change would be short-lived and likely not last much beyond when the vessel leaves the area. In addition, while at close range both fishes and invertebrates may experience injury from certain sound sources (Popper et al. 2014a; Sole et al. 2016), the injury or even loss of a few individual prey will not have a measurable impact on the overall prey abundance such that it will diminish the conservation value of designated critical habitat for Main Hawaiian Islands Insular DPS of false killer whales. Thus, we believe the effects of vessel noise on Main Hawaiian Islands Insular DPS of false killer whale designated critical habitat associated with the proposed research and enhancement activities are insignificant.

We do not anticipate vessel noise to generate sounds that will significantly impair the function of Main Hawaiian Islands Insular DPS of false killer whales' critical habitat because the Main Hawaiian Islands Insular DPS of false killer whale's ability to receive and interpret sound for the purposes of navigation, communication, and detection of predators and prey will not be affected by the temporary impacts from vessel noise. Therefore, the effects of vessel noise on the sound level characteristic of Main Hawaiian Islands Insular DPS of false killer whale designated critical habitat will be so minor that the effect cannot be meaningfully evaluated, meaning they will be insignificant.

Discharge and pollution from research vessels may occur. The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, noxious liquid substances, sewage, garbage, and air pollution from vessels within certain distances of the coastline. Unintentional and intentional discharge of pollutants from research vessels may affect certain water quality properties, trigger harmful algal blooms, and temporarily affect distributions and behaviors of ESA-listed species and their prey if they are large in size, and duration. This may effect the physical and biological feature that specifies prey species of sufficient quantity, quality, and availability to support individual growth reproduction and development, as well as overall population growth; as well as waters free of pollutants of a type and amount harmful to Main Hawaiian Islands Insular DPS of false killer whales. Operation of research vessels may result in a temporary increase of discharge and pollution within designated critical habitat. This increase in vessel traffic is likely to consist of only one research vessel operating within a particular area of critical habitat. The action area often has a lot of commercial and recreational vessel traffic, and the addition of a single research vessel may not even be measurable. The localized extent of any discharges from a few research vessels associated with the proposed action will likely be minor relative to the size of the action area. In addition, any pollutant discharge will be mixed rapidly into the water column and is likely to be indistinguishable from discharges associated with vessel traffic in the action area. Therefore, the effects of discharge and pollution from research vessels on designated critical habitat are considered to be insignificant.

In summary, we conclude that the effects from vessel traffic (physical disturbance and strike), vessel noise and underwater acoustic deterrents, and discharge and pollution from the NMFS PIFSC's proposed research and enhancement activities under Permit No. 22677 may affect, but are not likely to adversely affect critical habitat that has been designated for Main Hawaiian Islands Insular DPS of false killer whale.

Hawaiian Monk Seal Critical Habitat

Marine areas of Hawaiian monk seal designated critical habitat occur within the action area, and as such may be affected by the NMFS PIFSC's research and enhancement activities under Permit No. 22677. The designated critical habitat includes water depths from 0 meter (0 feet) to over

200 meters (656.2 feet), and supports adequate prey quality and quantity for juvenile and adult Hawaiian monk seal foraging. Potential stressors on designated critical habitat associated with the proposed action for Hawaiian monk seals include vessel traffic (physical disturbance and strike), vessel noise, discharge and pollution, anchorage and landings from vessel surveys, presence and transit from researchers, vehicles, and equipment, wash from aerial surveys, and hazing animals by throwing objects.

Small and occasionally large research vessels are proposed for use during research and enhancement activities under Permit No. 22677. Vessel movements involve transits to and from ports to various locations, vessel surveys, and use of research vessels during translocations within the action area. Research and enhancement activities involving vessel movements occur intermittently and are variable in duration. Operation of research vessels will result in a temporary increase of vessel traffic within designated critical habitat. This increase in vessel traffic is likely to consist of only one research vessel operating within a particular area of critical habitat. The action area often has a lot of commercial and recreational vessel traffic, and the addition of a single research vessel may not even be measurable. The brief physical transit of research vessels may result in brief obstruction of surface waters due to the presence of a research vessel and slight changes in dissolved oxygen levels, water temperature, and currents due to the research vessels displacement and mixing of water, but is not expected to have any effects on contaminant levels, depth, benthic habitat, and sea state. This may effect the physical and biological feature of (1) terrestrial areas and adjacent shallow, sheltered, aquatic areas with characteristics preferred by Hawaiian monk seals for pupping and nursing; and (2) marine areas from 0 to 200 meters (0 to 656.2 feet) in depth that support adequate prey quality and quantity for juvenile and adult Hawaiian monk seal foraging.

Prey species of Hawaiian monk seals, including some fish, may to be susceptible to physical disturbance and strike from vessels. We anticipate that prey species (e.g., inshore, benthic, and offshore teleosts, cephalopods, and crustaceans) of Hawaiian monk seals will be able to detect vessels and avoid them. Fish are able to use a combination of sensory cues to detect approaching vessels, such as sight, hearing, and their lateral line (for nearby changes in water motion). These prey species are not generally considered vulnerable to vessel strike as they are considered faster moving and do not occur regularly at the water’s surface. For these reasons, it is extremely unlikely that a research vessel will strike prey of Hawaiian monk seals.

Vessel presence may also cause a slight change in distribution of prey due to behavioral or physical disturbance. Prey species may exhibit a temporary behavioral response to oncoming vessels and regardless of the response, there is the potential for some type of stress or energetic cost as an individual fish must stop its current activity and divert its physiological and cognitive attention to responding to the vessel (Heffman et al. 2009). Behavioral avoidance and associated stress responses from detection of research vessels is not expected to result in impacts to the quantity, quality, or availability of prey species of Hawaiian monk seals. These effects will be highly localized, occurring only within close proximity to the transiting research vessel, and temporary, with habitat conditions quickly returning to pre-exposure values once the research vessel leaves the area. Given the localized and short-term nature of operation of research vessels in marine areas of critical habitat, it is expected to have an insignificant effect on the physical and biological features of designated critical habitat.

Transiting vessels also produce a variety of underwater sounds characterized as low-frequency, continuous, or tonal, with sound pressure levels at a source varying according to speed, burden, capacity, and length (Richardson et al. 1995b; Kipple and Gabriele 2007; Mckenna et al. 2012). The exact level of noise produced varies by vessel type. While such vessel noise will not physically obstruct water passage or affect water properties, depth, sea state, or oceanographic, benthic and algal features, it may affect prey in designated critical habitats. Prey in designated critical habitat of Hawaiian monk seals are likely to be exposed to and detect sounds emitted from research vessels. All fish species can detect vessel noise due to its low-frequency content and their hearing capabilities. Similarly, available information indicates that aquatic invertebrates, such as squid, which are prey for Hawaiian monk seals, are primarily sensitive to low-frequency sounds. Most cephalopods (e.g., octopus and squid) likely sense low-frequency sound below one kilohertz, with best sensitivities at lower frequencies (Packard et al. 1990; Budelmann 1992; Mooney et al. 2010). The vast majority of fishes do not show strong responses to low frequency sound. Because of the characteristics of vessel noise, sound produced by research vessels is unlikely to result in direct injury, hearing impairment, or other trauma to fishes or squid. Behavioral and/or physiological responses can occur. However, impacts from vessel noise will be intermittent, temporary, and localized, and such responses will not be expected to compromise the general health or condition of individuals. The only impacts expected from exposure to vessel noise for fishes and squid may include temporary auditory masking, short-term physiological stress, or minor changes in behavior. These effects will be highly localized and temporary. For these reasons, exposure to vessel noise is not expected to result in detectable impacts to the quantity, quality, or availability of prey to Hawaiian monk seals.

We do not expect invertebrates to respond strongly to vessel sound (Bennet et al. 1994; Albert 2011). A study on the effects of vessel noise on sea hare (*Stylocheilus striatus*) found that chronic exposure to vessel noise may affect some invertebrate's development and lead to increased mortality (Nedelec et al. 2014). However, the experimental conditions of the study are drastically different than the brief exposure to vessel noise that will result from research vessel operations in the action area. Another recent study examining the effects of broadband sounds, including recorded continuous vessel noise, on three representative benthic invertebrates (the clam, *Ruditapes philippinarum*; the decapod, *Nephrops norvegicus*; and, the brittlestar, *Amphiura filiformis*) indicated that continued exposure to broadband sounds may affect benthic invertebrate behavior in ways that alter nutrient cycling (Solan et al. 2016). However, this study found no significant effects on invertebrate tissue biochemistry, and behavioral responses including avoidance behavior, were mixed (Solan et al. 2016). Importantly, this study examined time integrated effects, which differ from those that would result from the brief exposure to noise from a single, transiting vessel. While avoidance behavior in prey may lead to a change in distribution, any such change would be short-lived and likely not last much beyond when the vessel leaves the area. In addition, while at close ranges both fishes and invertebrates may experience injury from certain sound sources (Popper et al. 2014a; Sole et al. 2016), the injury or even loss of a few individual prey will not have a measurable impact on the overall prey abundance such that it will diminish the conservation value of designated critical habitat for Hawaiian monk seals. Thus, we believe the effects of vessel noise on Hawaiian monk seal designated critical habitat associated with the proposed research and enhancement activities are insignificant.

Discharge and pollution from research vessels may occur. The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, noxious liquid substances, sewage, garbage, and air pollution from vessels within certain distances of the coastline. Unintentional and intentional discharge of pollutants from vessels may affect certain water quality properties, trigger harmful algal blooms, and temporarily affect distributions and behaviors of ESA-listed species and their prey if they are large in size, and duration. This may affect the physical and biological features that specifies terrestrial areas and adjacent shallow, sheltered areas for pupping and nursing; marine areas from 0 to 200 meters (0 to 656.2 feet) in depths for foraging; and significant areas for hauling-out, resting, or molting. The localized extent of any discharges from a few research vessels associated with the proposed action will likely be minor relative to the size of the action area. In addition, any pollutant discharge will be mixed rapidly into the water column and is likely to be indistinguishable from discharges associated with vessel traffic in the action area. Therefore, the effects of discharge and pollution from research vessels on designated critical habitat are considered to be insignificant.

Anchors used by research vessels may remain on the seafloor for an unspecified period of time and effect physical and biological features (1) shallow, sheltered aquatic areas with characteristics preferred by Hawaiian monk seals for pupping and nursing; and (2) marine areas from 0 to 200 meters (0 to 656.2 feet) in depth that supports adequate prey quality and quantity for juvenile and adult Hawaiian monk seal foraging. The area of Hawaiian monk seal habitat exposed to physical disturbance from anchors will be very small. Most of the kinetic energy from an anchor dissipates within the first few meters or feet of the object entering the water, causing it to slow considerably by the time it reaches the seafloor. The anchors are not anticipated to physically disturb or strike prey items of Hawaiian monk seals. Researchers will not anchor research vessels on coral. Therefore, the effects of anchorage of research vessels on Hawaiian monk seal critical habitat are considered insignificant.

The presence of cables and remotely operated vehicles during vessel surveys may effect the adequate space for movement and use within habitat characterized as sane terraces, talus slopes, submerged reefs and banks, nearby seamounts, barrier reefs, slopes of reefs and islands, and shallow, sheltered aquatic areas (e.g., reefs, tide pools, gently sloping beaches, and shelves or coves that provide refuge from storm surges and predators) preferred by animals for pupping and nursing as well as marine areas from 0 to 200 meters (0 to 656.2 feet) in depth that support foraging. While Hawaiian monk seals may temporarily avoid a small area during research and enhancement activities in designated critical habitat, the avoidance will be short in duration (i.e., lasting a few hours) and localized. During the short time periods that research and enhancement activities are conducted, any animals in the vicinity of these activities will be able to slightly alter course and access preferred habitats a short distance away. Further, while a transiting animal may need to slightly alter course (i.e., by a few meters or feet) to avoid research and enhancement activities, the presence of these researchers does not prevent animals from accessing preferred habitat areas. It is highly unlikely the presence of cables and remotely operated vehicles conducted during vessel surveys will prohibit access to shallow, sheltered aquatic areas for pupping and nursing and marine areas for foraging due to the short length of the cable and the ability of researchers to visually observe the area closely to prevent any such incidents. Therefore, the effects of from the presence of cables and remotely operated vehicles are considered discountable.

Overall, any effects to prey abundance (particularly in marine areas from 0 to 200 meters [0 to 656.2 feet] in depth that support adequate prey quality and quantity for juvenile and adult Hawaiian monk seal foraging) will be temporary following research and enhancement activities, and unaffected animals in close proximity will likely move into the area that was disturbed to utilize the unoccupied habitat. If reductions in prey items (e.g., inshore, benthic, and offshore teleosts, cephalopods, and crustaceans) do occur, they will be highly localized and temporary. Also, relative to the vast area that has been designated critical habitat, the area that may be affected by research and enhancement activities is very small and we anticipate a correspondingly small percentage of prey items could be affected.

Terrestrial areas of Hawaiian monk seal designated critical habitat occur within the action area, and as such may be affected by the NMFS PIFSC's research and enhancement activities under Permit No. 22677. The designated critical habitat includes terrestrial areas (e.g., sandy, protected beaches and low-lying vegetation) and significant areas (i.e., natural coastlines that are accessible to Hawaiian monk seals and are frequented by Hawaiian monk seals at least ten percent as often as the highest haul out site[s] on individual islands, or islets) used by Hawaiian monk seals for hauling-out, resting, or molting. These haul-out sites are generally characterized by sandy beaches, sand spits, or low shelving reef rocks. Potential stressors on terrestrial areas of designated critical habitat for Hawaiian monk seals include wash from aerial surveys, anchorage and landings from vessel surveys (e.g., small and large research vessels as well as kayaks) on beaches, in-air acoustic and visual deterrents, and hazing animals by throwing objects for behavioral modification.

During NMFS PIFSC research and enhancement activities, researchers and vehicles will transit through terrestrial areas and nearshore waters during various research and enhancement activities. Characteristics of terrestrial habitat include various substrates such as sand, shallow tide, pools, coral rubble, or rocky substrates. Researchers, research vessels, vehicles, and equipment may displace these various substrates by wash from aircraft, wash and hulls from research vessels, footprints, tracks, indentations, digging holes, and throwing objects (e.g., rocks, coral sticks, debris). Capture and restraint activities will involve the construction, and later removal, of shore-side pens. The shore-side pens are temporary structures made of chain-link fence held up by metal posts and sand floor for holding animals and will be removed after capture and restraint activities are completed. If available, shade cloth and/or canopies may be used as well in addition to the shore-side pens. Shore-side pens can be erected any time of the year. These temporary structures will be dismantled immediately after use, which typically will not exceed two weeks for holding animals. Temporary shore-side pens will be located in an area with cross ventilation, away from waves or high tide, and relatively close to the field camp. The ideal location is high on the berm, but not in the vegetation (these locations may not be available on all islands). Field camps established for research and enhancement activities are transient (deployed annually for up to five months in duration) and all disposable material will be removed from the island upon completion of the field season. Latrines will be dug to a depth of at least 3 meters (10 feet), and are filled in at the end of each field season. The physical transit by researchers, research vessels, vehicles, and presence of equipment (e.g., cables and microphones for vocalization studies) may result in brief obstruction of and slight displacement of various substrates in terrestrial areas and nearshore waters. Because of the temporary characteristics of in-air acoustic deterrents, the sound source is not expected to degrade the value of terrestrial areas and nearshore water habitat for behavioral patterns of Hawaiian monk seals that include hauling-out, resting, or molting. Therefore, the effects from the temporary presence of researchers, vehicles, and structures are considered insignificant.

Researchers will implement monitoring and mitigation measures that will reduce potential effects and are further described below. During aerial surveys, researchers will maintain a minimum altitude of 91.4 meters (200 feet) for fixed-wing aircraft and 76.2 meters (250 feet) for helicopters. Unmanned aircraft systems (e.g., APH-22 hexacopter) will maintain a minimum altitude of 7.5 meters (24.6 feet). Researchers will increase altitude of manned and unmanned aircraft if an animal reacts to its presence in order to reduce the potential for disturbance. During vessel surveys, researchers will maintain a minimum approach distance of approximately 10 meters (32.8 feet) to haulouts in the Main Hawaiian Islands. Research vessels will avoid landing on beach areas where animals are in the immediate vicinity. Anchorage areas for research vessels will be selected in consultation with Papahānaumokuākea Marine National Monument co-trustees. Therefore, the effects from the aerial surveys are considered insignificant.

The research and enhancement activities are not expected to have any permanent alterations to or effects on the characteristics of terrestrial areas and nearshore waters. Disturbance to terrestrial and significant areas on beaches and in nearshore waters will be transient as researchers will be careful not to adversely affect critical habitat. Therefore, the effects of wash from aerial surveys, anchorage and landings from vessel surveys (e.g., small and large research vessels as well as kayaks), in-air acoustic and visual deterrents, and hazing animals by throwing objects are considered insignificant. Given the localized and short-term nature of research and enhancement activities on terrestrial areas of critical habitat, they are expected to have an insignificant effect on the physical and biological features of Hawaiian monk seal designated critical habitat.

In summary, we conclude that the effects from vessel traffic (physical disturbance and strike), vessel noise, discharge and pollution, anchorage and landings from vessel surveys, presence and transit of researchers, vehicles and equipment, wash from aerial surveys, anchorage and landings from vessel surveys, in-air acoustic and visual deterrents, and hazing animals by throwing objects from the NMFS PIFSC's proposed research and enhancement activities under Permit No. 22677 may affect, but are not likely to adversely affect critical habitat that has been designated for the Hawaiian monk seal.

6.2 Species Likely to be Adversely Affected

This section identifies and examines the ESA-listed species that occur within the action area (see Figure 1) that are likely to be adversely affected by NMFS Permits and Conservation Division's issuance of scientific research and enhancement permit for Permit No. 22677. The only species that is likely to be adversely affected by the proposed action is the Hawaiian monk seal. The regulatory status and recovery plan references for this species is presented in Table 4. The determinations for the effects of stressors that are not likely to adversely affect Hawaiian monk seals during the proposed research and enhancement activities are discussed below. Other stressors that are likely to adversely affect Hawaiian monk seals during the proposed activities are discussed in more detail in Section 8.

Pollution

As discussed in Section 3.1.2, during vessel surveys, NOAA research vessels conform to the requirements of 33 C.F.R. §151, the Federal Water Pollution Control Act, International Maritime Organization ballast water guidelines, and MOC Environmental Guideline ENV 09. Furthermore, to our knowledge, no leakages have occurred during Hawaiian monk seal research and enhancement activities. An oil or fuel leak could pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately to the furthest extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the research vessels is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the research vessel), If a discharge occurs, the amount of leakage will be small, and would be expected to disperse quickly in the water and not affect ESA-listed species directly. Therefore, the effects on Hawaiian monk seals associated with pollution during the proposed research and enhancement activities are anticipated to be discountable.

Aerial Surveys

Aerial surveys under the proposed permit will be conducted with fixed-wing aircraft, helicopters, and unmanned aerial systems. An aircraft flying over Hawaiian monk seals in the water or hauled out on land can cause disturbance and result in ESA behavioral harassment. The effects from this disturbance may range from no response to initiating a flight response into the water. However, past observation demonstrates that Hawaiian monk seals rarely respond or appear to notice aircraft, perhaps due to the lack of aerial predators in their evolutionary history (NMFS 2019).

The amount of disturbance to Hawaiian monk seals by unmanned aerial systems is expected to vary depending on the type of aircraft. Disturbance by the unmanned aerial system (the APH-22 hexacopter) proposed for use under Permit. 22677 was assessed in field trials in 2015 and 2018. The data have not been fully analyzed but preliminary results suggest that significant disturbance resulting in MMPA take (defined as moving greater than two body lengths or flushing to the water) was a rare response among 259 observations. During the field trials, five seals were flown over at an altitude ranging from four to eight meters, and one of these (20 percent) changed position. At an altitude of nine to 14 meters (29.5 to 45.9 feet), less than ten percent changed position (N=86). At 25 to 33 meters (82 to 108.3 feet) approximately two percent changed position (N=83), and at 40 to 50 meters (131.2 to 164 feet) none changed position (N=84). Out of 259 observations only one seal moved to the water (after a 30-meter [98.4 feet] altitude overflight) (NMFS 2019). Based upon observations during aerial surveys, seals very rarely react to aircraft and when they do, typically just raise their heads momentarily. Observations of seal responses to non-survey manned aircraft in the Main Hawaiian Islands are consistent with this conclusion in that they are typically not bothered by even large, low-flying aircraft (NMFS 2019). Therefore, we believe the effects of aerial surveys on Hawaiian monk seals will be insignificant.

Vessel Surveys

As discussed earlier, boat surveys from manned vessels and remotely controlled aquatic vehicles are proposed to occur in areas where biologists cannot access land or where sand spits occur that are too small to access without likely disturbing seals. Vessel surveys near Hawaiian monk seal haulouts can cause disturbance and result in ESA behavioral harassment to monk seals. However, monk seal responses to vessel surveys are expected to be minor and similar to aerial surveys. For example, observational data has shown that Hawaiian monk seals showed no adverse reactions to bucket dredgers around Tern Island, Hawaii (Gilmartin 2003 as cited in Todd et al. 2014). In addition, although annual vessel activity from barges on the Kalaupapa Peninsula (located on the Main Hawaiian Islands) occurs, this area has still developed into a preferred pupping location for Hawaiian monk seals (National Park Service 2010). The vessels proposed for use during the research activities are expected to cause the same or similar responses to those observed previously. Further, there are no reports of PIFCS vessels striking Hawaiian monk seals during past Hawaiian monk seal research and enhancement activities (Young 2019).

Any form of entanglement risk through the use of remotely operated boats will be averted due to the short length of the communication cable and the ability for the research to visually identify (from the vehicle's camera and through the naked eye) if a Hawaiian monk seal were at risk of being entangled in the boat's cable. As a result, monk seal responses to vessel activity during the NMFS PIFSC research activities are expected to be minor. Therefore, we believe the effects of vessel surveys on Hawaiian monk seals will be discountable.

Non-Invasive Terrestrial Research Activities

Disturbance of Hawaiian monk seals from non-invasive terrestrial research activities are caused by close approaches from land surveys, photography, videography, passive acoustic monitoring, and opportunistic sampling (i.e. scat, spew, carcass salvage for necropsies). Individual animals may be affected by the presence of observers on the beach during these activities if they are alerted by the researcher and flee into the water. Most Hawaiian monk seals, even upon seeing the observer, do not flee, but rather alert, raise their head, or perhaps vocalize (Walters et al. 2014). Also during these activities, all field staff are trained to be unobtrusive and to remain low to the ground whenever seals may alert to human presence. Seals are specifically given a wide berth when they are especially susceptible to disturbance, such as lactating females or molting individuals. Furthermore, during camera system installments and maintenance, at least one monk seal biologist will accompany technicians to monitor seal response to the installation at all times. Researchers will minimize disturbance to seals by skirting the edge of the beach during the installation procedure. During opportunistic sampling and passive acoustic monitoring, researchers will try to stay out of site from seals by collecting samples while seals are not in the immediate vicinity or using vegetation or other coverage to avoid detection while recording vocalizations. Moreover, during passive acoustic monitoring, researchers will closely observe all microphone cables to ensure no entanglement risk for ESA-listed species.

The most common scenario for disturbance of Hawaiian monk seals during non-invasive terrestrial research activities involves the presence of researchers on Northwestern Hawaiian Island beaches where seals are resting. The seals tend to be distributed around the islands in singles or small clusters usually fewer than a dozen in number. It is thought that Hawaiian monk seals are typically not wary of human presence because they are rarely captured following a brief tagging event soon after they wean as pups. It is believed that past circumstances, especially those involving prolonged, frequent and intense harassment and disturbance associated with military and U.S. Coast Guard activities on Northwestern Hawaiian Island beaches, caused Hawaiian monk seals to avoid certain important beach habitats (Ragen 1999). Nevertheless, in response to researcher presence, seals often simply return to sleep, or watch the researcher until they are no longer visible. Sometimes, the seals do get agitated and move a few body lengths down the beach before settling (Walters et al. 2014).

As a result of the information stated above, Hawaiian monk seal responses to non-invasive terrestrial research activities during the NMFS PIFSC's proposed action are expected to be minor. Therefore, we believe the effects of non-invasive terrestrial research activities (excluding passive acoustic monitoring) on Hawaiian monk seals will be insignificant. In addition, we believe entanglement stressors resulting from passive acoustic monitoring, during non-invasive terrestrial research activities, on Hawaiian monk seals will be discountable.

Overall Responses to Population Monitoring Activities

Between 2014 and 2018, there were 120,601 sightings of Hawaiian monk seals that occurred during observational activity permitted under the NMFS PIFSC's previous Hawaiian monk seal research permit (NMFS 2019). Of these, 1.912 percent resulted in disturbances where seals moved a distance greater than two body lengths or fled into the water. Only 0.65 percent resulted in movements greater than two body lengths and 1.262 percent resulted in Hawaiian monk seals fleeing into the water. In addition, between 2014 and 2016, 2.7 percent of seals sighted rose their head as a result of observational activities performed by the NMFS PIFSC. However, annual reporting of head raises were discontinued in 2017 so more recent data are not available for this measure. As shown from these data, animals did not respond to the vast majority of sightings. These findings are consistent over longer periods (1997 through 2007), in which the overall rate of response to approaches was 2.95 percent, with less than one percent of animals entering the water (NMFS 2009).

Despite the fact that Hawaiian monk seals do not usually exhibit strong disturbance responses to population monitoring activities, it is not possible to rule out that there may be unobserved negative responses. While there is reason to believe that the level of disturbance associated with observation activities is benign, it is important to consider the potential consequences of behavioral disturbance. Walters et al. (2014) states that these include:

- Amplified corticosteroid levels or other physiological stress responses;
- Seals receiving wounds while fleeing over abrasive substrates (e.g., coral);
- Heightened risk of shark predation to Hawaiian monk seals that enter water when they would otherwise be on the beach;
- Increased risk of pups being exposed to adult male animal aggression if they enter the water in the vicinity of an aggressive male animal; and
- Disturbance of nursing for mother/pup pairs resulting in lower energy and nutrient intake by the pup.

However, in response to monitoring, Hawaiian monk seals have not been observed to exhibit the behavioral characteristics of a strong fight-or-flight response (e.g., massive cortisol release, extreme and persistent escape or attack behavior, cardiomyopathy, frequent death during invasive human interaction) (Reif and Bachand 2004). Abandonment of a beach or island/atoll subsequent to the researchers' actions has not been documented, and individuals are regularly resighted (NMFS 2019). We do not expect death or stress pathology (such as myopathic injury) to result from monitoring activities. In the rare event that Hawaiian monk seals move to the water during monitoring, we expect that individuals will experience a low-level stress response, without any fitness consequence. As a result, responses to population monitoring activities during the NMFS PIFSC's proposed action are expected to be minor. Therefore, we believe the effects of population monitoring activities on Hawaiian monk seals will be insignificant.

6.2.1 Status of Species Likely to be Adversely Affected

This section examines the status of the species that would be adversely affected by the proposed action. The status includes the existing level of risk that the ESA-listed species faces, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02. More detailed information on the status and trends of the ESA-listed species, and its biology and ecology can be found in the listing regulations and critical habitat designations published in the *Federal Register*, status reviews, recovery plans, and on this NMFS website: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, among others.

6.3 Hawaiian Monk Seal

The Hawaiian monk seal is a large phocid ("true seal") that is one of the rarest marine mammals in the world. The Hawaiian monk seal inhabits the Northwestern Hawaiian Islands and Main Hawaiian Islands (Figure 5).

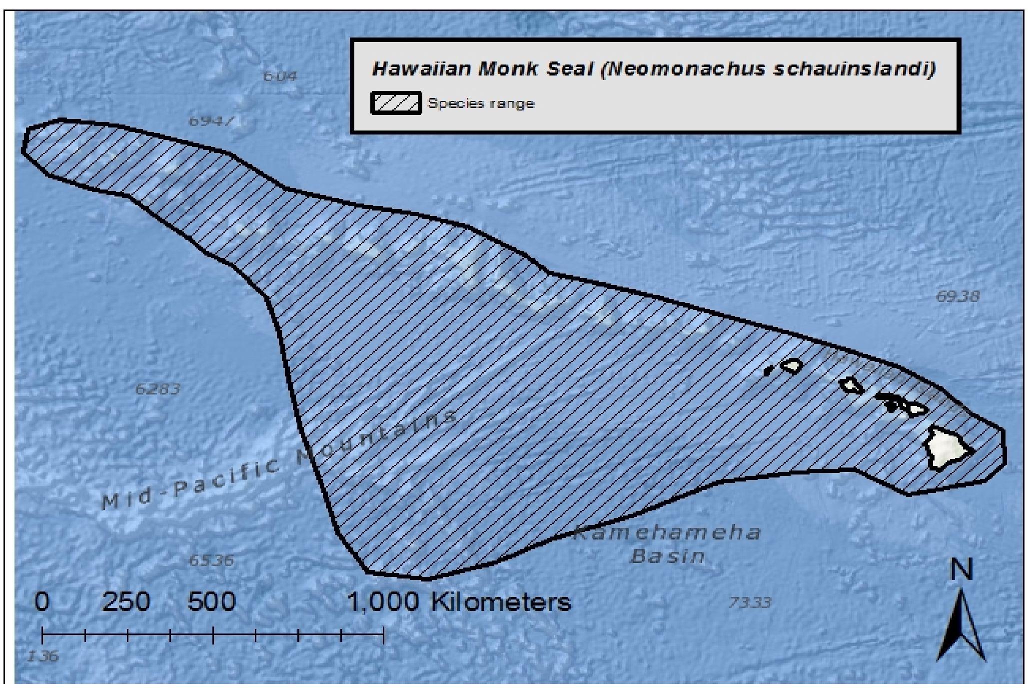


Figure 5. Map identifying the range of the endangered Hawaiian monk seal.

Hawaiian monk seals are silvery-grey with a lighter creamy coloration on their underside (newborns are black); they may also have light patches of red or green tinged coloration from attached algae. The Hawaiian monk seal was originally listed as endangered on November 23, 1976.

Information available from the recovery plan (NMFS 2007c), recent stock assessment report (Carretta et al. 2019), and status review (NMFS 2007b) were used to summarize the life history, population dynamics, and status of the species as follows.

6.3.1 Life History

Hawaiian monk seals can live, on average, 25 to 30 years. Sexual maturity in females is reached around five years of age and is thought to be similar for males, but they do not gain access to females until they are older. Females have a gestation period of ten to eleven months, and calves nurse for approximately one month while the mother fasts and remains on land. After nursing, the mother abandons her pup and returns to sea for eight to ten weeks before returning to beaches to molt. Males compete in a dominance hierarchy to gain access to females (i.e., guarding them on shore). Mating occurs at sea, providing opportunity for female mate choice. Hawaiian monk seals are considered foraging generalists that feed primarily on benthic and demersal prey such as fish, cephalopods, and crustaceans. They forage in sub-photic zones either because these areas host favorable prey items or because these areas are less accessible by competitors (Parrish et al. 2000).

6.3.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Hawaiian monk seal.

The Hawaiian monk seal inhabits the Northwestern Hawaiian Islands and Main Hawaiian Islands. The entire range of the Hawaiian monk seal is located within U.S. waters. In addition to a small but growing population found on the Main Hawaiian Islands, there are six main breeding sub-populations in the Northwestern Hawaiian Islands identified as: Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals. The latest published estimate of the total population of Hawaiian monk seals is 1,415 (95 percent confidence interval 1,348 to 1,525; CV=0.03) (Carretta et al. 2019).

The overall abundance of Hawaiian monk seals has declined by over 68 percent since 1958. However, in recent years, population increases are apparent based on recent range-wide abundance estimates. Current range-wide abundance estimates are available from 2013 through 2016 (see Figure 6 and Table 7). While these estimates remain somewhat negatively-biased for reasons explained in Baker et al. (2016), they provided a much more comprehensive assessment of status and trends than has been previously available. A Monte Carlo approximation of the annual multiplicative rate of realized population growth during 2013-2016 was generated by fitting 10,000 log-linear regressions to randomly selected values from each year's abundance distributions. The median rate (and 95 percent confidence limits) is 1.04 (1.01, 1.08). Thus, the best estimate is that the population grew at an average rate of about 4 percent per year from 2013 through 2016. Only one percent of the distribution was below one, indicating that there is a 99 percent chance that the monk seal population increased during 2013 through 2016.

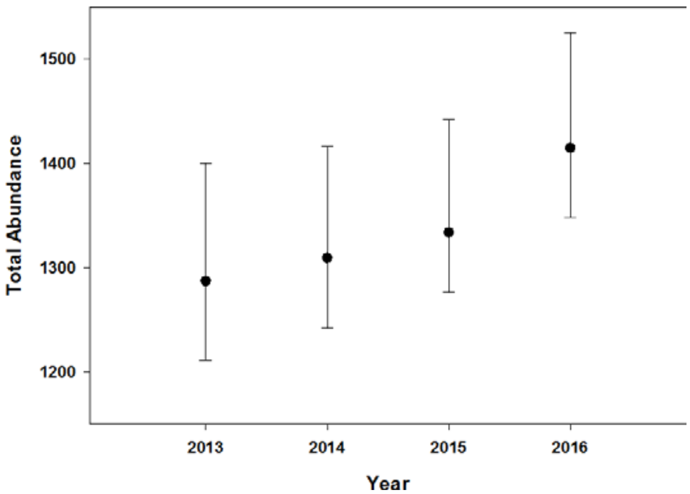


Figure 6. Range-wide abundance of Hawaiian monk seals, 2013 through 2016. Medians and 95 percent confidence limits are shown (Carretta et al. 2019).

Table 6. Total and estimated abundance of Hawaiian monk seals by location in 2014 and 2016.

	2014 Total (Carretta et al. 2017)			2016 Total (Carretta et al. 2019)		
Location	Non-pups	Pups	Total	Non-pups	Pups	Total
French Frigate Shoals	136	38	174	164	35	199
Laysan	188	35	223	208	31	239
Lisianski	129	11	140	142	23	165
Pearl and Hermes Reef	119	16	135	135	29	164
Midway	55	8	63	61	12	73
Kure	62	13	75	78	20	98
Necker	63	5	68	63	7	70
Nihoa	110	9	119	104	7	111
MHI (without Ni'ihau/Lehua)	132	15	147	124	16	140
Ni'ihau/Lehua	108	20	128	122	21	143
Range-wide	1102	170	1272	1214	201	1415

Genetic analysis indicates the species is a single panmictic population, thus warranting a single stock designation (Schultz et al. 2011). Genetic variation among monk seals is extremely low and may reflect a long-term history at low population levels and more recent human influences (Kretzmann et al. 2001; Schultz et al. 2009). In addition to low genetic variability, studies by Kretzmann et al. (1997) suggest the species is characterized by minimal genetic differentiation among sub-populations and, perhaps some naturally occurring local inbreeding. The potential for genetic drift should have increased when seal numbers were reduced by European harvest in the 19th century, but any tendency for genetic divergence among sub-populations is probably mitigated by the inter-island movements of seals. However, because the population is so small there is concern about long-term maintenance of genetic diversity, making it likely this species will remain endangered for the foreseeable future.

6.3.3 Vocalization and Hearing

The information on the hearing capabilities of endangered Hawaiian monk seals is somewhat limited, but they appear to have their most sensitive hearing at 12 to 28 kiloHertz. Below eight kiloHertz, their hearing is less sensitive than that of other pinnipeds. Their sensitivity to high frequency sound drops off sharply above 30 kiloHertz (Thomas et al. 1990; Richardson et al. 1995a; Richardson et al. 1995c). An underwater audiogram for a Hawaiian monk seal, based on a single animal whose hearing may have been affected by disease or age, was best at 12 to 28 kiloHertz and 60 to 70 kiloHertz (Thomas et al. 1990). The animal showed relatively poor hearing sensitivity, as well as a narrow range of best sensitivity and a relatively low upper frequency limit (Thomas et al. 1990). Schusterman et al. (2000) reviewed available evidence on the potential for pinnipeds to echolocate and indicated that pinnipeds have not developed specialized sound production or reception systems required for echolocation. Instead, it appears pinnipeds have developed alternative sensory systems (e.g., visual, tactile) to effectively forage, navigate, and avoid predators underwater.

6.3.4 Status

Hawaiian monk seals were once harvested for their meat, oil, and skins, leading to extirpation in the main Hawaiian Islands and near-extinction of the species by the 20th century (Hiruki and Ragen 1992; Ragen 1999). The species partially recovered by 1960, when hundreds of seals were counted on northwestern Hawaiian Islands beaches. Since then, the species has declined in abundance. Though the ultimate cause(s) for the decline remain unknown, threats include: food limitations in northwestern Hawaiian Islands, entanglement in marine debris, human interactions, loss of haul-out and pupping beaches due to erosion in northwestern Hawaiian Islands, disease outbreaks, shark predation, male aggression towards females, and low genetic diversity. With only 1,300 to 1,400 individuals remaining, the species' resilience to further perturbation is low.

6.3.5 Recovery Goals

See the 2007 Final Recovery Plan for the Hawaiian monk seal (NMFS 2007d) for complete downlisting/delisting criteria for each of the four following recovery goals:

1. Improve the survivorship of females, particularly juveniles, in sub-populations of the Northwestern Hawaiian Islands.
2. Maintain the extensive field presence during the breeding season in the Northwestern Hawaiian Islands.
3. Ensure the continued natural growth of the Hawaiian monk sea in the Main Hawaiian Islands by reducing threats including interactions with recreational fisheries, disturbance of mother-pup pairs, disturbance of hauled out seals, and exposure to human domestic animal diseases.
4. Reduce the probability of the introduction of infectious diseases into the Hawaiian monk seal population.

7 ENVIRONMENTAL BASELINE

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02; 84 FR 44976 published August 27, 2019).

A number of human activities have contributed to the status of populations of Hawaiian monk seals in the action area. Some human activities are ongoing and appear to continue to affect pinniped populations in the action areas for this consultation. Some of these activities, most notably hunting, occurred extensively in the past and continue at low levels that no longer appear to significantly affect pinniped populations, although the effects of past reductions in numbers persist today. The following discussion summarizes these impacts, which include climate change, human caused disturbance and mortality, fisheries interaction, aquaculture, sound (vessel sound and commercial shipping, seismic surveys, and marine construction), pollution (marine debris, pesticides and contaminants, and hydrocarbons), predation, disease and parasitism, adult male aggression, military activities, and scientific research activities.

7.1 Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Effects of climate change include sea level rise, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to impact ESA resources. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://www.climate.gov).

In order to evaluate the implications of different climate outcomes and associated impacts throughout the 21st century, many factors have to be considered. The amount of future greenhouse gas emissions is a key variable. Developments in technology, changes in energy generation and land use, global and regional economic circumstances, and population growth must also be considered.

A set of four scenarios were developed by the Intergovernmental Panel on Climate Change (IPCC) to ensure that starting conditions, historical data, and projections are employed consistently across the various branches of climate science. The scenarios are referred to as representative concentration pathways (RCPs), which capture a range of potential greenhouse gas emission pathways and associated atmospheric concentration levels through 2100 (IPCC 2014). The RCP scenarios drive climate model projections for temperature, precipitation, sea level, and other variables: RCP2.6 is a stringent mitigation scenario; RCP2.5 and RCP6.0 are intermediate scenarios; and RCP8.5 is a scenario with no mitigation or reduction in the use of fossil fuels. The IPCC future global climate predictions (2014 and 2018) and national and regional climate predictions included in the Fourth National Climate Assessment for U.S. states and territories (2018) use the RCP scenarios.

The increase of global mean surface temperature change by 2100 is projected to be 0.3 to 1.7 degrees Celsius under RCP2.6, 1.1 to 2.6 degrees Celsius under RCP 4.5, 1.4 to 3.1 degrees Celsius under RCP6.0, and 2.6 to 4.8degrees Celsius under RCP8.5 (IPCC 2014). The Paris Agreement aims to limit the future rise in global average temperature to 2 degrees Celsius, but the observed acceleration in carbon emissions over the last 15 to 20 years, even with a lower trend in 2016, has been consistent with higher future scenarios such as RCP8.5 (Hayhoe et al. 2018).

The globally-averaged combined land and ocean surface temperature data, as calculated by a linear trend, show a warming of approximately 1.0 degrees Celsius from 1901 through 2016 (Hayhoe et al. 2018). The IPCC Special Report on the Impacts of Global Warming (2018) (IPCC 2018) noted that human-induced warming reached temperatures between 0.8 and 1.2 degrees Celsius above pre-industrial levels in 2017, likely increasing between 0.1 and 0.3 degrees Celsius per decade. Warming greater than the global average has already been experienced in many regions and seasons, with most land regions experiencing greater warming than over the ocean (Allen, de Coninck et al. 2018). Global warming has led to more frequent heatwaves in most land regions and an increase in the frequency and duration of marine heatwaves (Allen et al. 2018). Average global warming up to 1.5degrees Celsius as compared to pre-industrial levels is expected to lead to regional changes in extreme temperatures, and increases in the frequency and intensity of precipitation and drought (Allen et al. 2018).

Consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney et al. 2012). Ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2014) and this rise has been linked to climate change. Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, tropical storms, heat waves, and droughts (IPCC 2014).

In the action area, changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish), ultimately affecting primary foraging areas of ESA-listed species including Hawaiian monk seals. Baker et al. (2012) evaluated the relative influence of climate versus direct anthropogenic impacts on historic trends in monk seal populations. Periods of growth and decline in monk seal abundance at four subpopulations in the action area were associated with positive and negative phases, respectively, of the Pacific Decadal Oscillation (PDO). Moreover, PDO regime shifts were followed, after approximately two-year lags, by corresponding changes in monk seal abundance trajectories, especially in the absence confounding human impacts. Due to this, Baker et al. (2012) proposed that the PDO is a proxy for varying productivity in the northern northwest Hawaiian Islands, the effects of which propagate vertically through the food web and are reflected in top predators such as the Hawaiian monk seal. Baker et al. (2012) found that long-term dynamics of monk seal populations may have been driven as much, if not more, by climate–ocean variability as by direct human activity.

In addition to the effects mentioned above, marine species' ranges in the action area are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. They predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses. This is particularly evident for Hawaiian monk seals distributed across the Northwest Hawaiian Islands whose haul out beaches are being lost due to impacts from sea level rise. Due to their low-lying topography, the Northwest Hawaiian Islands are particularly vulnerable to impacts from sea level rise (Baker et al. 2006). For example, from 1985 to 1996, approximately 35 percent of French Frigate Shoals pups were born at Whaleskate, a 6.8 hectacre island. In the late 1990s, the island disappeared due to natural erosion, which led to crowding at Trig Island, exposing pups to increased shark predation and ultimately contributing to a decline in the population (Baker et al. 2006). Baker et al. (2006) explored the potential for future habitat loss by creating topographic models of several Northwest Hawaiian Islands, evaluating the potential effects of sea level rise by 2100 under a range of basic passive flooding scenarios. Projected terrestrial habitat loss varied greatly among the islands examined with 3 to 65 percent habitat loss under a median scenario (48 centimeter rise), and 5 to 75 percent habitat loss under the maximum scenario (88 centimeter rise). In recent years, increases in habitat loss in the Northwest Hawaiian Islands has occurred. For instance, in September and October 2018, two of the main Hawaiian monk seal pupping and haulout islands at French Frigate Shoals, Trig Island and East Island were washed away by wave action with more changes in habitat anticipated to occur (NMFS 2019).

This review provides some examples of impacts to ESA-listed species and their habitats that may occur and for which there is evidence they are already occurring as the result of climate change in the action area. While it is difficult to accurately predict the consequences of climate change to Hawaiian monk seals, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats based on the evidence of climate change impacts already occurring in the action area.

7.2 Human-Caused Disturbance and Mortality

Currently, human activities in the Northwest Hawaiian Islands are limited and human disturbance is relatively rare; however, there has been a history of human disturbance on these islands. After the establishment of a Long Range Navigation (LORAN) station at Kure in 1960, pregnant Hawaiian monk seals abandoned the human-occupied beaches and instead pupped on ephemeral sand islets, possibly contributing to a 70 percent decrease in abundance over 20 years (Johnson et al. 1982). Military activities at Midway may have led to the extirpation of that subpopulation in the 1960s (Kenyon 1972). These activities have since ceased, and human disturbance is no longer a major threat in the Northwest Hawaiian Islands, but human-seal interactions have become an important issue on the Main Hawaiian Islands. From 2010 through 2015, there have been nine reported human-caused mortalities of monk seals (Carretta et al. 2018) with eight occurring on the Main Hawaiian Islands. Seven of these, although unconfirmed, appeared to be intentional based on probable cause of death which included skull fracture, blunt force trauma, and gunshot wound. Accidental causes of death during this time period include one probable boat strike (in 2015) and one research capture and handling-related mortality (in 2015). In July 2014, a dog or pack of dogs on Kauai attacked and injured at least five monk seals, one of which, a nursing pup, died from the wounds sustained (Carretta et al. 2018). While it is unlikely that all carcasses from human-caused monk seal mortalities are discovered and reported, the population within the Main Hawaiian Islands is fairly well monitored.

7.2.1 Fisheries Interaction

In the action area, fishery interactions with monk seals include hookings and entanglements in active gear, consumption of discarded catch, and competition for prey. Entanglement of monk seals in derelict fishing gear, which is believed to originate outside the Hawaiian archipelago, is described in Section 7.3.1. Fishery interactions are a concern in the Maine Hawaiian Islands, especially involving nearshore fisheries managed by the State of Hawaii (Gobush et al. 2016). Over the 30-year period between 1982 and 2012, approximately 11 Hawaiian monk seals have been observed entangled in fishing gear or other marine debris annually, with a total of nine documented deaths over the 31 years (Carretta et al. 2014). In 2014, 14 Hawaiian monk seal hookings were documented, 13 of which were classified as non-serious injuries, although nine of these would have been deemed serious had they not been mitigated (Carretta et al. 2017). One monk seal was found dead as result of a hook perforating its esophagus and lung. There are no fisheries operating in or near the Northwest Hawaiian Islands. In 2016, 11 Hawaiian monk seal hookings were documented and all were classified as nonserious injuries, although six of these would have been deemed serious had they not been mitigated (Henderson 2018b; Mercer 2018). Several incidents involved hooks used to catch ulua (jacks, *Caranx* spp.). Gobush et al. (2017) individually identified 297 monk seals between 1988 and 2014 and recorded that 83 (28 percent) of these had at least one documented embedded hooking or fishing gear (i.e., net) entanglement. Most individuals were aged two years or younger and a quarter of them were hooked or entangled multiple times based on observational data. The proportion of monk seals alive one year after a documented fisheries interaction varied by age class and ranged between 76 percent and 84 percent (Gobush et al. 2017). Survival one year later for monk seals with a documented fisheries interaction versus matched controls (all age classes combined) was not significantly different.

Hawaiian monk seals also interact with nearshore gillnets based on three Hawaiian monk seals confirmed dead in these gillnets in 2006, 2007, and 2010. However, no gillnet-related mortality or injuries have been confirmed since 2010, though two 2016 mortalities are considered suspect net mortalities (Mercer 2018).

No mortality or serious injuries have been attributed to the Main Hawaiian Islands' bottomfish handline fishery gear. Published studies on Hawaiian monk seal prey selection based upon scat/spew analysis and video from Hawaiian monk seal-mounted cameras provide evidence that monk seals fed on families of bottomfish that include commercial species (many prey items recovered from scats and spews were identified only to the level of family) (Goodman-Lowe 1998; Parrish et al. 2000). Quantitative fatty acid signature analysis (QFASA) results support previous studies showing that monk seals consume a wide range of species (Iverson et al. 2011). Deepwater-slope species, including two commercially targeted bottomfishes and other species not caught in the fishery, were estimated to comprise a large portion of the diet for some individuals. Similar species were estimated to be consumed by Hawaiian monk seals regardless of location, age or gender, but the relative importance of each species varied considerably between individual seals. These results highlight the need to better understand potential ecological interactions with the Main Hawaiian Island bottomfish handline fishery.

7.2.2 Aquaculture

Marine aquaculture systems are diverse, ranging from highly controlled land-based systems to open water cages that release wastes directly into the environment. Species produced in the marine environment are also diverse, and include seaweeds, bivalve mollusks, echinoderms, crustaceans, and finfish (Langan 2004). Aquaculture supplies more than 50 percent of all seafood produced for human consumption globally NOAA Marine Aquaculture website https://www.fisheries.noaa.gov/topic/aquaculture). The National Offshore Aquaculture Act of 2005 (S. 1195) promoted offshore aquaculture development within the EEZ and established a permitting process that encourages private investment in aquaculture operations, demonstrations, and research. Marine aquaculture is expected to expand in the U. S. EEZ due to increased demand for domestically grown seafood, coupled with improved technological capacity to farm in the open ocean.

The growth of the aquaculture industry has drawn attention to the potential environmental impacts of offshore aquaculture, including impacts to protected species. Although aquaculture has the potential to relieve pressure on ocean fisheries, it can also threaten marine ecosystems through the introduction of exotic species and pathogens, effluent discharge, the use of wild fish to feed farmed fish, and habitat destruction. Marine aquaculture operations have the potential to displace marine mammals from their foraging habitats or cause other disruptions to their behavior (Markowitz et al. 2004).

Farming the sea is a part of Hawaii's rich oceanic heritage and the state has been at the forefront of aquaculture research and technology (HDOA 2018). The Hawaii Ocean leasing law allows farm operations in state warm, subtropical marine waters, within 3 miles of shore.
Further, Hawaii is the first state to successfully operate commercial open ocean aquaculture cages in the U.S. Aquaculture cages are anchored to the sea floor but can be moved within the water column. Cages are tethered to buoys that contain an equipment room and feeding mechanism and can be large enough to hold hundreds of thousands of fish in a single cage.

In 2011, Hawaii's total aquaculture sales were valued at $40 million, an increase from $10 million in 2010. Algae sales accounted for 63 percent of the value, ornamental category six percent, finfish four percent, shellfish one percent, with the remaining 26 percent from sales of seedstock, broodstock and fingerlings. Furthermore, in 2014 aquaculture sales for Hawaii reached $78.2 million but receded to $75.7 million for 2016 (USDA 2017).

Open-ocean aquaculture encompasses a variety of infrastructure designs; in the U.S., submersible cages are the model used for offshore finfish production (Naylor 2006). One of the negative effects attributed to finfish culture is enrichment of the water column with dissolved nutrients, resulting from the decomposition of uneaten feed, and from metabolic wastes produced by the fish (Langan 2004). Further, the large amount of fixed gear (e.g., nets, cages, lines, buoys) used for open water aquaculture could represent an entanglement risk for Hawaiian monk seals in the action area. Entanglement in nets or lines around fish and mussel farms may cause injury, stress or death to seals. For example, in 2017, a Hawaiian monk seal traveled into a fish farm's net pen where it became entrapped and died (Jones 2017). Since then there are no other confirmed reports of Hawaiian monk seals becoming trapped or entangled in aquaculture gear. However, as the aquaculture industry grows in Hawaii, it is likely that incidents of monk seals interacting with aquaculture pens my increase as monk seals have been observed feeding on discarded fish from other fishery operations (Nitta and Henderson 1993).

7.2.3 Sound

Hawaiian monk seals that occur in the action area, specifically in the Main Hawaiian Islands, are regularly exposed to multiple sources of anthropogenic sounds. Anthropogenic sound is generated by commercial and recreational vessels, aircraft, sonar, ocean research activities, dredging, construction, offshore mineral exploration, military testing and training activities, and other human activities. These activities occur within the action area to varying degrees throughout the year. ESA-listed species have the potential to be impacted by increased levels of both background sound and high intensity, short-term sounds. Sources of anthropogenic noise are becoming both more pervasive and more powerful, increasing both oceanic background sound levels and peak intensity levels (Hildebrand 2004).

Sounds are often considered to fall into one of two general types, impulsive and non-impulsive, which differ in the potential to cause physical effects to animals (see Southall et al. (2007a) for in-depth discussion). Impulsive sound sources produce brief, broadband signals that are atonal transients and occur as isolated events or repeated in some succession. They are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period, and generally have an increased capacity to induce physical injury. Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous. Some can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time). The duration of non-impulsive sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

Anthropogenic sound within the marine environment is recognized as a potential stressor that can harm marine animals and significantly interfere with their normal activities (NRC 2005). The species considered in this opinion may be impacted by anthropogenic sound in various ways. Damage to marine mammal hearing and mass stranding events due to high-intensity sound exposure have been documented (Hildebrand 2004). Anthropogenic sounds may also produce a behavioral response including, but not limited to, changes in habitat to avoid areas of higher sound levels, changes in diving behavior, or (for cetaceans) changes in vocalization (MMC 2007). Many researchers have described behavioral responses of marine mammals to the sounds produced by boats and vessels, as well as other sound sources such as helicopters and fixed-wing aircraft, and dredging and construction. Most observations have been limited to short-term behavioral responses, which include temporary cessation of feeding, resting, or social interactions. Habitat abandonment can lead to more long-term effects, which may have implications at the population level. Interference, or masking, occurs when a sound is a similar frequency and similar to or louder than the sound an animal is trying to hear (Francis 2013).

Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Richardson 1995). Masking can reduce the range of communication, particularly long-range communication, such as that for blue and fin whales. Recent scientific evidence suggests that marine mammals, including blue and fin whales, compensate for masking by changing the frequency, source level, redundancy, or timing of their signals, but the long-term implications of these adjustments are currently unknown (Parks 2003; Mcdonald et al. 2006; Parks 2009).

Despite the potential impacts on individual Hawaiian monk seals, information is not currently available to determine the potential population level effects of cumulative anthropogenic sound sources in the marine environment (MMC 2007). For example, we currently lack empirical data on how sound impacts growth, survival, reproduction, and vital rates, nor do we understand the relative influence of such effects on the population being considered. As a result, the consequences of anthropogenic sound on Hawaiian monk seals remain uncertain.

This section is divided into subsections addressing the potential stressors from the following major of anthropogenic sound sources: vessels and commercial shipping; seismic surveys; military activities; active sonar; and pile driving and construction. A more detailed discussion of the effects on these sound sources on ESA-listed species can be found in the effects analysis in Section 8 below.

7.2.3.1 Vessel Sound and Commercial Shipping

Individual vessels produce unique acoustic signatures, although these signatures may change with vessel speed, vessel load, and activities that may be taking place on the vessel. Sound levels are typically higher for the larger and faster vessels. Peak spectral levels for individual commercial vessels are in the frequency band of ten to 50 Hertz and range from 195 dB re: μPa^2-s at 1 meter for fast-moving (greater than 20 knots) supertankers to 140 dB re: μPa^2-s at 1 meter for smaller vessels (NRC 2003b). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above two kHz, which may interfere with important biological functions of cetaceans (Holt 2008). At frequencies below 300 Hz, ambient sound levels are elevated by 15 to 20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013).

Much of the increase in sound in the ocean environment over the past several decades is due to increased shipping, as vessels become more numerous and of larger tonnage (NRC 2003b; Hildebrand 2009; Mckenna et al. 2012). Shipping constitutes a major source of low-frequency (five to 500 Hz) sound in the ocean (Hildebrand 2004), particularly in the Northern Hemisphere where the majority of vessel traffic occurs. While commercial shipping contributes a large portion of oceanic anthropogenic noise, other sources of maritime traffic can also impact the marine environment. These include recreational boats, whale-watching boats, research vessels, and ships associated with oil and gas activities.

In the action area approximately 89 percent of all vessel traffic is from civilian ships, eight percent from Navy ships, two percent foreign Navy ships, and one percent from U.S. Coast Guard ships (Mintz 2016). The heaviest vessel traffic within the action area is near the Main Hawaiian Islands (Mintz 2016). The geographic distribution of nonmilitary vessel traffic is shown in Figure **7** below. Marine species such as Hawaiian monk seals that are dependent upon coastal and estuarine nearshore environments around the Main Hawaiian Islands may be particularly susceptible to the cumulative effects of vessels sound.

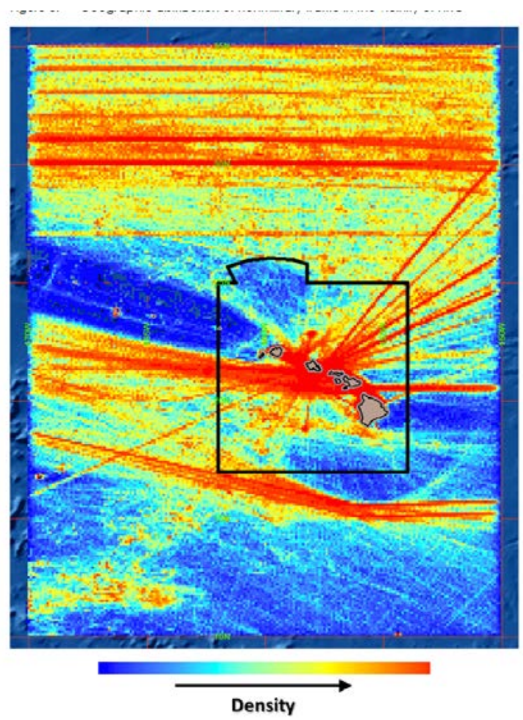


Figure 7**. Geographic distribution of nonmilitary vessel traffic within the action area (Mintz 2016).**

7.2.3.2 Seismic Surveys

Offshore seismic surveys involve the use of high energy sound sources operated in the water column to probe below the seafloor. Seismic surveys have been conducted off the coast of Hawaii in the past. Unlike other regions (e.g., Gulf of Mexico) where the large majority of seismic activity is associated with oil and gas development, seismic surveys conducted off of Hawaii are primarily for scientific research, to identify possible seafloor or shallow-depth geologic hazards, and to locate potential archaeological resources and benthic habitats that should be avoided. For example, in 2018, NSF-funded seismic research surveys were conducted on the research vessel *Marcus G. Langseth* off the Main Hawaiian Islands and over the Emperor Seamounts in the North Pacific Ocean. The research goals of the surveys were to gain a better understanding of the formation and evolution of the Hawaiian-Emperor Seamount chain, and providing valuable information regarding geohazards like tsunamis, submarine landslides, and earthquakes(NMFS 2018a)

There are two major categories of seismic surveys: (1) deep seismic surveys which include ocean bottom, vertical seismic profile or borehole, two-dimensional, three-dimensional, four-dimensional and wide azimuth surveys, and (2) high resolution surveys. Deep seismic survey acoustic sources consist of airgun arrays while receiver arrays consist of hydrophones or geophones encased in plastic tubing called streamers. When an airgun array fires an acoustic energy pulse is emitted and reflected or refracted back from the seafloor. These reflected/refracted acoustic signals create pressure fluctuations, which are detected and recorded by the streamers. Seismic airguns generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of ten to 20 seconds for extended periods (i.e., hours, days, weeks, months) (NRC 2003a). Most of the energy from airguns is directed vertically downward, but significant sound emission also extends horizontally. Peak SPLs from airguns usually reach 235 to 240 decibels at dominant frequencies of five to 300 Hertz (NRC 2003a). High-resolution surveys collect data on surface and near-surface geology used to identify archaeological sites, potential shallow geologic and manmade hazards for engineering, and site planning for bottom-founded structures. High-resolution seismic surveys may use airguns but also use other sound sources such as sub-bottom profilers (at 2.5 to 7 kHz), echosounders (single-beam at 12 to 240 kiloHertz; multibeam at 50 to 400 kiloHertz), boomers (at 300 to 3,000 Hertz), sparkers (at 50 to 4,000 Hertz), compressed high intensity radar pulse sub-bottom profiler (at 4 to 24 kiloHertz), pingers (at 2 kiloHertz), and side-scan sonars (16 to 1,500 kiloHertz). These sound sources are typically powered either mechanically or electromagnetically.

Exposure of Hawaiian monk seals to very strong impulsive sound sources from airgun arrays can result in auditory damage, such as changes to sensory hairs in the inner ear, which may temporarily or permanently impair hearing by decreasing the range of sound an animal can detect within its normal hearing ranges (reviewed in Finneran 2015). A TTS results in a temporary change to hearing sensitivity, and the impairment can last minutes to days, but full recovery of hearing sensitivity is expected. At higher received levels, particularly in frequency ranges where animals are more sensitive, a PTS can occur, meaning lost auditory sensitivity is unrecoverable. Either of these conditions can result from exposure to a single pulse or from the accumulation of multiple pulses, in which case each pulse need not be as loud as a single pulse to have the same accumulated effect. No instances of TTS or PTS of Hawaiian monk seals have occurred during recent seismic surveys near within and near the action area(RPS 2018).

Hawaiian monk seals are expected to exhibit a wide range of behavioral responses as a consequence of being exposed to seismic airgun sound fields. These responses are expected to be temporary with behavior returning to a baseline state shortly after the seismic source becomes inactive or leaves the area. Individual seals exposed to sound fields generated by seismic airguns could also exhibit responses not readily observable, such as stress, that may have adverse effects. Other possible responses to impulsive sound sources like seismic airguns include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007b; Zimmer and Tyack 2007; Tal et al. 2015), but similar to stress, these effects are not readily observable.

NMFS issues permits for seismic activity conducted near Hawaiian monk seals. MMPA and ESA permits specify the conditions under which researchers can operate seismic sound sources, such as airguns, including mitigation measures to minimize adverse effects to protected species. One such mitigation measure is the suspension of seismic survey activities whenever marine mammals are observed within the designated exclusion zone, which differs by species and sound source, as specified in the permit. At this moment there are no current or proposed research permits for seismic surveys in the action area. Also, it is important to note that these permits differ from the permits for directed take of Hawaiian monk seals such as those discussed in Section 7.2.5 below.

7.2.3.3 Marine Construction

Industrial activities and construction both in the ocean and along the shoreline can contribute to underwater noise. Pile-driving is commonly used for the construction of foundations for a large number of structures including bridges, buildings, retaining walls, harbor facilities, offshore wind turbines, and offshore structures for the oil and gas industry. Pile-driving during construction activities is of particular concern because it generates noise with a very high source level. During pile installation, noise is produced when the energy from construction equipment is transferred to the pile and released as pressure waves into the surrounding water and sediments. The impulsive sounds generated by impact pile driving are characterized by a relatively rapid rise time to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Illingworth and Rodkin 2001; Illingworth and Rodkin 2007; Reyff 2012). The amount of noise produced by pile driving depends on a variety of factors, including the type and size of the impact hammer, size of the pile, the properties of the sea floor, and the depth of the water. The predominant energy in pile impact impulses is at frequencies below approximately 2,000 Hertz, with most occurring below 1,000 Hertz (Laughlin 2006; Reyff 2008; Reyff 2012). Pressure levels from 190 to 220 dB re: 1 μPa were reported for piles of different sizes in a number of studies (NMFS 2006). Impact pile-driving occurs over small spatial and temporal scales and produces high-intensity, low-frequency, impulsive sounds with high peak pressures that can be detected by marine mammals. Injury to marine mammals is caused by pressure wave damage to hair cells, ear canals, or ear drums as these structures compress and expand with passage of the wave. Vibratory pile-driving produces a continuous sound with peak pressures lower than those observed in impulses generated by impact pile-driving (Popper et al. 2014b).

7.2.4 Military Activities

The U.S. Navy conducts training, testing, and other military readiness activities on range complexes throughout coastal and offshore areas in the U.S. and on the high seas. The U.S. Navy's Hawaii-Southern California Training and Testing range complex and

Surveillance Towed Array Sensor System (SURTASS) Low-Frequency Active (LFA) Sonar project area overlap with the action area for Permit No. 22677. During training, existing and established weapon systems, tactics, and sonar systems are used in realistic situations to support military readiness. Range complex activities include: routine gunnery, missile, surface fire support, amphibious assault and landing, bombing, sinking, torpedo, tracking, and mine exercises. Testing activities are conducted for different purposes and include at-sea research, development, evaluation, and experimentation. The U.S. Navy performs testing activities to ensure that its military forces have the latest technologies and techniques available to them. The majority of the training and testing activities the U.S. Navy conducts in the action area are similar, if not identical to activities that have been occurring in the same location for decades.

The U.S. Navy's activities produce sound and visual disturbance to marine mammals, including Hawaiian monk seals throughout the action area. Anticipated impacts from harassment due to the U.S. Navy's activities include changes from foraging, resting, milling, and other behavioral states that require low energy expenditures to traveling, avoidance, and some behavioral states that require higher energy expenditures. Based on the currently available scientific information, behavioral responses that result from stressors associated with these training and testing activities are generally temporary and have not been expected to affect the reproduction, survival, or recovery of ESA-listed species within the action area. Sound produced during U.S. Navy activities is also expected to result in instances of hearing impairment and permanent damage (e.g. TTS and PTS) to marine mammals, including Hawaiian monk seals. The U.S. Navy's activities constitute a federal action and take of ESA-listed marine mammals considered for these activities have previously undergone separate ESA section 7 consultation. Through these consultations with NMFS, the U.S. Navy has implemented monitoring and conservation measures to reduce the potential effects of underwater sound from activities on ESA-listed resources in the Pacific Ocean. Conservation measures include employing visual observers and implementing mitigation zones during activities using active sonar and explosives.

7.2.5 Scientific Research Activities

Several active research permits currently authorize takes of Hawaiian monk seals in the action area. These include ten active permits, comprising of one that would be replaced by the proposed action, allowing take of Hawaiian monk seals from research activities. Four of those permits only permit research on Hawaiian monk seals in captivity (17429 (Sea Life Park); 17967 (Minnesota Zoo); 19590 (University of California Santa Cruz); 21251 (Waikiki Aquarium)). Five of those permits only allow incidental harassment of Hawaiian monk seals incidental to research of other marine mammal species (19225 (Whale Trust); 20605 (Cascadia Research Collective); 21348 (NMFS Northwest Fisheries Science Center); 21482 (HDR, Inc.); 21585 (Oregon State University)). Therefore, most of this research does not overlap in area or timing.

The effects of many individual research and enhancement activities (e.g., a survey, a field trip to capture or approach animals) are short-term, lasting hours to days following the research event.

The responses of Hawaiian monk seals to scientific research activities conducted in the action area are further described in Section 8.2.2. Given the large proposed action area, it is unlikely that the exact location and timing of research under the various permits would overlap in time and space with the permitted research. The chance of repeated disturbance or take in the same day by more than one permit holder is further minimized by standard permit requirements to coordinate fieldwork among permit holders working in the same area.

7.3 Pollution

Several different types of anthropogenic pollution resulting from past, present and ongoing human activities adversely affect Hawaiian monk seals within the action area. For this opinion, we focus on three primary categories of marine pollutants: marine debris, pesticides and contaminants, and hydrocarbons. This section provides a general discussion of the three major pollutant categories above, including the stressor pathways and anticipated effects on Hawaiian monk seals, with an emphasis on geographic areas, habitats or species within the action area that are particularly susceptible to these threats.

7.3.1 Marine Debris

In the action area, Hawaiian monk seals become entangled in fishing and other marine debris at rates higher than reported for other pinniped species in other locations of the world (Henderson 2001). Several hundred cases of marine debris entanglement with monk seals have been documented (nearly all in the Northwest Hawaiian Islands), including nine mortalities (Henderson 2001; Henderson 2018a). The fishing gear polluting the reefs and beaches of the Northwest Hawaiian Islands and entangling monk seals seldom includes types used in Hawaii fisheries. For example, trawl net and monofilament gillnet accounted for approximately 35 percent and 34 percent, respectively, of the debris removed from reefs in the Northwestern Hawaiian Islands by weight, and trawl net alone accounted for 88 percent of the debris by frequency (Donohue et al. 2000), even though trawl fisheries have been prohibited in Hawaii since the 1980s. As a result, it is likely this gear is transported into the action area from distant locations outside of the action area by currents and waves. The NMFS and partner agencies continue to mitigate impacts of marine debris on monk seals and other wildlife. Marine debris is removed from beaches and seals are disentangled during annual population assessment activities at the main reproductive sites. Since 1996, annual debris survey and removal efforts in the Northwestern Hawaiian Island coral reef habitat have been ongoing (Donohue et al. 2000; Donohue et al. 2001; Dameron et al. 2007).

7.3.2 Pesticides and Contaminants

Ylitalo et al. (2008) analyzed blubber and blood samples for organochlorines from 158 Hawaiian monk seals at four of their six primary breeding colonies in the Northwestern Hawaiian Islands. They found that the health and fitness of Hawaiian monk seals from three of the four subpopulations may be at risk from elevated contaminant levels. Lopez et al. (2012) examined concentrations of a large suite of persistent organic pollutants in blubber and serum of juvenile and adult monk seals from the Main Hawaiian Islands. Adult females had the lowest blubber levels of most persistent organic pollutants, whereas adult males had the highest levels. Contaminant levels from the Main Hawaiian Islands were at similar or lower levels than those from remote Northwestern Hawaiian Island populations.

7.3.3 Hydrocarbons

Exposure to hydrocarbons released into the environment via oil spills and other discharges pose risks to Hawaiian monk seals. Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but exposure to large amounts of hydrocarbons and chronic exposure over time pose greater risks (Grant and Ross 2002). Acute exposure of marine mammals to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990). Hawaii has been increasingly reliant on imported crude oil (52 billion barrels/year) for electricity generation and transportation (Gulko et al. 2000). Large tankers use MHI ports that are immediately adjacent to coral reefs, and there was a 200 percent increase in the number of oil spills between 1980 to 1990 (Gulko et al. 2000). While 40 percent of reported spills are small, larger spills have resulted from ship groundings or offloading accidents. In a 1998 case, an oil spill near O’ahu caused reef damage when it washed ashore 75 miles northwest on Kaua’i. Oil spills in the NWHI are almost entirely due to groundings of fishing vessels on the isolated atolls. The October 1998 grounding of a 25 meter fishing vessel at Kure Atoll released over half of its 11,000 gallons of diesel onto the shallow reef environment (Gulko et al. 2000).

7.4 Predation

Sharks are the only known predators of Hawaiian monk seals. Shark injuries and scars from old injuries can be seen on many monk seals, and shark predation has been observed occasionally (Bertilsson-Friedman 2006). Tiger and Galapagos sharks are known to prey upon seals and are abundant in the Northwestern Hawaiian Islands (Dale et al. 2011a; Dale et al. 2011b). At French Frigate Shoals, Galapagos sharks also prey on preweaned pups. Between 1993 and 2010, an estimated 173 Hawaiian monk seal pups were killed by Galapagos sharks at French Frigate Shoals (Lowry et al. 2011). Shark culling from 2000 through 2007 removed 12 sharks, reducing annual pup predation from a high of 21 pups in 1999 to six to 11 pups in subsequent years (Gobush 2010). Given the decline in pup production (from 91 in 1993 to 37 in 2010), current predation rates are unsustainable (Lowry et al. 2011). However, as a result of continued shark culling efforts by the PIFSC, predation rates continue to be decreased.

7.5 Disease and Parasitism

Disease is a concern for Hawaiian monk seals in the action area given the species’ low genetic diversity and presumably depressed capacity for an effective immune response (Schultz et al. 2009; Schultz et al. 2010). As reviewed by Littnan et al. (2006) and Aguirre et al. (2007), infectious diseases that pose a risk to the species, include: chlamydia, toxoplasmosis, leptospirosis, morbillivirus, herpes, and heartworm. In 1978, the death of at least 50 Laysan Hawaiian monk seals was hypothesized to be associated with ciguatoxin poisoning, based on positive bioassay results and elephant seal feeding trials (DeLong and Gilmartin 1979). Ciguatoxin activity has since been detected in the tissues of dead stranded monk seals from the Northwestern Hawaiian Islands; however, ciguatoxin was also detected in 19 percent of healthy seals that were still alive several years later (Bottein et al. 2011). In addition to ciguatoxin, three Hawaiian monk seals, two adults and one pup, recently died of toxoplasmosis in 2018. Toxoplasmosis is an illness that leads to organ dysfunction and failure (NMFS 2018b). As a result of the three deaths, the total number of known Hawaiian monk seal mortalities from toxoplasmosis is 11 since 2001. However, it is estimated that the number of disease-related deaths is probably higher because more seals die each year than are found dead or are examined. Toxoplasmosis infections appear to be predominantly affecting females (eight of 11 seals) which is particularly threating to the species as a whole. Furthermore, toxoplasmosis is now the leading disease-related cause of death for Hawaiian monk seals. Cats play a distinctive and essential role in the life cycle of the parasite behind toxoplasmosis (*Toxoplasma gondii*). They shed the parasite eggs into the environment through their feces close to where Hawaiian monk seals may live. Once deposited in the environment, the parasite eggs can live for months to years and are washed from land to sea, where they can infect Hawaiian monk seals (NMFS 2018b).

7.6 Adult Male Aggression

Multiple-male aggression, or mobbing, was at times the primary cause of adult female mortality at Laysan Island, and single male aggression is episodically a significant cause of pup mortality. As a result, the sex ratio on Laysan Island, Hawaii was strongly skewed towards males in the early 1980s and this, combined with the social structure, asynchronous reproduction, and terrestrial habitat use patterns, resulted in dramatic sex ratio imbalances in particular areas in and around Laysan Island. While male and female ratios approached 1:1 in the northeast, in the southwest near Laysan Island it was 5:1 ranging up to 25:1 (Johanos et al. 2010). To mitigate for this imbalance, in 1998 a total of 40 adult male seals were either translocated (N=32), placed in permanent captivity (N=5), or were euthanized (N=1), and two died during translocation. These individuals were removed from the gene pool; however, the loss of these males has had little effect on the species as a whole, as Hawaiian monk seals are polygynous and exhibit low genetic diversity. As a result of the removals, the number of multiple male aggression-related deaths have declined dramatically (Johanos et al. 2010). Nevertheless, incidents of male aggression have persisted at rates lower than before due to successful male translocation methods. For example, at Kure Atoll in 2011, a high degree of male aggression against pups was observed. A known Kure male aggressor was captured and brought into captivity in early 2012; subsequently no pups were observed injured in 2012 beyond normal scratches weaned pups often exhibit (Walters et al. 2014).

7.7 Impact of the Baseline on Endangered Species Act-Listed Species

Collectively, the stressors described above have had, and likely continue to have, lasting impacts on the ESA-listed Hawaiian monks seals considered in this consultation. Some of these stressors result in mortality or serious injury to individual animals e.g., adult male aggression), whereas others result in more indirect (e.g., fishing that impacts prey availability) or non-lethal (e.g., vessel noise) impacts. Assessing the aggregate impacts of these stressors on Hawaiian monk seals is difficult and, to our knowledge, no such analysis exists.

We consider the best indicator of the aggregate impact of the *Environmental Baseline,* Hawaiian monks seals to be the status and trend of this species. As noted in Section 6.2.1, Hawaiian monk seals are experiencing increases in population throughout their range. This indicates that the *Environmental Baseline* is impacting this species in a fairly uniform way. The overall Hawaiian monk seals population is experiencing increasing population abundances despite the potential negative impacts of the activities described in the *Environmental Baseline*. Therefore, while the activities and associated stressors described in the *Environmental Baseline* may slow their recovery, recovery is not being prevented. For sub-populations experiencing slower rates of recovery (i.e, the Necker island sub-population), it is possible that the suite of conditions described in the *Environmental Baseline* is inhibiting their recovery. However, it is also possible that their populations are at such low levels that even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself. A thorough review of the status and trends of Hawaiian monk seals is discussed in the *Status of Species Likely to be Adversely Affected* section of this opinion.

8 EFFECTS OF THE ACTION

Section 7 regulations define "effects of the action" as all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 C.F.R. §402.02). Section 7 regulations (50 C.F.R. §402.17) elaborate on this definition as follows:

- *Activities that are reasonably certain to occur* - A conclusion of reasonably certain to occur must be based on clear and substantial information, using the best scientific and commercial data available. Factors to consider when evaluating whether activities caused by the proposed action (but not part of the proposed action) or activities reviewed under cumulative effects are reasonably certain to occur include, but are not limited to: (1) Past experiences with activities that have resulted from actions that are similar in scope, nature, and magnitude to the proposed action; (2) Existing plans for the activity; and (3) Any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

- *Consequences caused by the proposed action* - To be considered an effect of a proposed action, a consequence must be caused by the proposed action (i.e., the consequence would not occur but for the proposed action and is reasonably certain to occur). A conclusion of reasonably certain to occur must be based on clear and substantial information, using the best scientific and commercial data available. Considerations for determining that a consequence to the species or critical habitat is not caused by the proposed action include, but are not limited to: (1) The consequence is so remote in time from the action under consultation that it is not reasonably certain to occur; or (2) The consequence is so geographically remote from the immediate area involved in the action that it is not reasonably certain to occur; or (3) The consequence is only reached through a lengthy causal chain that involves so many steps as to make the consequence not reasonably certain to occur.

As discussed in Section 5, we identified the potential stressors created by the issuance of Permit No. 22677. In this section, we describe each of these potential stressors associated with the proposed action, the probability of Hawaiian monk seals being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given the probability of exposures) based on the available evidence. For any responses that will be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment will consider the risk posed to the viability of the population(s) those individuals comprise and to the species those population(s) represent. For this consultation, we are particularly concerned about behavioral and stress-based physiological disruptions and potential unintentional mortality that may result in Hawaiian monk seals that fail to feed, reproduce, or survive because these responses could have population-level consequences.

8.1 Stressors Associated with the Proposed Action

As discussed in Section 5, the stressors associated with the proposed action that may affect ESA-listed species and critical habitat include pollution, aerial surveys, vessel surveys, non-invasive research activities (i.e. close approach from land surveys, photography, videography, and passive acoustic monitoring), capture and restraint, remote chemical capture, sedation/anesthesia, specimen collection/health screening, marking, tagging, external instrument attachment, behavioral modification, translocation, temporary captivity, euthanasia, permanent captivity, disentanglement/dehooking, deworming/administration of drugs, supplemental feeding, vaccination, and administration of oxytocin.

Based on a review of available information, during consultation we determined which of these possible stressors will be likely to occur and which will be discountable or insignificant for the species affected by these activities. These species and stressors were discussed in Section 6. Stressors that are likely to adversely affect ESA-listed species are discussed in the *Exposure and Response Analysis* (Section 8.2 below).

During consultation we determined that capture and restraint, remote chemical capture, sedation/anesthesia, specimen collection/health screening, marking, tagging, external instrument attachment, behavioral modification, translocation, temporary captivity, euthanasia, permanent captivity, disentanglement/dehooking, deworming/administration of drugs, supplemental feeding, vaccination, and administration of oxytocin may adversely affect Hawaiian monk seals These stressors and the likely effects on Hawaiian are discussed below.

8.2 Exposure and Response Analysis

The exposure analysis identifies, as possible, the number, age (or life stage), and gender of the ESA-listed individuals that are likely to be exposed to the stressors and the population(s) of the sub-population(s) those individuals belong. The response analysis evaluates the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure.

8.2.1 Exposure Analysis

In this section, we quantify the likely exposure of ESA-listed species to the activities and associated stressors that may result from the proposed action (Section 3), and when possible quantify the number of exposures of an individual animal. The stressors that are likely to adversely affect Hawaiian monk seals are listed above. Table 1 specifies the number of MMPA takes that the NMFS Permits and Conservation Division proposes to authorize and the maximum amount of MMPA take the NMFS PIFSC will be authorized to perform on Hawaiian monk seals during the proposed research and enhancement activities. The NMFS PIFSC states that annual maximum MMPA take totals are based upon levels of disturbance takes in recent years at each location, adjusted to account for (1) realized or anticipated potential increases in abundance at some locations, (2) changes in the island physiography or vegetation that alter probabilities of disturbance, and (3) changes in NMFS MMPA definitions of pinniped takes by disturbance. Based on this explanation, our own evaluation of these numbers in comparison to the PIFSC's annual reports for past Hawaiian monk seal research and enhancement activities, and the conservative assumption that all MMPA take that the NMFS Permits and Conservation Division authorize *could* occur, we adopt the exposure numbers of ESA-listed species that are reasonably certain to occur as the number of animals specified in Table 1 as likely to be affected by the specific research and enhancement activities. These annual numbers and resulting effects are discussed below:

Tagging and External Instrumentation

For tagging and external instrumentation activities, the greatest number of annual exposures likely to occur is 400 (includes retagging) and 110 animals, respectively. Tagging and instrumentation activities can affect any life stage of male and female seals.

Bleach and Dye Marking

Bleach marking will comprise of a maximum of 1,200 annual exposures of males and female that are likely to occur. The responses of Hawaiian monk seals to bleaching/dyeing activities are discussed in Section 8.2.2.5. Bleach marking activities can affect any life stage of male and female seals.

Health Screening/Specimen Collection

Annually, health screening/specimen collection during the NMFS PIFSC's research and enhancement activities will result in 140 exposures. This includes up to five remote biopsy samples that may be collected from 10 Hawaiian monk seals of any age/sex excluding nursing pups. The responses of Hawaiian monk seals to health screening activities are discussed in Section 8.2.2.4. Health screening/specimen collection activities can affect any life stage of male and female seals.

Deworming

Deworming studies and treatments can be conducted on up to 300 animals annually, but during the study phase (used to establish efficacious deworming methods) the number of seals per year is estimated not to exceed 100. Proposed deworming activities would affect male and female juvenile and pup Hawaiian monk seals up to three years old.

Translocations

The number of translocation may vary as some of these activities are proposed to be conducted as warranted. However, the likely maximum number of translocations is as follows:

- 20 translocations of nursing pups (male and female) to birth or foster mothers.
- 60 translocations to alleviate risk as warranted (male and female of any life stage).
- Two translocations to the Northwestern Hawaiian Islands of any age seal in the Main Hawaiian Islands with unmanageable behavior to alleviate risk to humans and the seals.

In addition to translocations that will occur as warranted, other translocation activities will be confined to maximum exposure limits that cannot be exceeded. For example, during the NMFS PIFSC's proposed translocations activities, a maximum of 20 weaned pups and 30 juvenile/subadults will be translocated as one-way or as part of two-stage translocation for enhancement. Translocations for adult male removals (up to 20) may also occur. More details on Hawaiian monk seal responses to translocation activities are described in Section 8.2.2.9.

Adult Male Removal and Euthanasia

The NMFS PIFSC proposes to euthanize up to 20 Hawaiian monk seals over the course of the five-year permit. This includes up to ten moribund animals (males and females of any life stage) and ten aggressive adult male animals.

Unintentional Lethal Takes

As stated in the *Description of the Proposed Action* (Section 3), there is the potential for unintentional mortality to occur during the NMFS PIFSC's research and enhancement activities. The annual number of unintentional mortalities that may occur during the NMFS PIFSC proposed activities are two seals of any age or sex during research activities, two weaned pups of any sex during enhancement activities, four juveniles/subadults of any sex during enhancement activities, and two adult males during enhancement activities. The maximum number of unintentional mortalities that may occur during all five years of Permit No. 22677 are four seals of any age or sex during research activities, four weaned pups of any sex during enhancement activities, eight juveniles/subadults of any sex during enhancement activities, and four adult males during enhancement activities.

Disentanglement/Dehookings

An unlimited (i.e., as warranted) number of disentanglements and dehookings of Hawaiian monk seals would occur during the proposed NMFS PIFSC research and enhancement activities under Permit No. 22677. Both male and female seals of any life stage may be exposed to these activities. The responses of Hawaiian monk seals to disentanglements and dehookings are discussed in Section 8.2.2.12.

Supplementary Feeding

The NMFS PIFSC proposes to conduct supplemental feeding of up to 12 male and female post-rehabilitated pup and juvenile Hawaiian monk seals in the Northwestern Hawaiian Islands.

Behavioral Modification

The NMFS PIFSC's behavioral modification activities will, at most, result in the hazing of 70 Hawaiian monk seals of any life stage or sex (50 in the wild and 20 in permanent captivity). In addition, aggressive males will be hazed as warranted; however, it is likely that a maximum of ten adult males a year will be exposed to behavioral modification activities.

Vaccinations

A maximum of 1,520 exposures of Hawaiian monk seals (1,500 in the wild and 20 in permanent captivity) may occur during the NMFS PIFSC's proposed vaccination activities. Both male and females of any life stage may be exposed to vaccination activities. More information on the responses of Hawaiian monk seals to vaccination activities are presented in Section 8.2.2.12 below.

Validation Studies

A maximum of 20 male and female Hawaiian monk seals in permanent captivity would be exposed to research to validate or test field methods. Procedures involved with validation studies include administration of anesthesia and injectable sedatives; external instrumentation; marking, tagging, capture and restraint, and health screening.

8.2.2 Response Analysis

The response analysis evaluates the available evidence to determine how individuals of the species are likely to respond given their probable exposure. Given the exposure detailed above, here we describe the range of responses among ESA-listed Hawaiian monk seals that may result from exposure to the stressors associated with the proposed activities that will be authorized under Permit No. 22677 and are likely to adversely affect Hawaiian monk seals. These include stressors associated with the following activities: non-chemical captures (i.e., capture by hand, hoop net, stretcher net, or other net), chemical immobilization captures (darting/injectable immobilization), sedation/anesthesia, handling and biological sampling (i.e., biopsy), external instrument attachment/tagging/marking, translocation, captivity, euthanasia, disentanglement/dehooking, vaccination, administration of oxytocin, and supplemental feeding. Our response analysis considers and weighs evidence of adverse consequences, as well as evidence suggesting the absence of such consequences. In cases where data specific to a Hawaiian monk seals are unavailable, we rely on data from other pinniped species as surrogates.

In general, the proposed activities described in Section 3.1 have the potential to cause some sort of disturbance. Responses by animals to human disturbance are similar to their responses to potential predators (Harrington and Veitch 1992; Lima 1998; Gill et al. 2001; Frid and Dill 2002; Frid 2003; Beale and Monaghan 2004; Romero 2004). These responses manifest themselves as stress responses in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare a "fight or flight" response to more serious physiological changes resulting from chronic exposure to stressors. Stress responses can also lead to interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combination of these responses (Sapolsky et al. 2000; Frid and Dill 2002; Romero 2004; Walker et al. 2005). Further, these responses have been associated with abandonment of sites (Sutherland and Crockford 1993), reduced reproductive success (Giese 1996; Mullner et al. 2004), and the death of individual animals (Feare 1976; Daan 1996; Bearzi 2000).

The mammalian stress response involves the hypothalamic-pituitary-adrenal axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones adrenaline (epinephrine), glucocorticosteroids, and others (Thomson and Geraci 1986; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Gulland et al. 1999; Busch and Hayward 2009). These hormones can subsequently cause short-term weight loss, the liberation of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Thomson and Geraci 1986; Kaufman and Kaufman 1994; Dierauf and Gulland 2001a; Dierauf and Gulland 2001b; Cattet et al. 2003; Elftman et al. 2007; Fonfara et al. 2007; Noda et al. 2007; Mancia et al. 2008; Busch and Hayward 2009; Dickens et al. 2010). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer 2008). In highly stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Herraez et al. 2007; Cowan and Curry 2008). The most widely recognized hormonal indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the hypothalamic-pituitary-adrenal axis may persist for weeks (Dierauf and Gulland 2001b). Mammalian stress levels can vary by age, sex, season, and health status (Peters 1983; Hunt et al. 2006; Keay et al. 2006). In addition, smaller mammals such as pinnipeds tend to react more strongly to stress than larger mammals (Peters 1983; Hunt et al. 2006; Keay et al. 2006).

In sum, the stressors identified as likely to adversely affect Hawaiian monk seals may lead to a variety of stress-related responses. However, for most seals exposed to the research activities (a few seconds to several hours) relative to a Hawaiian monk seal's life history, the relatively short duration of the research and enhancement activities mean animals may exhibit only minor responses to many of the stressors. In addition to possibly causing a stress-related response, each research activity is likely to produce unique responses as detailed further below.

8.2.2.1 Capture and Restraint

Individual seals will experience varying degrees of stress and discomfort when being captured and restrained, depending upon the activity undertaken (NMFS 2019). NMFS PIFSC researchers propose to capture and restrain seals for a variety of research and enhancement activities, including: tagging/measuring, medical treatment, disentanglement/de-hooking, biomedical sampling, de-worming, vaccinations, administration of oxytocin, translocation, and instrumentation. Researchers have captured and restrained seals for decades and have established effective protocols to minimize impacts on seals (See Section 16.3); however, such activities are likely to result in a "fight or flight" response. The severity of such a response ranges from disturbance or alarm to possible injury or mortality. Responses are likely to occur in all seals (male or female, of any age), though the responses of recently weaned pups are likely to be less severe than older seals.

Hawaiian monk seals respond to capture and restraint by vocalizing, biting, or trying to escape. In an effort to escape capture, Hawaiian monk seals could incur bruising, injuries from nets used during the capture events, lacerations, abrasions, hematomas, concussions, fractures, hypothermia, and hyperthermia (excessively high body temperature which could lead to muscle rigidity, brain damage, or death). In addition to this, other risks from capture and restraint activities comprise of increased energy expenditure with the potential for capture myopathy due to prolonged or repeated stress events. Capture myopathy is characterized by degeneration and necrosis of striated and cardiac muscles, which can be fatal and may not develop until many days after capture and handling (Fowler 1986b). Nonetheless, death of Hawaiian monk seals from myopathy after capture events have not been recorded in the past 20 years of NMFS PIFSC research activities (NMFS 2019). Furthermore, after release, most seals enter the water and return to the beach within hours and recently weaned pups often remain on land after capture (NMFS 2014).

While nearly all capture and restraining activities will occur on land, the NMFS PIFSC proposes to also conduct in-water captures of seals if applicable. The capture techniques for in-water capture, as discussed in Section 3, are riskier than on land captures and will only be conducted when a seal's life is in jeopardy (i.e., entangled in marine debris) or for important research contexts (i.e., to retrieve data stored on an attached telemetry device) (NMFS 2019). In addition to the responses listed above from general capture and restraint activities, in-water capture of seals can include injuries from the use of crowding boards or pen panels (i.e. boards and panels used to heard seals in the water), drowning, and a potential for inadvertently exacerbating existing injuries that researchers want to ameliorate during the in-water capture event. Nonetheless, the potential for in-water captures is expected to be rare and to date, no in-water captures beyond depths of one to three feet (near shore) have been attempted by the NMFS PIFSC's HMSRP (NMFS 2019).

Effects of capture and restraint activities on Hawaiian monk seals were analyzed in Baker and Johanos (2002). To determine the effects of the NMFS PIFSC's capture and restraint activities on Hawaiian monk seals, the study compared the survival, migration, and condition of handled seals (N=549) and non-handled "control" seals (N=549) between 1983 and 1998. In their assessment, Baker and Johanos (2002) found that there were no significant differences in survival (i.e., resighting rates of 80 to 100 percent), observed migration, and body condition between handled seals and controls. Similarly, Henderson and Johanos (1988) determined that capture, brief restraint without sedation, and flipper tagging had no effect on subsequent behavior of weaned pups.

Although the above-mentioned data illustrates that the NMFS PIFSC's capture and restraint activities on Hawaiian monk seals are relatively innocuous, there may be rare instances when the action can be fatal. Between 1982 and 1999, five of the 4,800 handled seals (0.1 percent) died as a result of capture and/or restraint during the NMFS PIFSC research and enhancement activities on Hawaiian monk seals (Baker and Johanos 2002). One of these seals died as a result of male aggression after release (therefore, restraint may have been a contributing factor but was not the ultimate cause of death). Two seals died as a result of capture stress, and the cause of death was undetermined for the other two seals. In recent years (1999 through 2019), only three seals have died as a result of capture and/or restraint[5]. An old, adult male died while under restraint and sedation and the subsequent necropsy identified a heart abnormality (NMFS 2014). Another seal exhibited a defense behavior, rearing up its head defensively, upon approach by researchers. In the process, it hit a nearby rock, resulting in a catastrophic head injury. This appears to have been a rare incident because Hawaiian monk seals often perform similar displays in response to other

[5] A fourth seal died after a capture event, however, after necropsy it was determined that the seal was already in a terminal state before capture (NMFS 2019).

Hawaiian monk seals and are commonly found in rocky environments; however, researchers have since modified their protocols to avoid such risks (NMFS 2014). Their protocols now require researchers to evaluate for presence of hazards that could present a risk of injury to the animal or the handlers. The third Hawaiian monk seal death occurred in 2015 off Laysan Island. The Hawaiian monk seal's death was related to respiratory complications during sedation. In response to the death, several actions were taken by the NMFS PIFSC to decrease the chances of similar occurrences in the future. These actions include an increase in emergency response training for researchers and an increase of non-veterinary staff present during sedation events to take biological samples of Hawaiian monk seals. The increase in non-veterinary staff to take biological samples was implemented so that veterinarians can remain focused on the animal's status during sedation to be able to detect subtle shifts in breathing or responsiveness.

As a result of capture and restraint, seals are likely to experience a "fight or flight" response, which does not significantly change body condition or migration behavior. Less than one in a thousand handled Hawaiian monk seals die from related complications. Therefore, capture and restraint is likely to adversely affect Hawaiian monk seals with mortality of approximately one individual of either sex and of any age, annually. We will assess the impact of mortality from capture and restraint in a later section, when we consider the effect of the action on population viability (See Section 8.3).

8.2.2.2 Remote Chemical Capture (Darting/Injectable Immobilization)

When dealing with remote sedation of Hawaiian monk seals, one of the primary concerns is the potential for a darted animal to escape into the water, or if in the water, escape the perimeter set to contain it. A darted animal may not be able to surface unassisted after the drugs take effect. Additionally, because of the shunting of blood that takes place, drugs in the system can have uncharacteristically potent effects, such as faster induction times, which could result in drowning or other water inhalation-related issues (McKenzie et al. 2012). A review the drugs used for remote chemical immobilization are presented in Table 8 below.

Table 7. Brief review of drugs commonly used during remote chemical capture (Appendix E of NMFS 2019; see Section 16.5).

Class	Name	Effect/Uses	Dangers	Additional Information	Species Used
Benzodiazepine: excellent muscle relaxants commonly used in conjunction with cyclohexanes,	Diazepam	muscle relaxant, anticonvulsant, appetite stimulant	Sedation and ataxia, CNS excitement (dogs), hepatic failure or behavior changes (felines), muscle	Can be administered orally, rectally, or intravenously (IV), see Flumazenil or sarmazenil	Antarctic fur seal

commonly have antagonist			fasciculations (horses), possibly teratogenic	for antagonist information	
	Midazolam	Depresses central nervous system (CNS) to produce anxiolytic, sedative, skeletal muscle relaxant, and anticonvulsant effects	Respiratory depression, possibly teratogenic	When used alone has no predictable sedation effect, 3x as potent as diazepam and can be given intramuscularly (IM), IV, intra-carotid injection must be avoided, Flumazenil or sarmazenil given as reversal	South American fur seal, New Zealand fur seal, Antarctic fur seal, Australian fur seal, California sea lion, Stellar sea lion, Grey seal
Alpha-Adrenoreceptor Agonists: strong sedatives that can be completely antagonized, animal can be aroused while under	Xylazine	Produces state of sedation with a shorter period of analgesia, causes CNS depression, skeletal muscle relaxation, in high doses can cause respiratory depression	Can have an emetic effect, possibly may induce premature parturition, auditory stimuli can provoke delayed arousal responses, although analgesic effects are short lived (up to 30 min) complete recovery can take up to four hours), muscle tremors, bradycardia,	Should not be used with epinephrine, can be given IM or IV, respiratory stimulants (doxapram) can aid in alleviating respiratory depression affect, reversal agents include Yohimbine, atipamezole, and tolazoline	Antarctic fur seal, South African fur seal, Subantaric fur seal, Galapagos sea lion

			reduced respiratory rate, increased urination, hypersalivation, ataxia		
	Medetomidine	Used as a sedative for dogs and cats, small mammals, and exotics for procedures not requiring intubation or minor dental procedures	Bradycardia, occasional AV blocks, decreased respiration, urination, vomiting, hyperglycemia, rarely: apnea and death from circulatory failure, hypersensitivity	Should not be used during pregnancy, is not a muscle relaxant but does have large safety margin (at least for dogs), can be antagonized by Yohimbine, tolazoline, idazoxan, atipamezole	California sea lion, Stellar sea lion, Grey seal
	Dexmedetomidine	can be used for preanesthetic and sedation, analgesia	bradycardia, occasional AV blocks, decreased respiration, vomiting	Can be reversed with atipamezole, when given to dogs dosage is based upon surface area and not body weight, be administered either IM or IV, high safety margin, has not been tested with wildlife	Grey seal

Class	**Name**	**Effect/uses**	**Dangers**	**Additional Information**	**Species Used**
Cyclohexane: produce cataleptic state in which eyes remain open, used in conjunction with tranquilizers or sedatives to reduce risk of seizures	Ketamine	Inhibits NMDA-receptors so can be used to alleviate pain along with its anesthetic effects	can result in significant hypertension, hypersalivation, respiratory depression, emesis, erratic and prolonged recovery, dyspnea, spastic jerking movements, seizures, muscle tremors, hypertonicity, opisthotonos and cardiac arrest	Patients eyes will sometimes remain open, administered either IM or IV and has fairly rapid diffusion time, duration positively correlated with dosage amount but not intensity, should not be used alone because of its poor muscle relaxant qualities	South American fur seal, Antarctic fur seal, Galapagos fur seal, South African fur seal, Subantarctic fur seal, Galapagos sea lion,
	Tiletamine/Zolazepam	Used for restraint or anesthesia with muscle relaxation in short procedures, decreases both cardiac and blood pressure	Respiratory depression possible, apnea, tachycardia common, excessive salivation, cardiac arrest, muscle rigidity	Administration can be IM, subcutaneous (SQ) or IV and has very rapid onset, effect on respiration is unknown, long recovery time (up to four hours)	South American fur seal, New Zealand fur seal, Antarctic fur seal, Australian fur seal, Stellar sea lion, Australian sea lion, American sea lion, *New

					Zealand sea lion
Antagonist/ reversal agents: used to antagonize anesthesia and help animal return to normal faster than would otherwise be seen, usually very safe	Tolazoline	Used to reverse xylazine by relaxing smooth muscle	Adverse effects have been primarily studied in horses and found to be tachycardia, peripheral vasodilatation, piloerection, and muscle fasciculations	Very rapid acting with IV administration but may require multiple doses due to short duration	
	Atipamezole	Can be used to antagonize xylazine and medetomidine	Vomiting, diarrhea, hypersalivation, tremors, or excitation	Is very fast acting and capable of reversing drug effects fairly rapidly, very high safety margin	
	Flumazenil	Can be used to reverse benzodiazepine such as diazepam and midazolam	Prolonged exposure or use can lead to seizures, in humans injection site sensitivity. vomiting, vertigo, vasodilatation, ataxia and blurred vision have all been demonstrated	Potentially teratogenic at high dosages	

	Doxapram	CNS stimulant used to stimulate respiration during or after anesthesia as well as to speed up awakening and reflexes after anesthesia	Possibly linked with seizures, hypertension, arrhythmia, respiratory alkalosis	Has a narrow safety margin in humans, and increases myocardial oxygen demand while reducing cerebral blood flow	

In addition to possible drowning, a Hawaiian monk seal that has been darted may not be fully cognizant of its environment and could partially lose orientation and mobility control on land as the drugs start to take effect. This could be particularly problematic if the seal is situated in a setting with hazards that might result in physical injury (rocks, entrapments, cliffs, etc.) or near dangerous surf or currents.

Another danger is associated with the potential for a researcher's dart to miss the planned target zone, penetrating an unintended part of the seal's body (i.e., a vital organ), which could happen if trajectory or power is miscalculated, or if the seal moves during firing. For example, dart injections into the abdominal or chest regions can result in puncture of the stomach or lungs, which may be fatal. The risk of this is greater for smaller or thinner seals. This consideration may make it tempting to err on the side of less power to minimize the risk of organ penetration; however, under-powered injections may result in subcutaneous, or fatty layer, injection where drug absorption is slow and unpredictable (Kreeger and Arnemo 2012).

While the risks outlined above are standard considerations whenever remote sedation is employed, there are other issues that may arise. A summary of these effects are described below:

- Chemical immobilization for sedation or anesthesia requires an accurate assessment of an animal's weight and condition to determine the appropriate dosage. Miscalculation can lead to an overdose that may result in death.
- Dart injection of anesthetic into blubber rather than muscle tissue can lead to aseptic necrosis and large abscesses.
- Darts may hit an animal smaller than the intended target, leading to an inadvertent overdose.
- Animals under sedation can develop hyperthermia or hypothermia due to stress reactions and the effects of some drugs on thermoregulation. Both conditions can influence the physiological response of the animal to drugs or exacerbate existing health problems.

- Immobilizing drugs can result in respiratory depression or apnea (stopped breathing); muscle spasms; increased salivation, which can lead to choking; and complications for animals that already have kidney or liver diseases.

In line with what has already been demonstrated by members of the HMSRP when preforming field capture operations, careful planning and expertise will help to minimize both the amount of unforeseen issues that could arise, as well as the major ones discussed above. However, at a minimum, momentary pain and injury may occur during a procedure. We will assess the impact of remote chemical capture in a later section, when we consider the effect of the action on population viability (See Section 8.3).

8.2.2.3 Sedation/Anesthesia

Effects from sedation and anesthesia on Hawaiian monk seals overlap those of remote capture through chemical immobilization described above. Sedation, if appropriate, is typically accomplished with benzodiazepines (midazolam or diazepam (valium)) as shown in Table 9. In addition, anesthetics such as lidocaine could be administered to relieve the transitory pain experienced by the seal during invasive research activities (i.e., tagging), but this would considerably add to the restraint time, presenting an increase in the same risks described in Section 8.2.2.1.

Animals will be sedated under the direction of an attending veterinarian as necessary to reduce stress when restrained for health screening and instrumentation (with the exception of some flipper-tag mounted instruments). There is a small potential for mortality during restraint and sedation, especially for moribund animals. Risks associated with diazepam and midazolam sedation include:

- Delivering intravenous diazepam could cause pain, stress, and damage to the extradural vein or surrounding tissue. In addition, injectable diazepam has a rapid onset when given intravenously and is metabolized by the liver and excreted by the kidneys;
- Delivering intermuscular midazolam could cause pain, stress, and damage to surrounding tissue;
- Possible side effects include bradycardia (slowed heart rate), asphyxiation, apnea, respiratory depression, tremor, confusion, photophobia, blurred vision, nausea, vomiting, depressed gag reflex, lethargy, and ataxia (inability to coordinate muscle activity during voluntary movement). These effects are largely due to the fact that pinnipeds have a strong dive response that can be triggered by sedation and anesthesia (Walters et al. 2014); and
- Hyperthermia or hypothermia can occur during physical restraint, sedation, anesthesia, and handling outside the normal aquatic environment.

In addition to potential risks from the use of sedatives, the use of local anesthetics such as lidocaine can also present challenges. A surface anesthetic effect, e.g. loss of feeling or sensation, can be achieved by subcutaneous injection of lidocaine. The lidocaine injection hurts for several seconds to a minute following injection into the skin. Lidocaine can produce serious side-effects if injected intravascularly, and, if accidentally swallowed, can cause convulsions. The use of lidocaine with epinephrine is contraindicated as it may cause tachycardia (rapid heart rate). As a surface anesthetic, lidocaine is relatively safe, as evidenced by its availability in a variety of over-the-counter topical preparations for relieving pain and itching in humans (NMFS 2007a).

For infrequent and more invasive stranding response procedures (such as hook removal) requiring a longer duration or a deeper plane of anesthesia than can be achieved with injectable drugs, Hawaiian monk seals may be anesthetized using gas anesthesia. Prolonging immobilization by administering repeated doses of injectable agents is associated with a high risk of mortality, and an additional dose of Telazol should never be given (Gage 1993). Isoflurane, a halogenated ether with potent anesthetic action (NMFS 2007a), is an inhaled general anesthetic that induces reversible depression of the central nervous system, resulting in unconsciousness, analgesia, voluntary muscular relaxation, and suppression of reflex activity (Fowler 1986a). Isoflurane is especially useful for short procedures in which rapid recovery and few aftereffects are desirable. The effects of inhalation anesthetics increase predictably with increased dose, unlike injectable agents, which tend to be unpredictable and idiosyncratic among animals (Fowler 1986a). In general, captive animals have been observed to fully recover from anesthesia with isoflurane after eight hours (Gage 1993). isoflurane gas appears to have the best recovery characteristics, and be safe and reliable (Haulena and Heath 2001).

Although there are several risks associated with the administration of sedatives and anesthetics, NMFS PIFSC veterinarians will closely monitor all sedated and anesthetized Hawaiian monk seals during research activities to monitor for any abnormal signs (NMFS 2019). Also, it is important to note that the HMSRP has sedated Hawaiian monk seals for decades, and these past experiences have informed current protocols and dosages. The application of both diazepam and midazolam is regularly used for Hawaiian monk seal sedation with little to no adverse reactions reported (Walters et al. 2014). Effective sedation is expected to reduce the stress response caused by capture and restraint (Champagne et al. 2012). Additionally, individuals may experience a temporary loss of memory (i.e., forgetting the incident), resulting in the reduction of the severity of the stress response during future captures.

In summary, sedation activities are likely to result in adverse effects to Hawaiian monk seals resulting in ESA take by harassment and harm but these effects are expected to be temporary in nature. We will assess the impact of this take in a later section, when we consider the effect of the action on population viability (See Section 8.3)

Table 8. The drugs proposed for use by the National Marine Fisheries Service's Pacific Islands Fisheries Science Center for sedation, anesthesia, resuscitation, and veterinary medical treatments.

Drug Name	Possible Adverse Effects	Pharmacokinetics
Atropine Sulfate	Generally dose related; mild effects in healthy patients; severe effects with high or toxic doses include gastrointestinal (constipation, vomiting), central nervous system. Benzodiazepines may potentiate adverse effects. Used on numerous occasions in Hawaiian monk seals with no adverse reactions reported, though also marginal effectiveness observed. Used extensively in other pinnipeds during anesthesia with no observed side effects (Haulena and Schmitt 2018).	Well absorbed with peak effects on heart rate within three to four minutes; metabolized in liver and 30 to 50 percent of dose excreted unchanged in urine. Half-life (the time required for the concentration of the drug to reach half of its original value) in humans is two to three hours.
Butorphanol	Adverse effects in dogs/cats include ataxia, anorexia, or diarrhea (rare) and are typically less severe than adverse effects reported in full opiate agonists. May cause central nervous system depression or excitation in dogs. Can increase parasympathetic tone and decrease blood pressure and heart rate; these cardiovascular effects are similar to but lesser than opiate agonists (Plumb 2008). Should be used with caution in animals with compromised renal function, increased Cerebrospinal fluid pressure (head trauma) or other severe debilitation. Used in combination with benzodiazepines as pre-medication prior to general	Fully absorbed with oral administration but undergoes substantial first-pass effect. Fully metabolized in liver. Onset of action is three minutes in horses with peak effect at 15 to 30 minutes and duration of action up to four hours (Plumb 2008).

	anesthesia in two stranded Hawaiian monk seals.	
Ceftiofur crystalline free acid	Usually not serious and low occurrence; mild transient pain and possibility of abscess at injection site; diarrhea; hypersensitivity reactions include rash, fever, or anaphylaxis. Used in Hawaiian monk seals with no adverse effects. No adverse effects reported after use in humpback whales, California sea lions, northern elephant seals, and harbor seals, abscesses have been reported in some species (not specified) after IM injection (Simone C. A. and Stoskopf 2018)	Half-life in cattle is eight to 12 hours with peak levels after 30 to 45 minutes of IM injection. A study at the Marine Mammal Center on ten California sea lions resulted in maximum plasma concentrations at 24 hours post-IM injection; plasma drug levels at low levels would likely be maintained for five to eight days post-injection (Meegan et al. 2010).
Cefovecin	No adverse effects reported (Garcia-Parraga et al. 2016; Simone C. A. and Stoskopf 2018). Used at 4 mg/kg IM in treatment of an adult female Hawaiian monk seal to treat severse dorsal abscessation; no negative effects.	Pharmacokinetic studies conducted in Patagonian sea lions indicate that doses lower than that labeled for companion animals are equally effective. Plasma concentrations above 1.0 mcg/mL measured in harbor seals for greater than ten days (Simone C. A. and Stoskopf 2018)
Cimetidine (Tagamet)	Used in treatment of gastric ulcers in California sea lions; no adverse effects noted (Simone C. A. and Stoskopf 2018). Should be used with caution in patients with compromised kidney or liver function. Inhibits hepatic enzymes and may alter absorption of other drugs, including benzodiazepines, so needs to be administered separately (Plumb 2008; Simone C. A. and Stoskopf 2018).	Oral bioavailability in dogs is 95 percent, half-life 1.3 hours. Rapidly absorbed after oral administration in humans with 70 to 80 percent bioavailability (some is metabolized in the liver). Enters milk and crosses placenta.

Dexamethasone	Usually associated with long-term administration and manifested as clinical signs of hyperadrenocorticism; can retard growth in young animals; when given short-term, unlikely to cause significant harmful effects, even in massive doses. Few instances of use in Hawaiian monk seals with no adverse reactions reported.	Half-life in dogs is two to five hours; biologic activity can persist for greater than or equal to 48 hours.
Diazepam	Dogs may exhibit central nervous system excitement; in horses may cause muscle weakness and ataxia; in cats may cause irritability, depression, aberrant demeanor. Routinely used sedative in Hawaiian monk seals with no adverse reactions reported.	Highly lipid soluble and widely distributed throughout the body; readily crosses blood-brain barrier and is highly bound to plasma proteins, metabolized in liver to active metabolites nordiazepam, temazepam, and oxazepam, which are eliminated primarily in urine.
Doxapram HCL	Hypertension, arrhythmias, seizures, and hyperventilation, which are most probable with repeated or high doses. Increases myocardial oxygen demand and reduces cerebral blood flow. Few instances of use in Hawaiian monk seals with no adverse reactions recorded.	After IV injection, onset of effect in humans and animals within two minutes; in dogs, rapidly metabolized and excreted as metabolites in urine within 24 to 48 hours after administration. Serum half-life in dogs is 2.5 to 3.2 hours and in humans is 20 to 50 hours.
Epinephrine	Anxiety, tremors, excitability, vomiting, hypertension (with overdose), arrhythmias, high levels of uric acid in blood, and lactic acidosis (with prolonged use or overdosage). Few instances of use in Hawaiian monk seals with no adverse reactions reported.	Well absorbed following IM or subcutaneous injection; onset of action following subcutaneous injection is five to ten minutes; immediate action following IV injection; does not cross blood-brain barrier; actions end by uptake into sympathetic nerve endings; metabolism in liver and other tissues to inactive metabolites.
Famotidine (Pepcid)	Adverse effects are uncommon but in humans, may cause anorexia, vomiting, diarrhea, headache, dry mouth/skin. May	Partially absorbed after oral administration. Drug is 40 to 50 percent bioavailable in humans; 13 percent in horses.

	cause bradycardia if administered IV too rapidly (Plumb 2008).	Concentrates in liver, pancreas, kidney, and submandibular gland in rats. Does not cross blood-brain barrier or placenta. Elimination half-life two to three hours.
Fenbendazole	Generally no adverse effects at normal doses; hypersensitivity secondary to antigen release by dying parasites may occur, especially with high doses; vomiting reported infrequently in dogs and cats; well tolerated at doses up to 100 times recommended. Used in research field trial in Hawaiian monk seals and in captive care; no adverse effects reported from use but difficult to administer orally in field setting.	Marginally absorbed after oral administration; metabolized to active compound oxfendazole and sulfone; in sheep, cattle, and pigs, 44 to 50 percent of a dose is excreted unchanged in feces, and less than one percent in urine.
Flumazenil	In humans, injection site reactions, vomiting, cutaneous vasodilatation, vertigo, ataxia, and blurred vision; deaths have been associated with its use in humans having serious underlying diseases; large IV overdoses have rarely caused symptoms in otherwise healthy humans. Used in Hawaiian monk seals with no adverse reactions reported; trials with captive animals proved effective in reversing effects of midazolam.	Administered with rapid IV injection with therapeutic effects within one to two minutes; rapidly distributed and metabolized in liver; half-life in humans is approximately one hour.
Furosemide	May induce fluid and electrolyte imbalances; reported to cause hearing loss in cats and dogs given high IV doses; other effects include gastrointestinal problems, anemia, weakness, restlessness. Few instances of use in Hawaiian monk seals with no adverse reactions reported.	In dogs, the elimination half-life is approximately one to 1.5 hours; in humans, the diuretic effect takes place within five minutes and peak effects 30 minutes after IV injection.

Lidocaine HCL	At usual doses, serious adverse reactions are rare; most common are dose-related and rare, including central nervous system reactions, transient nausea and vomiting, and cardiac effects. Routinely used in Hawaiian monk seals during biopsy sampling with no adverse reactions reported.	Lidocaine has a high affinity for fat and adipose tissue and is bound to plasma proteins; rapidly metabolized in liver to active metabolites in liver to active metabolites; less than ten percent of an injected dose is excreted unchanged in urine.
Midazolam	Few adverse effects have been reported in humans including effects on respiratory and cardiac rates and blood pressure; other effects reported in humans include pain on injection, local irritation, headache, nausea, vomiting, and hiccups. Possibility of respiratory depression is principal concern in veterinary patients. Used in wild and captive Hawaiian monk seals with no adverse reactions reported; trials with captive animals indicated midazolam safe and effective.	Rapidly and nearly completely absorbed after IM injection; highly protein-bound and rapidly crosses the blood-brain barrier; metabolized in liver; elimination half-life in dogs averages 77 minutes and in humans is approximately two hours.
Naloxone	Generally considered very safe with wide margin of safety. Should be used with caution in animals with preexisting cardiac abnormalities.	Very rapid onset of action (one to five minutes), duration of action 45 to 90 minutes. Distributed in multiple organs, crosses placenta. Metabolized in liver and metabolites excreted in urine.
Praziquantel	In dogs, oral dosing can cause anorexia, vomiting, lethargy, or diarrhea but incidence is less than five percent greater incidences from injectable in dogs including pain at injection site, vomiting, drowsiness, and staggering gate.	Rapidly and nearly completely absorbed after oral administration; peak serum levels in dogs between 30 to 120 minutes; distributed throughout the body, crossing intestinal wall and blood-brain barrier into central nervous system; metabolized in liver and excreted primarily in urine;

	Used in research field trial (oral and IM) and in captive care (oral) of Hawaiian monk seals; no adverse effects reported from oral use; difficult to administer orally in field setting; swellings resulted from one IM injection in field use (Gobush et al. 2011). 15 mg/kg dose used in Hawaiian monk seals in rehabilitation with no adverse effects; resulted in clearance of infection in some animals after multiple treatments and visible passage of worms in as little as 30 to 60 minutes after oral treatment.	elimination half-life in dogs in three hours.
Prednisolone sodium succinate (Solu-delta-cortef)	Usually associated with long-term administration and manifested as clinical signs of hyperadrenocorticism; can retard growth in young animals; when given short-term for treatment of shock, unlikely to cause significant harmful effects, even in massive doses. Few instances of use in Hawaiian monk seals with no adverse reactions reported.	Biologic half-life is 12 to 36 hours.
Sodium pentobarbital	Barbituates depress the central nervous system in descending order starting with the cerebral cortex and loss of consciousness progressing to anesthesia; with overdose, deep anesthesia progresses to apnea due to depression of the respiratory center, followed by cardiac arrest (Leary et al. 2013). Used to effectively euthanize one aggressive adult male in 1991.	Onset of action within one minute after IV administration. Distributes rapidly to all body tissues with highest concentrations in brain and liver.
Tiletamine/Zolazepam (Telazol)	Apnea, bradycardia, tremors reported in multiple phocid species; mortalities have occurred in small number of	Little pharmacokinetic information is available. Rapid onset of action (within eight minutes in cats/dogs; mean

	animals at higher doses (Haulena and Schmitt 2018). Can cause respirator depression and apnea in most species, temporary pain is associated with IM injection (likely due to low pH).	duration of anesthesia is 27 minutes in dogs.

8.2.2.4 Specimen Collection/Health Screening

As discussed in Section 3, collection of skin, blubber, blood, hair, vibrissae, fecal matter, and swabs from Hawaiian monk seals will be conducted by experienced personnel. In addition, during these activities, researchers will also evaluate an individual Hawaiian monk seal's health and condition by conducting morphological measurements and ultrasounds. Summaries of the impacts expected from these activities are presented below.

Blood Collection

Researchers propose to collect blood samples from Hawaiian monk seals equating to no more than one percent of the animal's body weight (typically 96 milliliters or less). Blood collection requires the extended restraint of animals, which may increase the risk of stress-related effects and behavioral changes when the animals are released. During the procedure, blood collection can cause pain, stress, damage to the extradural vein or surrounding tissue, abscesses, and infection. In addition, blood removal would cause increased blood cell production, resulting in a metabolic cost to the Hawaiian monk seal. Such responses, however, are expected to be temporary and minor. Therefore, blood collection activities are likely to result in adverse effects to Hawaiian monk seals. We will assess the impact of blood collection in a later section, when we consider the effect of the action on population viability (See Section 8.3).

Biopsy (Darting and Punches)

Blubber, hair, and skin samples through biopsies will be collected on Hawaiian monk seals during research activities. While under sedation, seals may either not experience this procedure or experience a small and transient (few seconds) amount of additional discomfort and subsequent stress above and beyond that involved with capture and restraint. During the biopsy sampling procedure, NMFS PIFSC researchers have observed a short wiggle or twitch at the initiation of the blubber punch or when the punch reaches full depth, but heart rate and respiration are not commonly affected or return to normal after the procedure is complete (NMFS 2009). This is consistent with the behavioral responses observed in biopsy samples of cetaceans, which are not performed under sedation. Responses for whales include tail flicks and submerging with animals typically resuming normal behavior in a few minutes of the stressor being (Weinrich et al. 1991; Weinrich et al. 1992; Gauthier and Sears 1999).

During biopsy punch procedures, some additional seconds of handling will be involved with the process, which would prohibit the seal from engaging in natural behaviors for a short period of time. However, we believe that this cannot be quantified in a meaningful way. Scarring is likely to happen at the site of the blubber plug; however, no infections have been reported or responded to following the biopsy procedure (NMFS 2014; NMFS 2019).

In addition to performing biopsy punches on restrained Hawaiian monk seals, the NMFS PIFSC proposes to conduct remote biopsies. This method has not been used on Hawaiian monk seals before, but it has been successfully used on other pinnipeds such as Steller sea lions. For Steller sea lions, biopsy darting elicits an escape-avoidance response in most juveniles and adult females but less often in subadult and adult males (Hoberecht et al. 2006). After conducting the remote biopsy, the small wound site may drip blood for about ten minutes (Hoberecht et al. 2006). The physiological response from darting is expected to produce a similar reaction to other small wounds obtained by natural causes. Hazards of remote biopsy sampling may include:

- Inadvertently striking vulnerable areas such as the head or abdomen;
- Darts that penetrate too deeply and cause excessive bleeding or tissue damage
- Stuck darts or broken tips remaining attached to the animals, causing irritation and possibly abscess and infection and;
- Inadvertent repeated sampling of the same individual, thereby compounding the effects on that animal (NMFS 2007e).

Depending on the depth of penetration and force of impact, biopsy darts can damage internal organs if they strike the abdominal area, resulting in a fatal wound that may not be detected by researchers at the time of sampling. Animals can also be severely injured if darts strike them in the head (Gemmell and Majluf 1997). During the NMFS PIFSC's proposed activities, biopsy collection will target the rear of the animal (as with biopsy punches). Also, staff will have to demonstrate accuracy with biopsy darts or poles to within a four-inch area to mitigate risk of injury with non-target strikes prior to employing this method in the field. Furthermore, the NMFS PIFSC will closely monitor its remote biopsy activities and will only continue them if no significant effects on Hawaiian monk seals are observed. Therefore, biopsy activities are likely to result in adverse effects to Hawaiian monk seals. We will assess the impact of biopsies in a later section, when we consider the effect of the action on population viability (See Section 8.3)

Swab/Fecal Sampling

Swab sampling of orifices during the NMFS PIFSC's Hawaiian monk seal research activities could cause pain or irritation. Fecal sampling with a fecal loop or through digital extraction could also cause pain and irritation; additionally, perforation of the rectum during fecal sampling is a possibility when sampling pinnipeds (NMFS 2007a). In females, accidental insertion of a fecal loop into the vagina could result in discomfort or possibly introduction of pathogens (NMFS 2007a). However, when performed by a qualified, experienced person using commonly accepted standards of good practice (as is proposed under the NMFS PIFSC's research activities), these risks are likely negligible. Therefore, swab/fecal sampling activities are likely to result in adverse effects to Hawaiian monk seals but these effects are expected to be minor and temporary in nature. We will assess the impact of swab/fecal sampling in a later section, when we consider the effect of the action on population viability (See Section 8.3).

Milk Sampling

Milk may be collected opportunistically from lactating females during health assessments, only in rare occurrences if the female has lost or abandoned her pup (and the pup could not be reunited). Milk would be collected by manual expression of the teat, which will at most cause minor discomfort. However, impacts from the activity are expected to be minor. As a result, we conclude that milk sampling may result in temporary discomfort to a Hawaiian monk seal, but it would not reduce the fitness of any individual. In addition, oxytocin may also be administered to facilitate milk letdown during milk collection. Hawaiian monk seal responses to the administration of oxytocin is discussed below.

Overall, milk sampling activities are likely to result in adverse effects to Hawaiian monk seals but these effects are expected to be minor and temporary in nature. We will assess the impact of milk sampling in a later section, when we consider the effect of the action on population viability (See Section 8.3).

Hair/Vibrissae

Researchers would cut or pull up to two vibrissae for stable isotope and hormone analyses. Whiskers (vibrissae) are keratinous, hair-like structures that are highly innervated, have large blood sinuses, and are controlled by voluntary muscles (Hirons et al. 2001a). The removal of two whiskers, whether by cutting or pulling (if under sedation), would result in temporary pain for the seal. Further, the pulling of two whiskers may provide an entry point for infectious diseases. Whiskers are used as tactile sensors to navigate in water, detect prey, and follow the hydrodynamic trails of fish (Dehnhardt et al. 2001). Three experiments demonstrate the importance of whiskers to seals. In one study, a mask that was placed over the muzzle of a harbor seal (*Phoca vitulina*) prevented it from detecting a hydrodynamic trail (Dehnhardt et al. 2001). In another study, the removal of all whiskers temporarily impaired two juvenile harbor seals' ability to capture fish (Renouf 1979). Further, Davis et al. (1999) studied the hunting habits of Weddell seals and was able to observe the erection of vibrissae when a seal was very close to its prey suggesting a hydrodynamic receptor system in the vibrissae that helps guide seals during the final stages of an attack on prey. Similar to other pinniped species, monk seals likely use their whiskers to identify benthic prey (Hirons et al. 2001a). The removal of all whiskers would likely interfere with a Hawaiian monk seal's foraging behavior; however, the researchers would only remove a maximum of two annually. Hawaiian monk seals shed their whiskers periodically; they also damage or lose whiskers during normal foraging activities (Hirons et al. 2001a). These losses do not appear to affect their ability to forage, survive, or reproduce. Therefore, it is unlikely that the cutting or pulling of whiskers would affect a seal's ability to forage, survive, or reproduce. We conclude that whisker collection is likely to result in adverse effects to Hawaiian monk seals but these effects are expected to be minor and temporary in nature. We will assess the impact of this activity in a later section, when we consider the effect of the action on population viability (See Section 8.3).

Measurement/Weighing/Ultrasound

The researchers would measure, weigh, and ultrasound Hawaiian monk seals. Measuring and ultrasound involve the use of light pressure onto the skin of a seal and are not expected to result in any additional discomfort, beyond that of restraint. To weigh Hawaiian monk seals, the researchers would suspend the seal in a net. The process requires less than one minute and is expected to cause the seal minor discomfort (NMFS 2014; NMFS 2019), however these procedures are not likely to result in injury. Therefore, measurement, weight, and ultrasound activities are likely to result in adverse effects to Hawaiian monk seals but these effects are expected to be minor and temporary in nature. We will assess the impact of this activity in a later section, when we consider the effect of the action on population viability (See Section 8.3).

8.2.2.5 Marking (Bleaching/Dyeing)

The researchers propose to mark Hawaiian monk seals with bleach for easy identification and monitoring. Only Hawaiian monk seals that are asleep will be bleached. Moreover, molting seals, which are more restless and subject to disturbance, will be avoided. Disturbance is a possible stressor that may result from this activity.

Individual Hawaiian monk seals may awaken during bleaching/dyeing, whether or not they see the person applying the mark. Reaction behaviors could include: looking around, vocalizing at the observer, moving a short distance away, or fleeing into the water. In addition, bleach or dye could cause irritation to areas it might come into contact with (eyes, nose or skin surfaces). However, bleach is never applied to a part of the pelage that the Hawaiian monk seal could reach with a fore flipper, to ensure that the animal cannot rub any bleach on its face or in its eyes. Short-term effects are brief expenditures of energy associated with escape and no long-term effects are anticipated. As a result, marking activities are likely to adversely affect Hawaiian monk seals. We will assess the impact of marking in a later section, when we consider the effect of the action on population viability (See Section 8.3).

8.2.2.6 Tagging

Routine tagging will cause temporary stress and some transient pain. Flipper tags involve creating a small hole in the flipper, through which plastic tags are threaded while PIT tags are injected just below the skin and lateral lumbar area. This can cause temporary pain, stress, and the possibility of infection. Flipper tags might tear out over time, causing additional wounding to the flipper.

Since the early 1980s, nearly all Hawaiian monk seals have been captured, restrained and tagged with plastic flipper tags soon after weaning. To ensure that this practice did not have negative effects, Henderson and Johanos (1988) conducted a study at Lisianski Island to compare the early survival, behavior, and movements of tagged and untagged weaned pups. They found no differences in any of these metrics between tagged and untagged pups. For most Hawaiian monk seals, initial tagging at weaning is the only time in their lives they are handled by humans. However, some seals may be captured, restrained and retagged at an older age if their flipper tags become lost, worn or broken. Baker and Johanos (2002) compared the survival, migration, and condition of 437 seals during the year following retagging with an equal number of matched controls with pre-existing tags. It was important to choose control Hawaiian monk seals that were already tagged, so that probability of resighting would not be biased between the two groups. They found no differences in survival, migration, or condition between the retagged and control groups.

In summary, tagging is likely to adversely affect Hawaiian monk seals. However, despite the potential for injury or infection, tagging is not expected to reduce the survival rate, migration patterns, or body condition of Hawaiian monk seals. We will assess the impact of tagging in a later section, when we consider the effect of the action on population viability (See Section 8.3).

8.2.2.7 External Instrument Attachment

Similar to other research activities described above, attachment of instruments may increase stress, because the individual seals will be held for longer durations. Animals will be sedated under the direction of an attending veterinarian as necessary to reduce stress when restrained for instrumentation (with the exception of some flipper-tag mounted instruments). As a result, there is some risk to individual animals of mortality during restraint, especially moribund animals. In addition, attachment of instruments to the fur with epoxy can cause irritation and in some cases minor skin wounds at the margins of the attachment area. The hydrodynamic drag created by the instrument might hinder swimming performance and result in increased energetic costs of swimming and diving, potentially affecting foraging efficiency.

Baker and Johanos (2002) conducted an extensive study, examining the effects of tagging, blood sampling, and instrumentation with telemetry devices. There were no effects of tagging/handling on survival, migration, or condition of the tagged seals. Moreover, sample sizes were sufficient to detect a nine percent difference in resightings. The authors conclude that conservative selection procedures and careful handling techniques have no deleterious effects on Hawaiian monk seals.

Littnan et al. (2004) measured the impact of Crittercam attachment on the dive behavior of juvenile monk seals. They found that for short duration deployments (less than two weeks) there was no significant difference in dive behaviors (i.e., dive depth, dive duration, foraging trip duration) with or without the camera attached. However, descent and ascent on dives were slower with the Crittercam, possibly indicating energetic costs to individuals, but the results were not statistically significant. Crittercams have been the largest and least hydrodynamic of the telemetry instruments deployed to date so it is unlikely other technologies are impeding the seals' abilities to forage.

Another potential stressor associated with instrumentation is the increased potential for entanglement. Seals often forage or investigate marine debris, including fishing nets. Attached instruments may become snagged, trapping the seal. While the researchers have disentangled more than 300 Hawaiian monk seals, none of the entanglements were associated with attached instruments. Furthermore, the instruments are detached or shed, limiting the time during which a seal could become entangled.

Instrumentation is likely to result in a small, temporary increase in drag and may increase the risk of entanglement particularly for smaller and/or younger seals. As a result, the external instrumentation is likely to adversely affect Hawaiian monk seals. However, because of the limited duration (three days to two weeks) of deploying larger instruments (i.e., Crittercams), and based on previous experience and use of instruments by the NMFS PIFSC without issue, we do not expect this increase to cause significant problems in foraging, diving, or the avoidance of predators. We will assess the impact of external instrumentation in a later section, when we consider the effect of the action on population viability (See Section 8.3).

8.2.2.8 Behavioral Modification

As described in the *Description of the Proposed Action* (Section 3), behavioral modification techniques will be applied carefully and judiciously when needed for protection of individual Hawaiian monk seals and the public. Aversive stimuli that may be used would be tested carefully and effects from behavioral change generally enhance survival by removing a Hawaiian monk seal from an imminently threatening situation or remove an aggressive male from a location where it can attack a female, juvenile, or pup. However, general responses to the activities include disturbance, discomfort, annoyance, and habituation. In addition, risks of actions unique to behavioral modification include:

- Hazing and use of barriers to movement results in behavioral harassment and may cause stress;
- Tactile means (i.e, use of projectiles and prodding) of behavioral modification might involve momentary, minor pain or discomfort, though the techniques would not involve any type of intentional infliction of injury;
- Visual and audible hazing could cause stress and behavioral harassment. Further, louder aversive audio devices have the potential to cause TTS [6] for Hawaiian monk seals, although TTS is not anticipated because the researchers only propose to emit louder

[6] A TTS results in a temporary change to hearing sensitivity and the impairment can last minutes to days, but full recovery of hearing sensitivity is expected.

sounds (i.e., air horns, metal pipes, simulated explosions) using shorter play intervals or at greater distances from seals (See Table 10, Table 11, and Table 12); and

- In cases where the objective of behavioral modification is to move seals away from a specific area where they are, for example, interacting with people, achieving this objective could also displace the seal from resources (i.e., foraging or resting areas) that are important for maintenance and growth.

Table 9. Maximum sound levels and permissible cumulative exposures to aversive audio tools used during National Marine Fisheries Service Pacific Island Fisheries Science Center Hawaiian Monk Seal Research Program research and enhancement activities.

	Underwater[1] (measured 1 m from source)			In Air[2] (measured 1 m from source)		
	Maximum Source Level (dB rms)	# 10s Play Intervals	SELcum[3]	Maximum Source Level (dB rms)	# 10s Play Intervals	SELcum[3]
Predator Sounds (natural, non-impulsive)	146	15	168	105	15	127
Startle Sounds (man-made, non-impulsive)						
Boat motor	146	15	168	100	15	122
Simulated Explosion*	150	15	172	94	15	116
Recorded Horn	162	6	180	102	15	124
Air Horn (man-made, impulsive)				129[4]	0	NA
Metal Pipe (man-made, impulsive)	165**	2.5 seconds	169	104	5	121

[1] All recorded sounds played on an iPhone5 at MID volume, through a TOA amplifier at volume 10.
All decibels referenced to 1μPa (standard underwater pressure)
[2] All recorded sounds played on an iPhone5 at MID volume, through a TOA amplifier at volume 10.
All decibels referenced to 20μPa (standard air pressure)
[3] SEL_{cum} was calculated based on measured source levels and the equation:
SEL_{cum} = SPL (dB) + 10 $\log_{10}$ (duration of exposure in seconds).
[4] Note, commercially available airhorns, at the sound source, exceed the TTS threshold for in-air sounds, thus the airhorn would only be played at a greater distance from the animal. See Table 3.
[*] This is a computer-generated sound effects clip, without the impulsive qualities of a real explosion. Playbacks of underwater explosion sounds will either be conducted five to ten meters away from seals or in shorter time intervals to get under TTS.

**Peak-to-peak (rather than dBrms) source level was used to determine SELcum. This results in a conservative estimate of SELcum (i.e., higher SELcum is calculated using peak-to-peak compared to dBrms source level). This impulsive sound would quickly exceed SELcum thresholds if played continuously, thus it is only eligible to played with up to 3 brief strikes of the pipe during 2.5 seconds if animal is at close range.

Table 10. Maximum source levels and permissible cumulative sound exposure levels for aversive audio tools at variable distances.

	Underwater[2] (5 m[1] from source)			Underwater[2] (10 m[1] from source)		
	Maximum Source Level (dB rms)	# 10s Play Intervals	SELcum[3]	Maximum Source Level (dB rms)	# 10s Play Intervals	SELcum[3]
Predator Sounds (natural, non-impulsive)	136	15	158	131	15	153
Startle Sounds (man-made, non-impulsive)						
Boat motor	136	15	158	131	15	153
Simulated Explosion*	140	15	162	135	15	157
Air horn	152	15	174	147	15	169
Air Horn(man-made, impulsive)	129[4]	0.3	123	129[4]	0.8	123
Metal Pipe (man-made, impulsive)	155**	3	170	150	8	169

1 Sound attenuation based on 15*Log(distance in meters).
2 All recorded sounds played on an iPhone5 at MID volume, through a TOA ampilfication at volume 10.
All decibels referenced to 1µPa (standard underwater pressure).
3 SEL_{cum} was calculated based on measured source levels and the equation:
$SEL_{cum} = SPL\ (dB) + 10 \log_{10}$ (duration of exposure in seconds).
4 Note, commercially available airhorns, at the sound source, exceed the TTS threshold for in-air sounds, thus the airhorn would only be played at a greater distance from the animal. Given the high levels, and short time allowable, the airhorn should be played in several short one-second blasts, rather than continuous 10-second segments.
* This is a computer-generated sound effects clip, without the impulsive qualities of a real explosion. Playbacks of underwater explosion sounds will either be conducted five to ten meters away from seals or in shorter time intervals to get under TTS.
**Peak-to-peak (rather than dBrms) source level was used to determine SELcum. This results in a conservative estimate of SELcum (i.e., higher SELcum is calculated using peak-to-peak compared to dBrms source level; also as strikes to the pipe will have some pause in between, the cumulative time of exposure will not be 100% of the duration).

Table 11. Underwater and in-air temporary threshold shift-onset and permanent threshold shift-onset thresholds for Hawaiian monk seals exposed to impulsive noise (NOAA 2018; Southall et al. 2019)

Underwater/In-Air	TTS Onset: SEL (weighted)	TTS Onset: Peak SPL (unweighted)	PTS Onset: SEL (weighted)	PTS Onset: Peak SPL (unweighted)
Underwater	170	212	185	218
In-Air	123	155	138	161

TTS=temporary threshold shift
PTS=permanent threshold shift
SEL=sound exposure level
SPL=sound pressure level

While relatively modest effort has been made toward behavioral modification in Hawaiian monk seals, many insights are available from the management of other pinniped species. For example, California sea lions (*Zalophus californianus*) in Washington feeding on salmon at fish ladders were hazed with underwater firecrackers, chased by boat (NMFS 2019), and exposed to sounds in the 12 to 17 kiloHertz range from aversive audio devices (Greenlaw 1987). Also, taste-aversion conditioning was attempted using lithium chloride. These measures were initially successful in changing the sea lions' foraging patterns but the success was not long-lasting and habituation to the deterrent devices was apparent as predation rates of salmon later increased (Gearin et al. 1988). Aversive audio devices, underwater firecrackers, and vessel chase were tested on California sea lions, Steller sea lions (*Eumetopias jubatus*) and Pacific harbor seals *(Phoca vitulina richardsi*) feeding on endangered salmon at Ballard Locks, Seattle, Washington, resulting in apparently rapid habituation (Brown et al. 2008). Cracker shells, rockets, and rubber buckshot were also used on the sea lions but only brief deterrence occurred, followed by apparent habituation (Brown et al. 2008). A pulsed low voltage direct current (DC; pulse frequency of 2.0 Hertz and pulse width at 1,000 microseconds) effectively repelled harbor seals 2 to 3 meters (6.6 to 9.8 feet) from a gill net and effectively prevented depredation at a gill-net test fishery on the Frasier River, British Columbia, Canada over a 22-day period (Forrest et al. 2009).

Similar to other pinniped species described above, Hawaiian monk seals (specifically those located on the Main Hawaiian Islands), eventually respond to behavioral modification by returning to the location where the behavioral modification occurred. Displacement has typically been successful in disrupting behavior and removing Hawaiian monk seals from a dangerous or undesirable location, at least immediately, though it does not appear to discourage continued use of an area in the Main Hawaiian Islands. For example, Hawaiian monk seals hazed from the Poipu Keiki Pool had a high return rate with 60 percent returning at least once and 15 percent returning within two days of being hazed (NMFS 2019). In addition, return rates were higher for areas that would be considered normal Hawaiian monk seal habitat or attractive haulout areas (sandy beaches) where seals were encouraged not to haul out due to human concerns such as fear of interactions with people. In these cases, it appears that the draw to a given haulout area overrides the deterrent value of the displacement (NMFS 2019).

Overall, the general responses to behavioral modification techniques used during the NMFS PIFSC's research and enhancement activities consist of behavioral harassment, annoyance, or pain that is minor and temporary. As a result, behavioral modification is likely to adversely affect Hawaiian monk seals. Behavioral harassment will only be conducted to remove a seal from a potentially dangerous situation or remove an aggressive male from attacking other seals. As a result, marking activities are likely to adversely affect Hawaiian monk. We will assess the impact of this activity in a later section, when we consider the effect of the action on population viability (See Section 8.3).

8.2.2.9 Translocation

Translocations are intended to directly benefit those animals that are translocated, or in the case of aggressive male translocations, seals no longer exposed to the translocated males. The goal of survival enhancement is to improve the fitness of individuals while increasing population abundance; however, removing individuals from a subpopulation could reduce the viability of that subpopulation. Therefore, the researchers propose a "two-stage translocation" in which they would move a weaned pup to a location where it is more likely to survive. Once it has reached an age where survival rates are similar between the donor and recipient population, the seal would be translocated back to its natal or other suitable population. However, the relatively small number of seals that have been translocated as pups were judged not to have been a burden on recipient sites, nor have the source sites been depleted or had their sex ratios skewed due to the first stage translocations. Due to this, and because some survival decrement is expected to be associated with return (second stage) translocations, these have not been carried out by the NMFS PIFSC (NMFS 2019). Nevertheless, authorization for two-stage translocation is being requested in case juvenile survival patterns, which have varied greatly in the past, emerge which would warrant this action during the term of the permit. In addition, translocation of Hawaiian monk seals (of any size or sex) with unmanageable human interactions and aggressive male seals will be conducted as part of the proposed action.

Baker et al. (2011) analyzed data on 247 translocation events from 1984 through 2009. Hawaiian monk seals of both sexes with ages ranging from less than a month to over 15 years were moved distances of just a few to more than 2,200 kilometers (1,367 miles) away from their source sites with a variety of intended aims. Most of these involved the translocation of nursing and weaned pups (N=209) relocated for better foraging conditions, however 34 adult males relocated for aggression, and three juveniles relocated for unmanageable human interaction were also assessed. During the translocation activities (after Hawaiian monk seals were captured but before release), two adult males and one pup died. One adult male died while being restrained while the second adult male and pup died during temporary captivity. The cause of the deaths could not be determined but may have been linked to capture stress and/or a pre-existing condition. From the samples taken, the mortality rate from translocation activities for nursing and weaned animals (0.5 percent) was less severe than that of older Hawaiian monk seals (six percent mortality).

As noted above, animals which are translocated will experience stress (and in rare cases, mortality) during capture, handling, short-term captivity, and transport via boat, plane, car, or other mode of transportation. Upon translocation to the host population, the Hawaiian monk seal would be released to an unfamiliar environment. The Hawaiian monk seal may respond to this stressor by acclimating to its new environment, surviving, and reproducing. Alternatively, the Hawaiian monk seal may struggle in its new environment, die, or fail to reproduce. However, because most translocated animals are weaned pups, abandoned nursing pups, which are relocated to a potential foster mother, will experience heightened stress levels and will risk injury due to possible aggression by a non-receptive female. Nevertheless, abandoned pups are certain to die if they do not suckle, so the potential benefit of being able to suckle far outweighs any injury the animal may receive soliciting milk from a non-receptive female. Further discussion on the survivability of Hawaiian monk seals after translocation is discussed below.

Baker et al. (2011) analyzed the survivability of translocated Hawaiian monk seals and found that most translocated animals survived just as well at their release sites as native (non-translocated) Hawaiian monk seals at the same sites. For example, after comparing a sample size of 161 translocated pups to 130 non-translocated pups within French Frigate Shoals, Baker et al. (2011) determined that during the first year of translocation, relocated pups had a 45 percent survivability rate whereas non-relocated pups had a 43 percent rate. In addition, on the Main Hawaiian Islands, 79 percent of non-translocated Main Hawaiian Island pups lived one year or more (N=84), compared to 67 percent for 12 translocated pups. This difference was not statistically significant (logistic regression, p=0.36).

As for adult males translocated to the Main Hawaiian Islands, survivability rates of translocated seals also matched that of native Hawaiian monk seals. For example, estimated annual survival for the translocated males was 92.3 percent (95 percent CI 87.4 to 95.5 percent), which is comparable to that seen for native-born adults in the Main Hawaiian Islands. However, due to a lack of resight data for adult males translocated to Johnston Atoll and the three juveniles (relocated after unmanageable human interactions) after translocation, survivability rates for this small group could not be determined.

In addition to stress from capture, handling, temporary captivity, transport, and acclimating to a new environment, another effect of translocation is the spread of infectious disease. Baker et al. (2013) states that translocating may result in faster rates of disease spread than what would occur naturally. However, health screening of all translocated seals coupled with appropriate quarantine of returnees will reduce the risk of higher infection rates. In addition, the NMFS PIFSC will conduct disease surveillance throughout the species' range to detect any outbreaks (Baker et al. 2013). Also, Norris et al. (2016) found that there was minimal risk of exposing Hawaiian monk seals to novel infectious diseases as a result of translocation.

The stressors involved in the second stage translocation are similar to those in the first stage, but, as discussed in Section 3, would only involve juveniles. Therefore, we expect the stress-response, potential for injury, and exposure to an unfamiliar environment to be similar to the fitness consequences Hawaiian monk seals are exposed to in the first stage of translocation.

In addition to risks to the individual during translocation, other potential negative effects from translocation include impacts that the activity may have on both the source population that the translocated seal once belonged to and the host population to which the Hawaiian monk seal was moved. Risks involved include the development of male biased sex ratios. For example, the removal of female pups will ultimately result in male-biased sex ratios, which can lead to increased male aggression toward adult females and juveniles (Baker et al. 2013). In addition, translocations may overload the carrying capacity of host populations and deplete the numbers of animals for source populations (Baker et al. 2013). However, as mentioned earlier, only small numbers of Hawaiian monk seals are being translocated during the permit.

Translocation of Hawaiian monk seals usually involves many other activities, including: capture, restraint, sedation, temporary captivity, deworming, sampling, and instrumentation. Risks of these activities are described throughout this section; however, we include the effects of capture (i.e., elevated stress response) because it led to the death of two adult males and a pup, prior to translocation (Baker et al. 2011). Given the potential for elevated stress response in older individuals and nursing pups, we conclude that a maximum of three Hawaiian monk seals are likely to experience reduced fitness (i.e., mortality) as a result of translocation over the course of the five-year permit. As a result, translocation is likely to adversely affect Hawaiian monk seals. We will consider the impact of the loss of three animals and other impacts from translocation on the Hawaiian monk seal population in the risk analysis below (Section 8.3).

8.2.2.10 Temporary Captivity

Several of the proposed activities require placing a seal in temporary captivity (e.g., a few hours to a few weeks). For example, a Hawaiian monk seal may be placed in temporary captivity before it is translocated, while it is being tested for infectious diseases, or while the researchers are capturing other seals for translocation. The researchers are not proposing to place Hawaiian monk seals in longer-term captivity for captive care. Temporary captivity may involve isolating a seal in a pen on its natal beach or temporarily placing a seal in a permanent captive facility. We identified three potential stressors associated with temporary captivity: captive stress, potential for injury, and potential for disease transmission.

Over 500 Hawaiian monk seals have been placed in temporary captivity before translocation; of these, two have died during temporary captivity (0.59 percent). As described in the section above, one adult male and pup died in temporary captivity (Baker et al. 2011).

Although rare, Hawaiian monk seals held for longer periods (e.g., several months), for the purposes of captive care, have experienced physical ailments. A group of females, receiving captive care, and a lone pup, also receiving captive care, developed cataracts, which led to functional blindness. For the females, the cataracts may have been a result of an infectious disease (i.e., a group effect, as described under translocation). Such group effects are more likely to occur in prolonged captivity, as opposed to temporary captivity. Alternatively, the cataracts could have developed in response to prolonged exposure to ultraviolet light in the captive facilities (NMFS 2014). Since then, all captive facilities minimized possible contributing factors by reducing artificial light exposure, providing shade, and repainting pools. In addition, the researchers now screen, quarantine, and vaccinate all individuals before placing them in temporary captivity. These measures should reduce risks to all seals, including those held temporarily. We do not expect any such problems to arise during temporary captivity because the majority of Hawaiian monk seals held prior to translocation did not develop cataracts or experience any other adverse effects.

Given the data above, we expect two seals to die as a result of temporary captivity during the five-year permit. As a result, translocation is likely to adversely affect Hawaiian monk seals. ESA take in the form of harassment and harm can occur during the PIFSC's temporary captivity activities. We will consider the impact of the loss of two Hawaiian monk seals and other effects from temporary captivity in the risk analysis below (Section 8.3).

8.2.2.11 Euthanasia/Permanent Captivity

Euthanasia of an individual Hawaiian monk seal (either a moribund seal, severely injured seal, or an aggressive adult male) would have a direct consequence on an individual Hawaiian monk seal leading to death and loss of reproductive value. Similarly, permanent captivity will lead to a loss of reproductive value but will not result in mortality. We will consider the impact of euthanasia and permanent captivity on the Hawaiian monk seal population in the risk analysis below (Section 8.3).

8.2.2.12 Disentanglement/Dehooking

When Hawaiian monk seals are entangled in marine debris or are observed with an embedded fishing hook, they may be captured to remove the offending items. In some cases, debris is cut away from Hawaiian monk seals while they are asleep and no disturbance occurs. Disentanglement from marine debris may cause temporary stress, but will probably save the animal from death or serious injury (NMFS 2019). Radiographs and endoscopies may be used to aid in hooked seal evaluations, although these activities are commonly used in Hawaiian monk seal deehoking events are anticipated to only cause minor discomfort to seals (Dierauf et al. 2018).

Marine debris and hooking are known sources of serious injury and mortality. As such, the likely responses associated with disentanglement/dehooking are weighed against the consequences to the animal of leaving the debris or hooks in place. During disentanglement of Hawaiian monk seals caught in marine debris, removal of debris from severe wounds or from Hawaiian monk seals that have become very compromised by their entanglement, can pose a risk of causing excessive bleeding and other complications, potentially leading to death. Furthermore, dehooking seals can lead to the use of invasive surgical procedures which are used to remove hooks lodged inside a seal's body. As a result, disentanglement/dehooking is likely to adversely affect Hawaiian monk seals. Nevertheless, disentangling and de-hooking seals unequivocally saves Hawaiian monk seal lives and the benefits likely outweigh the potential adverse effects to some individuals. For example, from 2012 through 2016, the NMFS PIFSC's HMSRP and the Marine Mammal Health and Stranding Research Program conducted disentanglement and deehoking activities that averted 28 serious injury events of Hawaiian monk seals (Carretta et al. 2019). However, due to potential harassment and pain seals may incur during these activities, it should be noted that this activity is likely to adversely affect Hawaiian monk seals. We will consider the impact of this activity on Hawaiian monk seals in the risk analysis below (Section 8.3).

8.2.2.13 Deworming/Administration of Drugs and Supportive Fluids

Appendix F of NMFS (2019) lists all drugs proposed for use, as well as possible adverse effects, and the pharmacokinetics of each drug (i.e., how the drug is absorbed, distributed, the rate of action and duration of effect, chemical changes in the body, and effects and routes of excretion of metabolites) (see Section 16.6). In addition, supportive fluids such as electrolytes, dextrose, and sodium bicarbonate may be administered at the discretion of the attending veterinarian in response to adverse reactions to capture, handling, and drug administrations.

Administration of deworming and other medications (e.g., antibiotics and emergency response drugs) can occur by various routes, each with some potential risk (Walters et al. 2014). Injections (intra-muscular or subcutaneous) can cause pain, stress, swelling, and the risk of infection at the injection site. Oral intubation for administration of drugs also can cause pain and stress, and carries the risk of introducing fluids into the trachea and lungs, which may lead to pneumonia. Topical application of medication has a potential to disturb or stress seals if they awaken during the application.

The proposed drugs and supportive fluids have been used, or have been approved, by veterinarians with substantial pinniped experience. No severe adverse reactions have been observed that would preclude future use. Drugs and supportive fluids are administered, at the discretion of the attending veterinarian, for the benefit of the seal. For example, sedatives are given to reduce stress during certain handling events, and emergency drugs are administered if a seal has an adverse reaction during handling.

Drugs and supportive fluids would be administered only if deemed necessary by an attending veterinarian and for the sole purpose of improving the condition of a seal. They are likely to cause discomfort or pain upon injection. As a result, the administration of drugs is likely to adversely affect Hawaiian monk seals. Though there is the possibility of adverse drug reactions, the risk has been minimized by previous testing on monk seals (in the wild or in captivity) and other pinnipeds, resulting in protocols to maximize safety of administration. For Hawaiian monk seals, we are not aware of adverse drug reactions, injury, or mortality as a result of these activities, though the potential exists. However, due to the potential for adverse reactions and responses from capture and handling, the administration of drugs and supportive fluids are likely to adversely affect Hawaiian monk seals. We will consider the impact of this take on Hawaiian monk seals in the risk analysis below (Section 8.3).

Deworming medication has been shown to have positive fitness effects on Hawaiian monk seals. Treated Hawaiian monk seals experienced higher growth rates than non-treated Hawaiian monk seals (Gobush et al. 2011). However, as noted from past experiences, it is possible that injection of deworming medicine may cause abscesses (NMFS 2019). As a result, deworming is likely to adversely affect Hawaiian monk seals. However, after the observation of abscesses, improved handling methods, re-doubled vigilance in cleaning the injection sites and maintaining the cleanliness of needles, syringes and medicine, and splitting doses of praziquantel were subsequently employed, after which no further swellings or injections occurred. We will consider the impact of deworming on Hawaiian monk seals in the risk analysis below (Section 8.3).

8.2.2.14 Supplemental Feeding

Supplemental feeding of wild Hawaiian monk seals would occur only in the Northwestern Hawaiian Islands where human presence is minimal. Responses associated with this activity potentially include disturbance and the possibility of developing behavioral issues (such as fisheries interactions or approaching humans). As a result, supplemental feeding is likely to adversely affect Hawaiian monk seals. We discussed disturbance of Hawaiian monk seals in Section 6.2 and concluded that responses are short lived and include, at most, minor physiological changes. The possibility of developing behavioral issues is a greater concern because Hawaiian monk seals that approach humans for food must be removed for the safety of both species. The Northwestern Hawaiian Islands are protected as the Papahānaumokuākea Marine National Monument. As such, they are uninhabited by humans, except for a small group of researchers and cultural practitioners, who are allowed access to the islands and surrounding waters. These people receive extensive training on environmental awareness and know to give seals a wide berth. Therefore, dangerous human-seal interactions are unlikely to occur in the Northwestern Hawaiian Islands, even if a Hawaiian monk seal has developed behavioral issues. For example, Hawaiian monk seals that develop behavioral issues in the Main Hawaiian Islands are often translocated to the Northwestern Hawaiian Islands, where the behaviors are no longer a threat to the seal or humans. It is highly unlikely that a Hawaiian monk seal from the Northwest Hawaiian Islands will migrate to the Main Hawaiian Islands (NMFS 2014). However, due to the risk of behavioral issues, supplemental feeding is likely to adversely affect Hawaiian monk seals. We will consider the impact of supplemental feeding on Hawaiian monk seals in the risk analysis below (Section 8.3).

8.2.2.15 Vaccination

Vaccines would most likely be administered to Hawaiian monk seals through injections that could involve capture and restraint. Responses to vaccination would thus include those associated with disturbance, injection and potentially capture/restraint, discussed in previous sections. Other specific responses to vaccination may include an immune response, which results in a local reaction at the site of injection on rare occasions characterized by heat and swelling that resolves in five to seven days, or febrile response (i.e., fever). However, risks specifically associated with vaccination will be mitigated by the cautious, stepwise approach to determining safety and efficacy of specific vaccines and applying them judiciously. The HMSRPs vaccination protocol are designed to minimize unnecessary disturbance and all personnel are trained and skilled in vaccine administration techniques (NMFS 2019). To date, over 1,400 vaccine doses have been administered by the HMSRP with no adverse effects. However, due to needle injection and capture/restraint, vaccination is likely to adversely affect Hawaiian monk seals. We will consider the impact of vaccination on Hawaiian monk seals in the risk analysis below (Section 8.3).

8.2.2.16 Treatment of Wounds

The researchers propose to treat wounds. They would lance, drain, and clean shallow abscesses (e.g., injuries inflicted by adult males). Treatments would be done by or under the direction of a veterinarian. They would be followed by the administration of a long-acting antibiotic to prevent or treat infection which may lead to similar responses discussed in Section 8.2.2.13.

Hawaiian monk seals would likely experience temporary discomfort and pain during the treatment of wounds. As a result, treatment of wounds is likely to adversely affect Hawaiian monk seals. However, treatment of the wound and administration of long-acting antibiotics are expected to relieve long-term pain and prevent possible infections. Lancing also allows for the drainage of pockets harboring pathogenic bacteria that can cause systemic infection and death in pinnipeds (Petrauskas et al. 2008). We will consider the impact of the treatment of wounds on Hawaiian monk seals in the risk analysis below (Section 8.3).

8.2.2.17 Administration of Oxytocin

The administration of oxytocin to adult female Hawaiian monk seals has not yet been conducted. Injectable oxytocin is used commonly in animals to induce or facilitate uterine contractions during birth or induced abortion (Plumb 2008). In post-partum animals, it is administered to treat retained placentas, uterine prolapse and metritis (Plumb 2008). It also facilitates milk let-down and can be used to treat agalactia (Plumb 2008). Its applied use in supporting maternal bonding has not been evaluated in pinnipeds. However, given the low risk when administered to post-partum animals (Plumb 2008) the HMSRP proposes to administer injections of oxytocin to monk seals intramuscularly during interventions to establish/re-establish maternal association.

Oxytocin is contraindicated in some pre-partum conditions but in the postpartum non-pregnant animal, contraindications are few and adverse effects are rare (Plumb 2008). The primary adverse effects to a postpartum female would be uterine discomfort as the drug causes uterine contractions (Plumb 2008), however this hormone is normally circulating in postpartum females and the uterine involution that occurs is a normal and necessary physiological process. In extremely rare situations, if a Hawaiian monk seal were to be pregnant with twins and retained one of them in the uterus due to dystocia, administration of oxytocin could cause adverse effects. This would most likely be avoided by the NMFS PIFSC's established visual health assessment protocols prior to intervention, as a retained pup and placenta would lead to signs of illness that would be readily detectable by field staff.

In regards to changes in the composition of milk after the injection of oxytocin, little to no effects are expected to occur. For example, Oftedal et al. (1988) compared the composition of milk samples from hooded seals obtained after intermuscular administration of oxytocin to chemically immobilized animals with that of milk samples collected immediately postmortem from animals that had been shot and found no difference in sugar or other major constituents. Oftedal et al. (1988) concluded that single injectable doses of oxytocin had little if any effect on milk composition.

In all, the effects of administering oxytocin to adult female Hawaiian monk seals would be similar to that of vaccination and blood collection as there may be minor pain and blood loss during needle insertion. In addition, Hawaiian monk seals may experience slight uterine discomfort as oxytocin stimulates uterine contractions. However, all adverse effects resulting from the injection of oxytocin are minor and temporary. As a result, the administration of oxytocin is likely to adversely affect Hawaiian monk seals. We will consider the impact of the administration of oxytocin to Hawaiian monk seals in the risk analysis below (Section 8.3).

8.2.2.18 Overall Effects of Research and Enhancement Activities

Overall, the effects to Hawaiian monk seals by the NMFS PIFSC's research and enhancement are expected to be beneficial as a whole. Harting et al. (2014) indicated that up to a third of the Hawaiian monk seals alive in the 2012 population comprised of either intervention seals or the descendants of Hawaiian monk seals that were exposed to intervention activities. Disentangling and de-hooking Hawaiian monk seals, for example, unequivocally saves Hawaiian monk seal lives. A total of 885 interventions occurred range-wide from 1980 through 2012 under the NMFS PIFSC's HMSRP. These included 645 interventions classified as mitigating medium- to high-risk threats, involving 532 different Hawaiian monk seals. The benefits of other actions, such as translocation and deworming, are less certain, but are analyzed for efficacy post-hoc using rigorous statistical analysis. This is a fundamental element of the HMSRP approach, whereby enhancement is coupled with research and monitoring to test the efficacy of interventions and adjust as needed to maximize benefits to conservation.

For the research and enhancement activities proposed in the NMFS PIFSC's application, small changes in the population (due to mortalities) would likely amount to an unequivocal change in population status. The majority of the potential lethal takes of females are associated with enhancement activities. These activities will focus on Hawaiian monk seals that are already at elevated risk of natural mortality and enhancement activities are expected to achieve benefits in improved survival.

8.3 Risk Analysis

In this section, we assess the consequences of the responses of individuals that have been exposed to the stressors we have identified as adversely affecting Hawaiian monk seals, the populations those individuals represent, and the species as a whole. Whereas the *Response Analysis* (Section 8.2.2) identified the potential responses of ESA-listed species to the proposed action, this section summarizes our analysis of the expected risk to individuals, populations, and species given the expected exposure to the stressors (as described in Section 8.2.1) and the expected responses to those stressors (as described in Section 8.2.2).

We measure risk to individuals of endangered or threatened species based upon effects on the individual's "fitness," which may be indicated by changes to the individual's growth, survival, annual reproductive fitness, and lifetime reproductive success. When we do not expect ESA-listed animals exposed to an action's effects to experience reductions in fitness, we will not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species as a whole. As a result, if we conclude that ESA-listed animals are not likely to experience reductions in their fitness, we will conclude our assessment. If, however, we conclude that individual animals are likely to experience reductions in fitness, we will assess the consequences of those fitness reductions on the population(s) those individuals belong to.

As stated in the response analysis (Section 8.2.2), the PIFSC's proposed research and enhancement activities may lead to a wide array of adverse effects ranging from behavioral responses (i.e., escape), minor discomfort, pain, potential injury, or mortality of Hawaiian monk seals. As noted in Section 8.2.1, these activities and effects may impact all life stages of Hawaiian monk seal (i.e., nursing pups, weaned pups, juveniles, sub-adults, and adults). More invasive procedures that have resulted in injury or mortality, such as capture and restraint and temporary captivity can, in rare cases, reduce the fitness of a proportion of individual animals that react strongly to the stressors created by these activities. For these individuals (particularly pups or older seals), strong responses will have energetic consequences that could lead to mortality. However, most of the proposed research and enhancement activities and associated mitigation measures are not expected to reduce the long-term fitness of any individual Hawaiian monk seal.

Since all of the activities that are likely to adversely affect Hawaiian monk seals involve some form of direct contact with Hawaiian monk seals ranging from capture and restraint, injection, or specimen sampling, ESA take in the form of harassment and harm are anticipated to occur in response to each of the activities listed in Section 8.2.2. Further, as stated in Section 8.2.1, the MMPA take numbers presented in Table 1 for activities likely to adversely affect Hawaiian monk seals were used to assist in informing the total amount of ESA take that is likely to occur as a result of the proposed action. We adopted these numbers based on the reasoning presented in Section 8.2.1 and their relation to ESA take and individual fitness is presented below.

The annual potential mortality or decrease in fitness includes of a maximum of 30 seals and up to 40 seals over the course of the five-year permit. This mainly consists of 20 aggressive adult males euthanized or captured and taken into permanent captivity over the course of the five year permit. In addition, 10 male and female seals of multiple life stages may be unintentionally killed by research and enhancement activities in a year and 20 over the course of the five year period (see Section 8.2.1 for the life stages and sex of Hawaiian monk seals authorized for unintentional mortality).

In the Programmatic Environmental Impact Statement prepared for issuing permits for Hawaiian monk seal research and enhancement activities, Walters et al. (2014) simulated the loss of 34 individuals, as compared to a baseline of no authorized unintentional mortality. To test the worst-case scenario, they assumed all mortalities "of either sex" to be females. Using a baseline abundance (N=898 animals)[7], they found that the loss of 34 individuals resulted in the reduction of the realized growth rate from 0.985 (95 percent CI=0.971 to 0.998) to 0.981 (95 percent CI=0.968 to 0.994). This difference is not statistically significant (P=0.67) and the confidence intervals overlap considerably. Walters et al. (2014) states that the expected small changes in the population would likely amount to an unclear change in population status. Also, because the losses amount to a small number of individuals, the geographic extent and biological level of the impacts would be minor. Furthermore, Walters et al. (2014) states that the majority of the potential lethal takes during the NMFS PIFSC's research activities are associated with enhancement. As a result, these activities focus on Hawaiian monk seals that are already at elevated risk of natural mortality (i.e., moribund seals) and enhancement activities are expected to achieve benefits in improved survival. In addition, the Hawaiian monk seal population has grown considerably since 2013 with a population size of 1,415 and a positive annual growth rate of four percent (Carretta et al. 2019). Therefore, lethal take of 30 to 40 individuals annually or

[7] Baseline abundance was calculated using 2013 Hawaiian monk seal abundance estimates (N=1,212). At the time the Programmatic Environmental Impact Statement was drafted, Hawaiian monk seals were experiencing an average yearly decline of four percent of the population. This population decline was applied to the 2013 abundance estimate which yielded a ten-year baseline scenario. The baseline scenario projected that in ten years, the mean number of Hawaiian monk seals in the total population would be 898.

over the course of a five-year period will result in even less of an impact to the current Hawaiian monk seal population as a whole.

In addition to mortality, non-lethal ESA take by the PIFSC during its proposed activities that are likely to adversely affect monk seals will mostly lead to short-term fitness consequences illustrated in the response section above. The exposure of 3,814 seals annually (which includes as warranted estimates) to non-lethal take will mostly consist of behavioral responses, minor discomfort or pain, and in rare instances, injury. However, it is important to note that during the PIFSC's 2014 through 2019 research and enhancement activities, only one seal died as a result of the NMFS PIFSC's activities, and none were injured (NMFS 2019). Aside from rare instances of injury, which could lead to direct losses in fitness and reproductive value for an individual, most non-lethal take (>99 percent) will result in short-term fitness losses which are anticipated to be negligible but may have an impact on reproductive value, specifically for adult females, if the disturbance occurred during the mating and pupping season.

Based on our analyses, the proposed action is likely to reduce the fitness of some individuals through lethal and non-lethal take, including eliminating (in the case of mortality) or reducing their reproductive potential, at least temporarily particularly in the case of adult females depending on the severity of disturbance during the mating and pupping season. We discuss how these effects will impact the survival and recovery of Hawaiian monk seals in Section 10.

9 CUMULATIVE EFFECTS

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action areas. We conducted electronic searches of Google and other electronic search engines for other potential future state or private activities that are likely to occur in the action area. We are not aware of any non-Federal actions that are likely to occur in the action areas during the foreseeable future that were not considered in the *Environmental Baseline* (Section 7) of this opinion. Further, we are not aware of any proposed or anticipated changes in fishing that would substantially change the impacts of the proposed activities. However, as noted in Section 7, climate change and impacts from rising sea levels appear to be contributing to losses in habitat used for Hawaiian monk seal mating and pupping in the Northwest Hawaiian Islands.

10 INTEGRATION AND SYNTHESIS

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 8) to the *Environmental Baseline* (Section 7) and the *Cumulative Effects* (Section 9) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the *Status of the Species Likely to be Adversely Affected* (Section 6.2). For this consultation, we determined that the stressors associated with the proposed action may affect, but are not likely to adversely affect designated critical habitat; therefore, only ESA-listed Hawaiian monk seals are discussed in this section and no assessment of whether designated critical habitat will be destroyed or adversely modified was conducted.

The previous discussions summarize the probable risks the proposed action pose to threatened and endangered species that are likely to be exposed to the stressors associated with the research and enhancement activities under Permit No. 22677. These summaries integrate the exposure profiles presented previously with the results of our response analyses for each of the proposed activities determined to be likely to cause adverse effects to Hawaiian monk seals considered in this opinion.

10.1 Hawaiian Monk Seal

A small reduction in numbers is anticipated as a result of the proposed actions. Based on our analysis of the research activities, we expect a maximum of 30 Hawaiian monk seals to succumb to lethal take annually and a maximum of 40 Hawaiian monk seals to succumb to lethal take throughout the entirety of the NMFS PIFSC's proposed five-year permit. Death of an individual monk seal would have a direct fitness consequence to the individual leading to lost reproductive potential. This lost reproductive potential will vary depending on the sex (male or female) and maturity of the individual. The death of a male would have less of an effect on the population than the loss of a female. Loss of a sexually mature female will have immediate effects on recruitment while lost reproductive potential from mortality of a juvenile female might not be realized for several years. However, the maximum amount of lethal take authorized during the proposed activities would be similar to the level assessed in the 2014 Programmatic Environmental Impact Statement, which determined that impacts from the level of mortality would be minor for the Hawaiian monk seal species as a whole (Walters et al. 2014).

Using recent abundance estimates for the Hawaiian monk seal population (N=1,415), the maximum annual lethal take over the proposed five-year research permit will account for a loss of less than three percent of the Hawaiian monk seal population, which is less than the four percent annual growth rate of the population (Carretta et al. 2019). Further, the loss of males and moribund seals (the majority of authorized mortalities) are minimally important to population viability. Non-lethal take is anticipated to impact the entire population resulting in approximately 3,814 exposures, however, as discussed in the risk analysis, these impacts would mostly result in short-term losses in fitness which are mostly anticipated to be negligible but may impact the reproductive value of specific individuals (i.e., adult females) during the nursing and pupping season.

The Final Recovery Plan for Hawaiian monk seals states that the ultimate goal of the plan is to assure the long-term viability of the Hawaiian monk seal in the wild, allowing initially for reclassification to threatened status and, ultimately, removal from the List of Endangered and Threatened Wildlife. In addition, the following recovery actions presented in the 2007 Hawaiian Monk Seal Recovery Plan (NMFS 2007d) are relevant to the overall purpose of the proposed actions:

- Prevent entanglements of monk seals
- Reduce shark predation on monk seals
- Minimize exposure and spread of infectious disease
- Conserve Hawaiian monk seal habitat
- Reduce Hawaiian monk seal interactions with fisheries
- Use diet analysis, foraging studies, nutritional status, and ecosystem monitoring to evaluate possible competition with fisheries.
- Reduce the likelihood and impact of human disturbance
- Reduce impacts from compromised and grounded vessels
- Reduce the impact of contaminants
- Continue population monitoring and research

As noted, the population of Hawaiian monk seals may be increasing. The anticipated lethal and non-lethal take of Hawaiian monk seals as a result of research and enhancement activities (specifically capture and restraint, remote chemical capture, sedation/anesthesia, specimen collection/health screening, marking, tagging, external instrument attachment, behavioral modification, translocation, temporary captivity, euthanasia, permanent captivity, disentanglement/dehooking, deworming/administration of drugs, supplemental feeding, vaccination, and administration of oxytocin) could affect the fitness of individual animals, but we believe the implementation of best management practices, protocols, and other conservation measures will minimize the effects of the proposed action on Hawaiian monk seals. For this reason, we believe the action is not likely to impede the recovery objectives above for Hawaiian monk seals, particularly given that the proposed action is focused on achieving the recovery objectives for this species, and will not result in an appreciable reduction in the likelihood of the recovery of this species in the wild. Therefore, we conclude the proposed action is not likely to jeopardize the continued existence of Hawaiian monk seals in the wild.

11 CONCLUSION

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of consequential actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Hawaiian monk seals.

12 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (16 U.S.C. §1532(19)). NMFS defines "Harm" as "an act which actually kills or injures fish or wildlife and may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR 222.102). NMFS' interim guidance defines "Harass" as an act that "creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering" (NMFSPD 02-110-19). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

All research and enhancement activities associated with the proposed issuance of Permit No. 22677 involved directed take for the purposes of scientific research and recovery. Therefore, the NMFS does not expect the proposed action will incidentally take threatened or endangered species. However, we request that the NMFS Permits and Conservation Division report to us whether the MMPA-authorized take specified in Table 1 actually occurs and the actual numbers of take in comparison to the permitted MMPA take numbers at the expiration of the permit, as well as any available information on the response animals exhibited to those takes. Such information will be used to inform the *Environmental Baseline* and *Effects of the Action* for future consultations for the authorization of permits to the NMFS PIFSC, and other similar research activities permitted by the NMFS Permits and Conservation Division.

13 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

We make the following conservation recommendations, which will provide information for future consultations involving the issuance of permits that may affect ESA-listed marine mammals, sea turtles, and fish:

- **Documentation of Responses in Annual Reports**
    - Researchers should thoroughly document the time spent in all attempted capture and release activities and the responses of target animals to these activities in order to assess stress responses on the part of these animals and develop measures to further minimize the stress responses resulting from capture and restraint activities. In addition, researchers should thoroughly document the behavioral reactions to all biological sampling and tagging activities in order to determine whether additional measures to further minimize stress are needed. Researchers should submit this information to the NMFS Permits and Conservation Division as part of their required annual reporting. The NMFS Permits and Conservation Division should post this information on their Authorizations and Permits for Protected Species online database (https://apps.nmfs.noaa.gov/) including all attachments detailing the results.
- **Documentation of Responses in Future Permit Applications**
    - The NMFS Permits and Conservation Division should require that all researchers conducting invasive tagging of pinnipeds provide detailed information on the responses they have observed from their past research. Researchers should provide a high-level of detail in their application and supporting materials to inform recommendations related to minimizing impacts of invasive tagging on ESA-listed pinnipeds. These reports should be provided to the NMFS ESA Interagency and Cooperation Division during future Section 7 consultations involving pinniped research and enhancement activities.
- **Results of Tagging**
    - The NMFS Permits and Conservation Division should gather data from researchers conducting invasive tagging of pinnipeds to provide detailed information on how many tags were successfully deployed, how many tags were unsuccessfully deployed, how many tags failed to transmit entirely, and how many tags were delayed and for how long in transmitting after deployment. This should be provided as part of the annual reporting.
- **Data Sharing**
    - The NMFS Permits and Conservation Division should work to establish protocols for data sharing among all permit holders. While many researchers in the community collaborate, having a national standard for data sharing among all

researchers permitted by the NMFS will reduce impacts to trusted resources by minimizing duplicative research and enhancement efforts. We recommend basic reporting information be required from each researcher including the species, location, number of individuals, and age, sex, and identity (if known) at the expiration of each permit. This information would further inform the tracking of impacts of multiple research and enhancement activities on ESA-listed pinnipeds.

- **Aggregate Take Tracking**
  - The NMFS Permits and Conservation Division should develop a system for tracking and evaluating the extent of take issued and that which is realized for any given population of ESA-listed species. The NMFS Permits and Conservation Division's current permit tracking allows tracking of individual permit takes. For the purpose of understanding the extent of research and enhancement at broad scales (e.g., number of research permits in a particular region), it remains difficult to quantify the extent of take each individual population of ESA-listed species may be subject to across permits for any given period of time. Such aggregate take tracking would be better enable us to evaluate the impacts of multiple, simultaneous research and enhancement efforts on ESA-listed species.
- **Designated Critical Habitat**
  - We recommend that the NMFS Permits and Conservation Division include terms and conditions in the scientific research permits to actively avoid, to the maximum extent practicable, designated critical habitat for the Main Hawaiian Islands Insular DPS of false killer whale and Hawaiian monk seal. The NMFS Permits and Conservation Division should use best management practices within Papahānaumokuākea Marine National Monument (2008) to develop these terms and conditions.
- **Action Agency**
  - We recommend the NMFS PIFSC consult with the NMFS ESA Interagency Cooperation Division on the funding and/or carrying out their research and enhancement activities, in addition to the NMFS Permits and Conservation Division for the proposed issuance of scientific research and enhancement permits, as they are also part of the same Federal agency that should ensure that their actions are not likely to jeopardize the continued existence of threatened or endangered species, or adversely modify or destroy their designated critical habitat.
- **Programmatic Consultation**
  - We recommend the NMFS Permits and Conservation Division continue to work collaboratively with the NMFS ESA Interagency Cooperation Division to explore opportunities for developing and consulting on scientific research permit programmatic consultations for other ESA-listed species and/or tax (e.g., pinnipeds).

- **Improving Best Management Practices**
    - We recommend the NMFS Permits and Conservation Division work with the PIFSC to continue developing and implementing innovative best management practices for the protection of non-target species, specifically sea turtles, during its proposed research and enhancement activities. Also, we recommend the NMFS Permits and Conservation Division work with the PIFSC to implement methods to prevent any loss in fitness or reproductive value for adult female Hawaiian monk seals during important times of the year for the species (i.e., mating and pupping season).

In order for NMFS ESA Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their designated critical habitat, The NMFS Permits and Conservation Division should notify the ESA Interagency Cooperation Division of any conservation recommendations they implement in their final action.

14 Reinitiation Notice

This concludes formal consultation for the NMFS Permits and Conservation Division's proposed action to issue Permit No. 22677. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(1) The amount or extent of taking specified in the incidental take statement is exceeded.
(2) New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
(3) The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion.
(4) A new species is listed or critical habitat designated under the ESA that may be affected by the action.

15 References

Acevedo-Whitehouse, K., A. Rocha-Gosselin and D. Gendron, 2010. A novel non-invasive tool for disease surveillance of free-ranging whales and its relevance to conservation programs. Animal Conservation, 13(2): 217-225.

Aguirre, A.A., T.J. Keefe, J.S. Reif, L. Kashinsky, P.K. Yochem, J.T. Saliki, J.L. Stott, T. Goldstein, J.P. Dubey, R. Braun and G. Antonelis, 2007. Infectious disease monitoring of the endangered hawaiian monk seal. Journal of Wildlife Diseases, 43: 229-241.

Albert, D.J., 2011. What's on the mind of a jellyfish? A review of behavioural observations on aurelia sp. Jellyfish. Neurosci Biobehav Rev, 35(3): 474-482. Available from https://www.ncbi.nlm.nih.gov/pubmed/20540961. DOI 10.1016/j.neubiorev.2010.06.001.

Allen, M.R., H. de Coninck, O.P. Dube and D.J. Heogh-Guldberg Ove; Jacob, Kejun; Revi, Aromar; Rogelj, Joeri; Roy, Joyashree; Shindell, Drew; Solecki, William; Taylor, Michael; Tschakert, Petra; Waisman, Henri; Halim, Sharina Abdul; Antwi-Agyei, Philip; Aragón-Durand, Fernando; Babiker, Mustafa; Bertoldi, Paolo; Bindi, Marco; Brown, Sally; Buckeridge, Marcos; Camilloni, Ines; Cartwright, Anton; Cramer, Wolfgang; Dasgupta, Purnamita; Diedhiou, Arona; Djalante, Riyanti; Dong, Wenjie; Ebi, Kristie L.; Engelbrecht, Francois; Fifita, Solomone; Ford, James; Forster, Piers; Fuss, Sabine; Hayward, Bronwyn; Hourcade, Jean-Charles; Ginzburg, Veronika; Guiot, Joel; Handa, Collins; Hijioka, Yasuaki; Humphreys, Stephen; Kainuma, Mikiko; Kala, Jatin; Kanninen, Markku; Kheshgi, Haroon; Kobayashi, Shigeki; Kriegler, Elmar; Ley, Debora; Liverman, Diana; Mahowald, Natalie; Mechler, Reinhard; Mehrotra, Shagun; Mulugetta, Yacob; Mundaca, Luis; Newman, Peter; Okereke, Chukwumerije; Payne, Antony; Perez, Rosa; Pinho, Patricia Fernanda; Revokatova, Anastasia; Riahi, Keywan; Schultz, Seth; Séférian, Roland; Seneviratne, Sonia I.; Steg, Linda; Suarez Rodriguez, Avelino G.; Sugiyama, Taishi; Thomas, Adelle; Vilariño, Maria Virginia; Wairiu, Morgan; Warren, Rachel; Zhou, Guangsheng; Zickfeld, Kirsten, 2018. Technical summary. In: *Global warming of 1.5°c. An ipcc special report on the impacts of global warming of 1.5°c above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [v. Masson-delmotte, p. Zhai, h. O. Pörtner, d. Roberts, j. Skea, p.R. Shukla, a. Pirani, w. Moufouma-okia, c. Péan, r. Pidcock, s. Connors, j. B. R. Matthews, y. Chen, x. Zhou, m. I. Gomis, e. Lonnoy, t. Maycock, m. Tignor, t. Waterfield (eds.)].

Baker, J., D.,, L.L. Charles and W.J. David, 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the northwestern hawaiian islands. Endangered Species Research, 2: 21-30. Available from https://www.int-res.com/abstracts/esr/v2/p21-30/.

Baker, J.D., 2008. Variation in the relationship between offspring size and survival provides insight into causes of mortality in hawaiian monk seals. Endangered Species Research, 5: 55-64. DOI 10.3354/esr00122.

Baker, J.D., B.L. Becker, T.A. Wurth, T.C. Johanos, C.L. Littnan and J.R. Henderson, 2011. Translocation as a tool for conservation of the hawaiian monk seal. Biological Conservation, 144(11): 2692-2701. Available from http://www.sciencedirect.com/science/article/pii/S000632071100293X. DOI https://doi.org/10.1016/j.biocon.2011.07.030.

Baker, J.D., A.L. Harting, M.M. Barbieri, S.J. Robinson, F.M.D. Gulland and C.L. Littnan, 2017. Modeling a morbillivirus outbreak in hawaiian monk seals (neomonachus schauinslandi) to aid in the design of mitigation programs. Journal of wildlife diseases, 53(4): 736-748. DOI 10.7589/2016-10-238.

Baker, J.D., A.L. Harting, T.C. Johanos and C.L. Littnan, 2016. Estimating hawaiian monk seal range-wide abundance and associated uncertainty. Endangered Species Research, 31: 317-324. DOI 10.3354/esr00782.

Baker, J.D., A.L. Harting and C.L. Littnan, 2013. A two-stage translocation strategy for improving juvenile survival of hawaiian monk seals. Endangered Species Research, 21(1): 33-44. Available from https://www.int-res.com/abstracts/esr/v21/n1/p33-44/.

Baker, J.D., E. Howell and J. Polovina, 2012. Relative influence of climate variability and direct anthropogenic impact on a sub-tropical pacific top predator, the hawaiian monk seal. Marine Ecology Progress Series, 469: 175-189. DOI 10.3354/meps09987.

Baker, J.D. and T.C. Johanos, 2002. Effects of research handling on the endangered hawaiian monk seal. Marine Mammal Science, 18(2): 500-512. Available from <Go to ISI>://000175164000012.

Baker, J.D., T.C. Johanos, T.A. Wurth and C.L. Littnan, 2014. Body growth in hawaiian monk seals. Mar. Mamm. Sci., 30(1): 259-271. Available from https://doi.org/10.1111/mms.12035 [Accessed 2019/11/06]. DOI 10.1111/mms.12035.

Beale, C.M. and P. Monaghan, 2004. Human disturbance: People as predation-free predators? Journal of Applied Ecology, 41: 335-343.

Bearzi, G., 2000. First report of a common dolphin (*delphinus delphis*) death following penetration of a biopsy dart. Journal of Cetacean Research and Management, 2(3): 217-222.

Bennet, D.H., C.M. Falter, S.R. Chipps, K. Niemela and J. Kinney, 1994. Effects of underwater sound simulating the intermediate scale measurement system on fish and zooplankton of lake pend orielle, idaho. Department of Fish and Wildlife Resources, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, Idaho.

Bertilsson-Friedman, P., 2006. Distribution and frequencies of shark-inflicted injuries to the endangered hawaiian monk seal (monachus schauinslandi). Journal of Zoology, 268: 361-368. DOI 10.1111/j.1469-7998.2006.00066.x.

Bottein, M.Y., L. Kashinsky, Z. Wang, C. Littnan and J.S. Ramsdell, 2011. Identification of ciguatoxins in hawaiian monk seals (*monachus schauinslandi*) from the northwestern and main hawaiian islands. Environmental Science and Technology, 45(12): 5403-5409. Available from http://www.ncbi.nlm.nih.gov/pubmed/21591690. DOI 10.1021/es2002887.

Brown, R., S. Jeffries, B. Wright, M. Tennis, P. Gearin, S. Riemer and D. Hatch, 2008. Field report: 2007 pinniped research and management activities at bonneville dam.

Budelmann, B.U., 1992. Hearing in nonarthropod invertebrates. In d. B. Webster, r. R. Fay, and a. N. Popper (eds.), evolutionary biology of hearing (pp. 141–155). New york, ny: Springer-verlag.

Busch, D.S. and L.S. Hayward, 2009. Stress in a conservation context: A discussion of glucocorticoid actions and how levels change with conservation-relevant variables. Biological Conservation, 142(12): 2844-2853. Available from http://www.sciencedirect.com/science/article/B6V5X-4X5HY76-2/2/d033e2831537ec1c22623b0300258b8d.

Carretta, J.V., K.A. Forney, E.M. Oleson, D.W. Weller, A.e.R. Lang, J.D. Baker, M. Muto, B. Hanson, A.J. Orr, H.R. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell and R.L. Brownell, 2019. U.S. Pacific marine mamal stock assessments: 2018. Available from https://repository.library.noaa.gov/view/noaa/20266. DOI https://doi.org/10.25923/x17q-2p43.

Carretta, J.V., V. Helker, M.M. Muto, J. Greenman, K. Wilkinson, D. Lawson, J. Viezbicke and J. Jannot, 2018. Sources of human-related injury and mortality for u.S. Pacific west coast marine mammal stock assessments, 2012-2016. US Department of Commerce.

Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, D. Lynch, L. Carswell, R. Brownell Jr. and D. Mattila, 2014. U. S. Pacific marine mammal stock assessments, 2013. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center: pp: 414.

Carretta, J.V., E.M. Oleson, A.e.R. Lang, D.W. Weller, J.D. Baker, M. Muto, B. Hanson, A.J. Orr, H.R. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell and R.L. Brownell, 2017. U.S. Pacific marine mammal stock assessments, 2016. Available from https://repository.library.noaa.gov/view/noaa/14915. DOI http://doi.org/10.7289/V5/TM-SWFSC-577.

Cattet, M.R.L., K. Christison, N.A. Caulkett and G.B. Stenhouse, 2003. Physiologic responses of grizzly bears to different methods of capture. J. Wildl. Dis., 39(3-Jan): 649-654. Available from <Go to ISI>://000185459200019.

Champagne, C.D., D.S. Houser, D.P. Costa and D.E. Crocker, 2012. The effects of handling and anesthetic agents on the stress response and carbohydrate metabolism in northern elephant seals. PLoS One, 7(5): e38442-e38442. Available from https://www.ncbi.nlm.nih.gov/pubmed/22693622

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3365037/. DOI 10.1371/journal.pone.0038442.

Chance, R., T.D. Jickells and A.R. Baker, 2015. Atmospheric trace metal concentrations, solubility and deposition fluxes in remote marine air over the south-east atlantic. Marine Chemistry, 177: 45-56. DOI 10.1016/j.marchem.2015.06.028.

Conn, P.B. and G.K. Silber, 2013. Vessel speed restrictions reduce risk of collision-related mortality for north atlantic right whales. Ecosphere, 4(4): art43. DOI 10.1890/es13-00004.1.

Cowan, D.E. and B.E. Curry, 1998. Investigation of the potential influence of fishery-induced stress on dolphins in the eastern tropical pacific ocean: Research planning. National Marine Fisheries Service, Southwest Fisheries Science Center.

Cowan, D.E. and B.E. Curry, 2002. Histopathological assessment of dolphins necropsied onboard vessels in the eastern tropical pacific tuna fishery. National Marine Fisheries Service, Southwest Fisheries Science Center.

Cowan, D.E. and B.E. Curry, 2008. Histopathology of the alarm reaction in small odontocetes. J. Comp. Pathol., 139(1): 24-33. Available from http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WHW-4SRM8D5-1&_user=3615566&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000060967&_version=1&_urlVersion=0&_userid=3615566&md5=cdc4e38e365ae382f0fc59bd710b50ce; <Go to ISI>://000258181400004. DOI 10.1016/j.jcpa.2007.11.009.

Cox, T.M., T.J. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T.W. Cranford, L. Crum, A. D'amico, G. D'spain, A. Fernandez, J.J. Finneran, R. Gentry, W. Gerth, F. Gulland, J.A. Hildebrand, D.S. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. Macleod, P. Miller, S. Moore, D.C. Mountain, D. Palka, P.J. Ponganis, S.A. Rommel, T. Rowles, B.L. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J.G. Mead and L. Benner, 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management, 7(3): 177-187.

Craig, M.P. and T.J. Ragen, 1999. Body size, survival, and decline of juvenile hawaiian monk seals, monachus schauinslandi. . Mar. Mamm. Sci., 15(3): 786-809. Available from https://doi.org/10.1111/j.1748-7692.1999.tb00843.x [Accessed 2019/11/06]. DOI 10.1111/j.1748-7692.1999.tb00843.x.

Daan, N., 1996. Multispecies assessment issues for the north sea. In: E.K.PikitchD.D.Huppert and M.P.Sissenwine, (Eds.), pp: 126-133.

Dale, J.J., C.G. Meyer and C.E. Clark, 2011a. The ecology of coral reef top predators in the papahānaumokuākea marine national monument. Journal of Marine Biology, 2011: 1-14. DOI 10.1155/2011/725602.

Dale, J.J., A.M. Stankus, M.S. Burns and C.G. Meyer, 2011b. The shark assemblage at french frigate shoals atoll, hawai'i: Species composition, abundance and habitat use. PLoS One, 6(2): e16862. DOI 10.1371/journal.pone.0016962.g001.

Dameron, O.J., M. Parke, M.A. Albins and R. Brainard, 2007. Marine debris accumulation in the northwestern hawaiian islands: An examination of rates and processes. Mar Pollut Bull, 54(4): 423-433. DOI 10.1016/j.marpolbul.2006.11.019.

Davis, R.W., L.A. Fuiman, T.M. Williams, S.O. Collier, W.P. Hagey, S.B. Kanatous, S. Kohin and M. Horning, 1999. Hunting behavior of a marine mammal beneath the antarctic fast ice. Science, 283(5404): 993. Available from http://science.sciencemag.org/content/283/5404/993.abstract. DOI 10.1126/science.283.5404.993.

Dehnhardt, G., B. Mauck, W. Hanke and H. Bleckmann, 2001. Hydrodynamic trail-following in harbor seals (phoca vitulina). Science, 293(5527): 102-104. Available from http://www.ncbi.nlm.nih.gov/pubmed/11441183. DOI 10.1126/science.1060514.

Dickens, M.J., D.J. Delehanty and L.M. Romero, 2010. Stress: An inevitable component of animal translocation. Biological Conservation, 143(6): 1329-1341. Available from <Go to ISI>://000278572300003; http://ac.els-cdn.com/S000632071000073X/1-s2.0-S000632071000073X-main.pdf?_tid=eb0f8ad6-a933-11e3-9e0d-00000aacb361&acdnat=1394552800_5f0e3b586080082cee3eb60628a3bb63. DOI 10.1016/j.biocon.2010.02.032.

Dierauf, L. and M. Gulland, 2001a. Marine mammal unusual mortality events. In: Crc handbook of marine mammal medicine. CRC Press: pp: 69-81.

Dierauf, L.A., F.M.D. Gulland and K.L. Whitman, 2018. Crc handbook of marine mammal medicine, third edition. Boca Raton: CRC Press LLC.

Dierauf, L.A. and F.M.D. Gulland, 2001b. Crc handbook of marine mammal medicine. Second Edition Edn., Boca Raton, Florida: CRC Press.

Doney, S.C., M. Ruckelshaus, J.E. Duffy, J.P. Barry, F. Chan, C.A. English, H.M. Galindo, J.M. Grebmeier, A.B. Hollowed and N. Knowlton, 2012. Climate change impacts on marine ecosystems. Marine Science, 4.

Donohue, M., R. Brainard, M. Parke and D. Foley, 2000. Mitigation of environmental impacts of derelict fishing gear through debris removal and environmental monitoring.

Donohue, M.J., R.C. Boland, C.M. Sramek and G.A. Antonelis, 2001. Derelict fishing gear in the northwestern hawaiian islands: Diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. Marine Pollution Bulletin, 42(12): 1301-1312. Available from http://www.sciencedirect.com/science/article/pii/S0025326X01001394. DOI https://doi.org/10.1016/S0025-326X(01)00139-4.

Duce, R.A., P.S. Liss, J.T. Merrill, E.L. Atlas, P. Buat-Menard, B.B. Hicks, J.M. Miller, J.M. Prospero, R. Arimoto, T.M. Church, W. Ellis, J.N. Galloway, L. Hansen, T.D. Jickells, A.H. Knap, K.H. Reinhardt, B. Schneider, A. Soudine, J.J. Tokos, S. Tsunogai, R. Wollast and M. Zhou, 1991. The atmospheric input of trace species to the world ocean. Global Biogeochemical Cycles, 5(3): 193-259. DOI 10.1029/91gb01778.

Elftman, M.D., C.C. Norbury, R.H. Bonneau and M.E. Truckenmiller, 2007. Corticosterone impairs dendritic cell maturation and function. Immunology, 122(2): 279-290. Available from <Go to ISI>://000249429400014. DOI 10.1111/j.1365-2567.2007.02637.x.

Feare, C.J., 1976. Desertion and abnormal development in a colony of sooty terns infested by virus-infected ticks. Ibis, 118: 112-115.

Finneran, J.J., 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. Journal of the Acoustical Society of America, 138(3): 1702-1726. Available from http://scitation.aip.org/docserver/fulltext/asa/journal/jasa/138/3/1.4927418.pdf?expires=1449078832&id=id&accname=guest&checksum=5989B1D35DA67FCA6869CD2032968804.

Fonfara, S., U. Siebert, A. Prange and F. Colijn, 2007. The impact of stress on cytokine and haptoglobin mrna expression in blood samples from harbour porpoises (phocoena phocoena). Journal of the Marine Biological Association of the United Kingdom, 87(1): 305-311.

Forrest, K., J. Cave, C. Michielsens, M. Haulena and D. Smith, 2009. Evaluation of an electric gradient to deter seal predation on salmon caught in gill-net test fisheries. North American Journal of Fisheries Management, 29: 885-894. DOI 10.1577/M08-083.1.

Fowler, M.E., 1986a. Zoo and wild animal medicine. Philadelphia, Pennsylvania: W.B. Saunders Company.

Fowler, M.E., 1986b. Zoo and wild animal medicine. 2nd edition. Philadelphia, Pennsylvania: W.B. Saunders Company.

Francis, C.D.J.R.B., 2013. A framework for understanding noise impacts on wildlife: An urgent conservation priority. Frontiers in Ecology and the Environment, 11(6): 305-313.

Frid, A., 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation, 110(3): 387-399.

Frid, A. and L. Dill, 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology, 6(1).

Gage, L.J., 1993. Marine mammals. In: Zoo and wild animal medicine: Current therapy, 3rd edition, M. E. Fowler, (Ed.). W.B. Saunders Co., Philadelphia, Pennsylvania.

Gall, S.C. and R.C. Thompson, 2015. The impact of debris on marine life. Marine Pollution Bulletin, 92(2-Jan): 170-179. Available from http://www.ncbi.nlm.nih.gov/pubmed/25680883. DOI 10.1016/j.marpolbul.2014.12.041.

Garcia-Parraga, D., J.A. Gilabert, F.J. Garcia-Pena, T. Alvaro, J.M. Ros-Rodriguez, M. Valls and T. Encinas, 2016. Long-lasting concentrations of cefovecin after subcutaneous and intramuscular administration to patagonian sea lions (otaria flavescens). Veterinary journal (London, England : 1997), 208: 65-69. DOI 10.1016/j.tvjl.2015.09.015.

Gauthier, J. and R. Sears, 1999. Behavioral response of four species of balaenopterid whales to biopsy sampling. Marine Mammal Science [Mar. Mamm. Sci.]. Vol. 15, no. 1, pp. 85-101. Jan 1999.

Gearin, P.J., R. Pfeifer, S. J. Jeffries, R. L. DeLong and M.A. Johnson., 1988. Results of the 1986-1987 california sea lion-steelhead trout predation control program at the hiram m. Chittenden locks. NWAFC Processed Rep. 88-30, 111 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115.

Gemmell, N.J. and P. Majluf, 1997. Projectile biopsy sampling of fur seals. Marine Mammal Science, 13(3): 512-516. Available from https://doi.org/10.1111/j.1748-7692.1997.tb00661.x [Accessed 2019/03/22]. DOI 10.1111/j.1748-7692.1997.tb00661.x.

Geraci, J.R., 1990. Physiological and toxic effects on cetaceans. Pp. 167-197 *In:* Geraci, J.R. and D.J. St. Aubin (eds), Sea Mammals and Oil: Confronting the Risks. Academic Press, Inc.

Giese, M., 1996. Effects of human activity on adelie penguin (pygoscelis adeliae) breeding success. Biological Conservation, 75: 157-164.

Gill, J.A., K. Norris and W.J. Sutherland, 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation, 97: 265-268.

Gobush, K., J. Baker and F. Gulland, 2011. Effectiveness of an antihelminthic treatment in improving the body condition and survival of hawaiian monk seals. Endangered Species Research, 15(1): 29-37.

Gobush, K., T. Wurth, J. Henderson, B. Becker and C. Littnan, 2016. Prevalence of interactions between hawaiian monk seals (nemonachus schauinslandi) and nearshore fisheries in the main hawaiian islands. Pacific Conservation Biology, 23. DOI 10.1071/PC15029.

Gobush, K., T. Wurth, J. Henderson, B. Becker and C. Littnan, 2017. Prevalence of interactions between hawaiian monk seals (nemonachus schauinslandi) and nearshore fisheries in the main hawaiian islands. Pacific Conservation Biology, 23(1): 25-31.

Gobush, K.S., 2010. Shark predation on hawaiian monk seals: Workshop ii and post-workshop developments. N. P. I. F. S. C. NOAA (Ed.). Department of Commerce, Honolulu, Hawaii: pp: 43.

Goodman-Lowe, G.D., 1998. Diet of the hawaiian monk seal (monachus schauinslandi) from the northwestern hawaiian islands during 1991 to 1994. Marine Biology, 132(3): 535-546. Available from https://doi.org/10.1007/s002270050419. DOI 10.1007/s002270050419.

Grant, S.C.H. and P.S. Ross, 2002. Southern resident killer whales at risk: Toxic chemicals in the british columbia and washington environment. In: Canadian Technical Report of Fisheries and Aquatic Sciences 2412. Fisheries and Oceans Canada., Sidney, B.C.: pp: 124.

Greaves, D.K., M.O. Hammill, J.D. Eddington, D. Pettipas and J.F. Schreer, 2004. Growth rate and shedding of vibrissae in the gray seal, halichoerus grypus: A cautionary note for stable isotope diet analysis. Mar. Mamm. Sci., 20(2): 296-304. Available from https://doi.org/10.1111/j.1748-7692.2004.tb01158.x [Accessed 2019/11/06]. DOI 10.1111/j.1748-7692.2004.tb01158.x.

Greenlaw, C.F., 1987. Psychoacoustics and pinnipeds. In: Acoustical deterrents in marine mammal conflicts with fisheries, B. R. Mate and T. J. Harvey, (Eds.). Oregon Sea Grant Publication.

Greer, A.W., 2008. Trade-offs and benefits: Implications of promoting a strong immunity to gastrointestinal parasites in sheep. Parasite Immunology, 30(2): 123–132. Available from http://onlinelibrary.wiley.com/store/10.1111/j.1365-3024.2008.00998.x/asset/j.1365-3024.2008.00998.x.pdf?v=1&t=ie4adnli&s=8597687b96e362166fd1a6ff184ab6818a031199.

Gulko, D., J. Maragos, A. Friedlander, C. Hunter and R. Brainard, 2000. Status of coral reefs in the hawaiian archipelago. In: Status of coral reefs of the world: 2000. Australian Institute of Marine Science, Cape Ferguson, Queensland, and Dampier, Western Australia.

Gulland, F.M.D., M. Haulena, L.J. Lowenstine, C. Munro, P.A. Graham, J. Bauman and J. Harvey, 1999. Adrenal function in wild and rehabilitated pacific harbor seals (phoca vitulina richardii) and in seals with phocine herpesvirus-associated adrenal necrosis. Marine Mammal Science, 15(3): 810-827.

Harrington, F.H. and A.M. Veitch, 1992. Calving success of woodland caribou exposed to low-level jet fighter overflights. Arctic, 45(3): 213-218.

Harting, A., T. Johanos and C. Littnan, 2014. Benefits derived from opportunistic survival-enhancing interventions for the hawaiian monk seal: The silver bb paradigm. Endangered Species Research, 25: 89-96. DOI 10.3354/esr00612.

Haulena, M. and R.B. Heath, 2001. Marine mammal anesthesia. pp: 655-688.

Haulena, M. and T. Schmitt, 2018. Anesthesia. In: Crc handbook of marine mammal medicine, third edition, L. A. DieraufF.M.D. Gulland and K. L. Whitman, (Eds.). CRC Press LLC, Boca Raton: pp: 587-606.

Hayhoe, K., S. Doherty, J.P. Kossin, W.V. Sweet, R.S. Vose, M.F. Wehner and D.J. Wuebbles, 2018. In *impacts, risks, and adaptation in the united states: Fourth national climate assessment, volume ii* (reidmiller, d.R., et al. [eds.]). U.S. Global Change Research Program, Washington, DC, USA. DOI 10.7930/NC4.2018.CH2.

Hazen, E.L., S. Jorgensen, R.R. Rykaczewski, S.J. Bograd, D.G. Foley, I.D. Jonsen, S.A. Shaffer, J.P. Dunne, D.P. Costa, L.B. Crowder and B.A. Block, 2012. Predicted habitat shifts of pacific top predators in a changing climate. Nature Climate Change, 3(3): 234-238. DOI 10.1038/nclimate1686.

HDOA, 2018. Aquaculture in hawaii. Hawaii Department of Agriculture, Animal Industry Division, http://hdoa.hawaii.gov/ai/aquaculture-and-livestock-support-services-branch/aquaculture-in-hawaii/.

Heffman, G., BB Collette, DE Facey and B.W. Bowen, 2009. Early life history. In: The diversity of fishes: Biology, evolution and ecology, G. HeffmanBB ColletteDE Facey and B. W. Bowen, (Eds.). Wiley-Blackwell: pp: 129-139.

Henderson, J.R., 2001. A pre and post marpol annex v summary of hawaiian monk seal entanglements and marine debris accumulation in the northwestern hawaiian islands, 1982_1998. Mar. Pollut. Bull., 42: 584-589.

Henderson, J.R., 2018a. Hawaiian monk seal research program hawaiian monk seal entanglement data collected in the hawaiian archipelago, 1974-2016. US National Oceanographic Data Center.

Henderson, J.R., 2018b. Hawaiian monk seal research program hawaiian monk seal fisheries interaction data collected in the hawaiian archipelago, 1976-2016. US National Oceanographic Data Center.

Henderson, J.R. and T.C. Johanos, 1988. Effects of tagging on weaned hawaiian monk seal pups. Wildl. Soc. Bull., 16(3): 312-317. Available from <Go to ISI>://A1988Q121800013.

Herraez, P., E. Sierra, M. Arbelo, J.R. Jaber, A.E. de los Monteros and A. Fernandez, 2007. Rhabdomyolysis and myoglobinuric nephrosis (capture myopathy) in a striped dolphin. J. Wildl. Dis., 43(4): 770–774. Available from http://www.jwildlifedis.org/cgi/content/abstract/43/4/770

<Go to ISI>://000251034100028

http://www.jwildlifedis.org/doi/pdf/10.7589/0090-3558-43.4.770.

Hildebrand, J., 2004. Impacts of anthropogenic sound on cetaceans. Unpublished paper submitted to the International Whaling Commission Scientific Committee SC/56 E, 13.

Hildebrand, J.A., 2009. Metrics for characterizing the sources of ocean anthropogenic noise. Journal of the Acoustical Society of America, 125(4): 2517.

Hirons, A.C., D.M. Schell and D.J. St. Aubin, 2001a. Growth rates of vibrissae of harbor seals (<i>phoca vitulina</i>) and steller sea lions (<i>eumetopias jubatus</i>). Canadian Journal of Zoology, 79(6): 1053-1061. DOI 10.1139/cjz-79-6-1053.

Hirons, A.C., D.M. Schell and D.J. St. Aubin, 2001b. Growth rates of vibrissae of harbor seals (phoca vitulina) and steller sea lions (eumetopias jubatus). Canadian Journal of Zoology, 79(6): 1053-1061. Available from https://doi.org/10.1139/z01-055 [Accessed 2019/11/06]. DOI 10.1139/z01-055.

Hiruki, L.M. and T.J. Ragen, 1992. A compilation of historical monk seal, monachus schauinslandi, counts. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center: pp: 183.

Hoberecht, L., D. J. Vos and G. R. VanBlaricom, 2006. A remote biopsy system used to sample steller sea lion (eumetopias jubatus) blubber.

Hobson, K. and H.E. Welch, 1992. Determination of trophic relationships within a high arctic marine food web using ??13c and ??15n analysis. Marine Ecology-progress Series - MAR ECOL-PROGR SER, 84: 9-18. DOI 10.3354/meps084009.

Hobson, K.A., D.M. Schell, D. Renouf and E. Noseworthy, 1996. Stable carbon and nitrogen isotopic fractionation between diet and tissues of captive seals: Implications for dietary reconstructions involving marine mammals. Canadian Journal of Fisheries and Aquatic Sciences, 53(3): 528-533. Available from https://doi.org/10.1139/f95-209 [Accessed 2019/11/06]. DOI 10.1139/f95-209.

Holt, M.M., 2008. Sound exposure and southern resident killer whales (*orcinus orca*): A review of current knowledge and data gaps. In: NOAA Technical Memorandum. U.S. Department of Commerce: pp: 59.

Hunt, K.E., R.M. Rolland, S.D. Kraus and S.K. Wasser, 2006. Analysis of fecal glucocorticoids in the north atlantic right whale (eubalaena glacialis). Gen Comp Endocrinol, 148(2): 260-272. Available from http://www.ncbi.nlm.nih.gov/pubmed/16650423. DOI 10.1016/j.ygcen.2006.03.012.

Illingworth, R. and R. Rodkin, 2001. Noise and vibration measurements associated with the pile installation demonstration project for the san francisco-oakland bay bridge east span. Technical Report of Illingworth & Rodkin, Inc., Petaluma, CA.

Illingworth, R. and R. Rodkin, 2007. Compendium of pile driving sound data. Prepared for the California Department of Transportation, Sacramento, CA.

Insley, S., A. Phillips and I. Charrier, 2003. A review of social recognition in pinnipeds. Aquatic Mammals: 181-201. DOI 10.1578/016754203101024149.

IPCC, 2014. Climate change 2014: Impacts, adaptation, and vulnerability. Ipcc working group ii contribution to ar5. Intergovernmental Panel on Climate Change.

IPCC, 2018. Summary for policymakers. In: *Global warming of 1.5°c. An ipcc special report on the impacts of global warming of 1.5°c above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [masson-delmotte, v., p. Zhai, h.-o. Pörtner, d. Roberts, j. Skea, p.R. Shukla, a. Pirani, moufouma-okia, c. Péan, r. Pidcock, s. Connors, j.B.R. Matthews, y. Chen, x. Zhou, m.I. Gomis, e. Lonnoy, maycock, m. Tignor, and t. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland: 32pp.

Iverson, S.J., J. Piché and W. Blanchard, 2011. Hawaiian monk seals and their prey assessing characteristics of prey species fatty acid signatures and consequences for estimating monk seal diets using quantitative fatty acid signature analysis. Available from https://repository.library.noaa.gov/view/noaa/3785.

Jensen, A.S. and G.K. Silber, 2004. Large whale ship strike database. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources: pp: 37.

Johanos, T.C., B.L. Becker, J.D. Baker, T.J. Ragen, W.G. Gilmartin and T. Gerrodette, 2010. Impacts of sex ratio reduction on male aggression in the critically endangered hawaiian monk seal *monachus schauinslandi*. Endangered Species Research, 11: 123-132. DOI 10.3354/esr00259.

Johnson, A.M., R.L. Delong, C.H. Fiscus and K.W. Kenyon, 1982. Population status of the hawaiian monk seal (*monachus schauinslandi*), 1978. Journal of Mammalogy, 63: 415-421.

Jones, C., 2017. Rare monk seal dies in fish farm off hawaii. USA Today.

Kaufman, G.A. and D.W. Kaufman, 1994. Changes in body-mass related to capture in the prairie deer mouse (peromyscus maniculatus). J. Mammal., 75(3): 681-691. Available from <Go to ISI>://A1994PE09200013.

Keay, J.M., J. Singh, M.C. Gaunt and T. Kaur, 2006. Fecal glucocorticoids and their metabolites as indicators of stress in various mammalian species: A literature review. Journal of Zoo and Wildlife Medicine, 37(3): 234-244. DOI 10.1638/05-050.1.

Kendrick, K.M., 2000. Oxytocin, motherhood and bonding. Experimental physiology, 85 Spec No: 111s-124s. DOI 10.1111/j.1469-445x.2000.tb00014.x.

Kenyon, K.W., 1972. Man versus the monk seal. Journal of Mammalogy, 53: 687-696.

Kipple, B. and C. Gabriele, 2007. Underwater noise from skiffs to ships. pp: 172-175.

Koski, W.R., G. Gamage, A.R. Davis, T. Mathews, B. Leblanc and S.H. Ferguson, 2015. Evaluation of uas for photographic re-identification of bowhead whales, balaena mysticetus. Journal of Unmanned Vehicle Systems, 3(1): 22-29.

Kreeger, T. and J. Arnemo, 2012. Handbook of wildlife chemical immobilization.

Kretzmann, M.B., N.J. Gemmell and A. Meyer, 2001. Microsatellite analysis of population structure in the endangered hawaiian monk seal. Conservation Biology, 15(2): 457-466.

Kretzmann, M.B., W.G. Gilmartin, A. Meyer, G.P. Zegers, S.R. Fain, B.F. Taylor and D.P. Costa, 1997. Low genetic variability in the hawaiian monk seal. Conservation Biology, 11(2): 482-490.

Kurle, C., M., and G. Worthy, 2002. Stable nitrogen and carbon isotope ratios in multiple tissues of the northern fur seal callorhinus ursinus: Implications for dietary and migratory reconstructions. Marine Ecology Progress Series, 236: 289-300. Available from https://www.int-res.com/abstracts/meps/v236/p289-300/.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet and M. Podesta, 2001. Collisions between ships and whales. Marine Mammal Science, 17(1): 35-75.

Langan, R., 2004. Balancing marine aquaculture inputs and extraction: Combined culture of finfish and bivalve molluscs in the open ocean. BULLETIN-FISHERIES RESEARCH AGENCY JAPAN: 51-58.

Laughlin, J., 2006. Underwater sound levels associated with pile driving at the cape dissapointment boat launch facility, wave barrier project. Washington State Parks Wave Barrier Project Underwater Technical Report.

Leary, S., Wendy Underwood, Raymond Anthony, Samuel Cartner, Douglas Corey, Temple Grandin, Cheryl Greenacre, Sharon Gwaltney-Brant, Control Center, Mary Ann McCrackin, Robert Meyer, David Miller, Jan Shearer and R. Yanong, 2013. Avma guidelines for the euthanasia of animals: 2013 edition. American Veterinary Medical Association, Schaumburg, Illinois.

Lima, S.L., 1998. Stress and decision making under the risk of predation. Advances in the Study of Behavior, 27: 215-290.

Littnan, C.L., J.D. Baker, F.A. Parrish and G.J. Marshall, 2004. Effects of video camera attachment on the foraging behavior of immature hawaiian monk seals. Marine Mammal Science, 20(2): 345-352.

Littnan, C.L., B.S. Stewart, P.K. Yochem and R. Braun, 2006. Survey for selected pathogens and evaluation of disease risk factors for endangered hawaiian monk seals in the main hawaiian islands. EcoHealth, 3(4): 232-244. DOI 10.1007/s10393-006-0059-z.

Lopez, J., D. Boyd, G.M. Ylitalo, C. Littnan and R. Pearce, 2012. Persistent organic pollutants in the endangered hawaiian monk seal (monachus schauinslandi) from the main hawaiian islands. Marine pollution bulletin, 64(11): 2588-2598.

Lowry, L., D.W. Laist, W.G. Gilmartin and G. Antonelis, 2011. Recovery of the hawaiian monk seal (*monachus schauinslandi*): A review of conservation efforts, 1972 to 2010, and thoughts for the future. Aquatic Mammals, 37(3): 397-419. DOI 10.1578/am.37.3.2011.397.

Luksenburg, J.A. and E.C.M. Parsons, 2009. The effects of aircraft on cetaceans: Implications for aerial whalewatching.

Mancia, A., W. Warr and R.W. Chapman, 2008. A transcriptomic analysis of the stress induced by capture-release health assessment studies in wild dolphins (tursiops truncatus). Molecular Ecology, 17(11): 2581-2589. Available from <Go to ISI>://000256757800003. DOI 10.1111/j.1365-294X.2008.03784.x.

Markowitz, T.M., A.D. Harlin, B. Würsig and C.J. McFadden, 2004. Dusky dolphin foraging habitat: Overlap with aquaculture in new zealand. Aquatic Conservation: marine and freshwater ecosystems, 14(2): 133-149.

Mcdonald, M.A., J.A. Hildebrand and S.M. Wiggins, 2006. Increases in deep ocean ambient noise in the northeast pacific west of san nicolas island, california. Journal of the Acoustical Society of America, 120(2): 711-718.

Mckenna, M.F., D. Ross, S.M. Wiggins and J.A. Hildebrand, 2012. Underwater radiated noise from modern commercial ships. Journal of the Acoustical Society of America, 131(2): 92-103.

McKenna, M.F., D. Ross, S.M. Wiggins and J.A. Hildebrand, 2013. Relationship between container ship underwater noise levels and ship design, operational and oceanographic conditions. Scientific reports, 3.

McKenzie, J., B. Page, S. Goldsworthy and M. Hindell, 2012. Behavioral responses of new zealand fur seals (arctocephalus forsteri) to darting and the effectiveness of midazolam and tiletamine-zolazepam for remote chemical immobilization. Mar. Mamm. Sci., 29. DOI 10.1111/j.1748-7692.2011.00553.x.

Meegan, J., W. Collard, G. S. Grover, N. Pussini, B. Van Bonn and F. Gulland, 2010. Ceftiofur pharmacokinetics. In: Abstract in the International Association for Aquatic Animal Medicine 2010 Proceedings.

Mercer, T.A., 2018. Hawaiian monk seal research program hawaiian monk seal fisheries interaction data collected in the main hawaiian islands, 1976-2016. US National Oceanographic Data Center.

Mintz, J.D., 2016. Characterization of vessel traffic in the vicinities of hrc, socal, and the navy operating areas off the u.S. East coast. Center for Naval Analyses, Environment and Energy Team, Resource Analysis Division: pp: 82.

MMC, 2007. Marine mammals and noise: A sound approach to research and management. Marine Mammal Commission.

Mooney, T.A., R.T. Hanlon, J. Christensen-Dalsgaard, P.T. Madsen, D. Ketten and P.E. Nachtigall, 2010. Sound detection by the longfin squid (loligo pealeii) studied with auditory evoked potentials: Sensitivity to low-frequency particle motion and not pressure. The journal of experimental biology, 213, 3748–3759.

Mullner, A., K.E. Linsenmair and W. Wikelski, 2004. Exposure to ecotourism reduces survival and affects stress response in hoatzin chicks (opisthocomus hoazin). Biological Conservation, 118: 549-558.

National Park Service, 2010. Project to repair the kalaupapa dock structures environmental assessment.

Naylor, R.L., 2006. Environmental safeguards for open-ocean aquaculture. Issues in Science and Technology, 22(3): 53-58.

Nedelec, S.L., A.N. Radford, S.D. Simpson, B. Nedelec, D. Lecchini and S.C. Mills, 2014. Anthropogenic noise playback impairs embryonic development and increases mortality in a marine invertebrate. Sci Rep, 4: 5891. Available from https://www.ncbi.nlm.nih.gov/pubmed/25080997. DOI 10.1038/srep05891.

Nitta, E. and J. Henderson, 1993. A review of interactions between hawaii's fisheries and protected species Marine Fisheries Review

NMFS, 2006. Biological opinion on the issuance of section lo(a)(l)(a) permits to conduct scientific research on the southern resident killer whale (orcinus orca) distinct population segment and other endangered or threatened species. National Marine Fisheries Service, Northwest Region, Seattle, Washington: pp: 92.

NMFS, 2007a. Biological opinion on activities authorized on steller sea lions and northern fur seals pursuant to the marine mammal protection act and section 10(a)(l)(a) of the endangered species act. National Oceanic and Atmospheric Administration, Silver Spring.
NMFS, 2007b. Hawaiian monk seal (monachus schauinslandi). 5-year review: Summary and evaluation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service: pp: 15.
NMFS, 2007c. Recovery plan for the hawaiian monk seal (monachus schauinslandi). National Oceanic and Atmospheric Administration, National Marine Fisheries Service: pp: 165.
NMFS, 2007d. Recovery plan for the hawaiian monk seal (monachus schauinslandi) : Revision. N. M. F. S. United States (Ed.).
NMFS, 2007e. Steller sea lion and northern fur seal research final programmatic environmental impact statement. National Marine Fisheries Service, Silver Spring, MD.
NMFS, 2009. Biological opinion on nmfs' permits, conservation and education division's proposal to issue a permit to national marine fisheries services' pacific islands science center marine mammal research program for studies of hawaiian monk seals in the hawaiian archipelago and johnston atoll, pursuant to section 10(a)(1)(a) of the endangered species act of 1973 [permit no. 10137]. O. o. P. Resources (Ed.). National Marine Fisheries Service, Silver Spring, Maryland.
NMFS, 2014. Biological and conference opinion on the implementation of the hawaiian monk seal research and enhancement program and issuance of scientific research permit number 16632, pursuant to section 10(a)(1)(a) of the endangered species act of 1973.
NMFS, 2018a. Biological opinion on the national science foundation-funded seismic survey in the north pacific ocean, and issuance of an incidental harassment authorization pursuant to section 101(a)(5)(d) of the marine mammal protection act (mmpa). Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring.
NMFS, 2018b. Three monk seals found dead on o'ahu this week. National Marine Fisheries Service.
NMFS, 2019. Nmfs pacific island fisheries science center hawaiian monk seal scientific research program permit application (file no. 22677)
NOAA, 2018. Revisions to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (version 2.0): Underwater thresholds for onset of permanent and temporary threshold shifts. Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, Maryland.
Noda, K., H. Akiyoshi, M. Aoki, T. Shimada and F. Ohashi, 2007. Relationship between transportation stress and polymorphonuclear cell functions of bottlenose dolphins, tursiops truncatus. Journal of Veterinary Medical Science, 69(4): 379-383.
Norris, T., C. Littnan, F.M.D. Gulland, J.D. Baker and J. Harvey, 2016. An integrated approach for assessing translocation as an effective conservation tool for hawaiian monk seals. Endangered Species Research, 32. DOI 10.3354/esr00788.
NRC, 2003a. National research council: Ocean noise and marine mammals., Washington, D.C.: National Academies Press.
NRC, 2003b. Ocean noise and marine mammals. National Academies Press.

NRC, 2005. Marine mammal populations and ocean noise. Determining when noise causes biologically significant effects. National Academy of Sciences, Washington, D. C.

Oftedal, O.T., D.J. Boness and W.D. Bowen, 1988. The composition of hooded seal (cystophora cristata) milk: An adaptation for postnatal fattening. Canadian Journal of Zoology, 66(2): 318-322. Available from https://doi.org/10.1139/z88-047 [Accessed 2019/10/21]. DOI 10.1139/z88-047.

Packard, A., H.E. Karlsen and O. Sand, 1990. Low frequency hearing in cephalopods. Journal of comparative physiology a, 166, 501–505.

Papahānaumokuākea Marine National Monument, 2008. Management plan, volume i.

Parks, S.E., 2003. Response of north atlantic right whales (eubalaena glacialis) to playback of calls recorded from surface active groups in both the north and south atlantic. Marine Mammal Science, 19(3): 563-580. Available from <Go to ISI>://000183992800008.

Parks, S.E., 2009. Assessment of acoustic adaptations for noise compensation in marine mammals. In: 2009 onr marine mammal program review. Alexandria, Virginia.

Parrish, F.A., M.P. Craig, T.J. Ragen, G.J. Marshall and B.M. Buhleier, 2000. Identifying diurnal foraging habitat of endangered hawaiian monk seals using a seal-mounted video camera. Mar. Mamm. Sci., 16(2): 392-412. Available from <Go to ISI>://000086106200009.

Peters, R.H., 1983. The implications of body size. Cambridge University Press.

Petrauskas, L., S. Atkinson, F. Gulland, J.A. Mellish and M. Horning, 2008. Monitoring glucocorticoid response to rehabilitation and research procedures in california and steller sea lions. J. Exp. Zool. Part A, 309A(2): 73-82. Available from <Go to ISI>://000253007600003. DOI 10.1002/jez.435.

Plumb, D.C., 2008. Plumb's veterinary drug handbook 6th edition. Ames Iowa: Blackwell Publishing.

Popper, A.N., T.J. Carlson, B.M. Casper and M.B. Halvorsen, 2014a. Does man-made sound harm fishes? Journal of Ocean Technology, 9(1): 11-20.

Popper, A.N., A.D. Hawkins, R. Fay, R., D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies and W.N. Tavolga, 2014b. Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ansi-accredited standards committee s3/sc1 and registered with ansi. Springer, New York, NY: pp: 88.

Ragen, T.J., 1999. Human activities affecting the population trends of the hawaiian monk seal. American Fisheries Society Symposium, 23: 183 - 194.

Reif, J.S. and A. Bachand, 2004. Morphometry, hematology, and serum chemistry in the hawaiian monk seal (*monachus schauinslandi*). Marine Mammal Science, 20: 851-860.

Renouf, D., 1979. Fishing in captive harbour seals (*phoca vitulina concolor*): A possible role for vibrissae. Netherlands Journal of Zoology, 30(3): 504-509.

Reyff, J.A., 2008. Underwater sound pressure levels associated with marine pile driving: Assessment of impacts and evaluation of control measures. Journal of Transportation Research Board, CD 11-S: 481-490.

Reyff, J.A., 2012. Underwater sounds from unattenuated and attenuated marine pile driving. In: The effects of noise on aquatic life, A. N. Popper and A. D. Hawkins, (Eds.). Springer Science + Business Media, LLC, New York, NY: pp: 439-444.

Richardson, W.J., 1995. Marine mammal hearing. In: Marine mammals and noise, C. R. W. J. G. J. RichardsonC. I. Malme and D. H. Thomson, (Eds.). Academic Press, San Diego, California: pp: 205-240.

Richardson, W.J., J. Charles R. Greene, C.I. Malme and D.H. Thomson., 1995a. Marine mammals and noise. Academic Press, Inc., San Diego, CA. ISBN 0-12-588440-0 (alk. paper). 576pp.

Richardson, W.J., S. Davis, R.E. Harris, D.W. Owens, N.J. Patenaude, D.H. Thomson, R.C. Atkinson and W.J. Marshall, 1995b. Assessment of potential impact of small explosions in the korea strait on marine animals and fisheries. LGL Ltd. Environmental Research Associates, BBN Systems and Technologies.

Richardson, W.J., C.R.G. Jr., C.I. Malme and D.H. Thomson, 1995c. Marine mammals and noise. San Diego, California: Academic Press, Inc.

Riedman, M., 1990. The pinnipeds: Seals, sea lions, and walruses. Univ of California Press.

Romero, L.M., 2004. Physiological stress in ecology: Lessons from biomedical research. Trends in Ecology and Evolution, 19(5): 249-255.

RPS, 2018. Protected species mitigation and monitoring report: Marine geophysical (seismic) surveys in the north pacific ocean (main hawaiian islands survey and emperor seamount chain survey).

Sapolsky, R.M., L.M. Romero and A.U. Munck, 2000. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. Endocrine Reviews, 21(1): 55-89. Available from http://edrv.endojournals.org/cgi/content/abstract/21/1/55. DOI 10.1210/er.21.1.55.

Schultz, J.K., J.D. Baker, R.J. Toonen and B.W. Bowen, 2009. Extremely low genetic diversity in the endangered hawaiian monk seal (*monachus schauinslandi*). J. Hered., 100(1): 25-33. Available from <Go to ISI>://000261901400004. DOI 10.1093/jhered/esn077.

Schultz, J.K., J.D. Baker, R.J. Toonen, A.L. Harting and B.W. Bowen, 2011. Range-wide genetic connectivity of the hawaiian monk seal and implications for translocation. Conservation Biology, 25(1): 124-132.

Schultz, J.K., A.J. Marshall and M. Pfunder, 2010. Genome-wide loss of diversity in the critically endangered hawaiian monk seal. Diversity, 2(6): 863-880. DOI 10.3390/d2060863.

Schusterman, R.J., D. Kastak, D.H. Levenson, C.J. Reichmuth and B.L. Southall, 2000. Why pinnipeds don't echolocate. Journal of the Acoustical Society of America, 107(4): 2256-2264.

Simone C. A. and M.K. Stoskopf, 2018. Pharmaceuticals and formularies. In: Crc handbook of marine mammal medicine, third edition, L. A. DieraufF.M.D. Gulland and K. L. Whitman, (Eds.). CRC Press LLC, Boca Raton: pp: 607-673.

Solan, M., C. Hauton, J.A. Godbold, C.L. Wood, T.G. Leighton and P. White, 2016. Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. Sci Rep, 6: 20540. Available from https://www.ncbi.nlm.nih.gov/pubmed/26847483. DOI 10.1038/srep20540.

Sole, M., M. Lenoir, J.M. Fontuno, M. Durfort, M. van der Schaar and M. Andre, 2016. Evidence of cnidarians sensitivity to sound after exposure to low frequency noise underwater sources. Sci Rep, 6: 37979. Available from https://www.ncbi.nlm.nih.gov/pubmed/28000727. DOI 10.1038/srep37979.

Southall, B., A. Bowles, W. Ellison, J. Finneran, R. Gentry, C. Greene, D. Kastak, D. Ketten, J. Miller, P. Nachtigall, W. Richardson, J. Thomas and P. Tyack, 2007a. Mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals, 33(4): 122.

Southall, B., J. Finneran, C. Reichmuth, P. Nachtigall, D. Ketten, A. Bowles, W. Ellison, D. Nowacek and P. Tyack, 2019. Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45: 125-232. DOI 10.1578/AM.45.2.2019.125.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas and P.L. Tyack, 2007b. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals, 33(4): 411-521.

St. Aubin, D.J. and J.R. Geraci, 1988. Capture and handling stress suppresses circulating levels of thyroxine (t4) and triiodothyronine (t3) in beluga whale, delphinapterus leucas. Physiological Zoology, 61(2): 170-175.

St. Aubin, D.J., S.H. Ridgway, R.S. Wells and H. Rhinehart, 1996. Dolphin thyroid and adrenal hormones: Circulating levels in wild and semidomesticated *tursiops truncatus*, and influence of sex, age, and season. Marine Mammal Science, 12(1): 1-13. Available from <Go to ISI>://A1996TQ36100001.

Strathearn, L., P. Fonagy, J. Amico and P.R. Montague, 2009. Adult attachment predicts maternal brain and oxytocin response to infant cues. Neuropsychopharmacology : official publication of the American College of Neuropsychopharmacology, 34(13): 2655-2666. DOI 10.1038/npp.2009.103.

Sutherland, W.J. and N.J. Crockford, 1993. Factors affecting the feeding distribution of red breasted geese, branta ruficollis, wintering in romania. Biological Conservation, 63: 61-65.

Sweeney, K., V.T. Helker, W.L. Perryman, D. LeRoi, L. Fritz, T. Gelatt and R. Angliss, 2016. Flying beneath the clouds at the edge of the world: Using a hexacopter to supplement abundance surveys of steller sea lions (eumetopias jubatus) in alaska. Journal of Unmanned Vehicle Systems, 4(1): 70-81.

Tal, D., H. Shachar-Bener, D. Hershkovitz, Y. Arieli and A. Shupak, 2015. Evidence for the initiation of decompression sickness by exposure to intense underwater sound. Journal of Neurophysiology, 114(3): 1521-1529. Available from http://jn.physiology.org/content/114/3/1521.long.

Thomas, J.A., P. Moore, R. Withrow and M. Stoermer, 1990. Underwater audiogram of a hawaiian monk seal (monachus schauinslandi). Journal of the Acoustical Society of America, 87(1): 417-420.

Thomson, C.A. and J.R. Geraci, 1986. Cortisol, aldosterone, and leukocytes in the stress response of bottlenose dolphins, tursiops truncatus. Can. J. Fish. Aquat. Sci., 43(5): 1010-1016.

Todd, V.L.G., I.B. Todd, J.C. Gardiner, E.C.N. Morrin, N.A. MacPherson, N.A. DiMarzio and F. Thomsen, 2014. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science, 72(2): 328-340. Available from https://doi.org/10.1093/icesjms/fsu187 [Accessed 10/14/2019]. DOI 10.1093/icesjms/fsu187.

Vanderlaan, A.S. and C.T. Taggart, 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed. Marine Mammal Science, 23(1): 144-156.

Walker, B.G., P. Dee Boersma and J.C. Wingfield, 2005. Physiological and behavioral differences in magellanic penguin chicks in undisturbed and tourist-visited locations of a colony. Conservation Biology, 19(5): 1571-1577.

Walters, J.S., E. Sobeck, M. Luipold, R.S. Sprague, D. Schofield, J.D. Baker, C.L. Littnan, M. Vandersande, A. Sloan, P.M. Payne, C. Holmes and A. Harting, 2014. Final programmatic environmental impact statement executive summary : Hawaiian monk seal recovery actions. Available from https://repository.library.noaa.gov/view/noaa/5052.

Weinrich, M.T., R.H. Lambertsen, C.S. Baker, M.R. Schilling and C.R. Belt, 1991. Behavioural responses of humpback whales (*megaptera novaeangliae*) in the southern gulf of maine to biopsy sampling. Report to the International Whaling Commission, Special Issue 13: 91-98.

Weinrich, M.T., R.H. Lambertsen, C.R. Belt, M.R. Schilling, H.J. Iken and S.E. Syrjala, 1992. Behavioral reactions of humpback whales megaptera novaeangliae to biopsy procedures. Fishery Bulletin, U.S., 90: 588-598.

Ylitalo, G.M., M. Myers, B.S. Stewart, P.K. Yochem, R. Braun, L. Kashinsky, D. Boyd, G.A. Antonelis, S. Atkinson and A.A. Aguirre, 2008. Organochlorine contaminants in endangered hawaiian monk seals from four subpopulations in the northwestern hawaiian islands. Marine Pollution Bulletin, 56(2): 231-244.

Yochem, P.K., 2004. Contingency plan for hawaiian monk seal : Unusual mortality events. Available from https://repository.library.noaa.gov/view/noaa/3392.

Young, S., 2019. Personal communication with sara young, mmpa directed take permit analyst for the pifsc research permit, regarding ship strike.

Zhao, L. and D.M. Schell, 2004. Stable isotope ratios in harbor seal phoca vitulina vibrissae: Effects of growth patterns on ecological records. Marine Ecology-progress Series - MAR ECOL-PROGR SER, 281: 267-273. DOI 10.3354/meps281267.

Zimmer, W.M.X. and P.L. Tyack, 2007. Repetitive shallow dives pose decompression risk in deep-diving beaked whales. Marine Mammal Science, 23(4): 888-925. Available from <Go to ISI>://000250087100008.

16 APPENDICES

16.1 Appendix A: Draft Permit No. 22677

Permit No. 22677

Effective Date: January 1, 2020

Expiration Date: December 31, 2024
Reports Due: March 31, annually

PERMIT TO TAKE PROTECTED SPECIES[8] FOR SCIENTIFIC AND ENHANCEMENT PURPOSES

[8] "Protected species" include species listed as threatened or endangered under the ESA, and marine mammals.

I. Authorization

This permit is issued to the NMFS Pacific Islands Fisheries Science Center, Protected Species Division, Hawaiian Monk Seal Research Program, 1845 Wasp Boulevard, Building 176, Honolulu, HI 96818, (hereinafter "Permit Holder;" Responsible Party: Charles Littnan, Ph.D.), pursuant to the provisions of the Marine Mammal Protection Act of 1972 as amended (MMPA; 16 U.S.C. 1361 *et seq*.); the regulations governing the taking and importing of marine mammals (50 CFR Part 216); the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq*.); and the regulations governing the taking, importing, and exporting of endangered and threatened species (50 CFR Parts 222-226).

II. Abstract

The objectives of the permitted activity, as described in the application, are to carry out research and enhancement activities designed to conserve and recover the endangered Hawaiian monk seal (*Neomonachus schauinslandi*). Research is intended to identify impediments to recovery, inform the design of conservation interventions, and evaluate those measures. Enhancement activities are designed to improve the survival and reproductive success of individual monk seals, with the intent to improve subpopulation and overall species' status.

III. Terms and Conditions

The activities authorized herein must occur by the means, in the areas, and for the purposes set forth in the permit application, and as limited by the Terms and Conditions specified in this permit, including appendices and attachments. Permit noncompliance constitutes a violation and is grounds for permit modification, suspension, or revocation, and for enforcement action.

A. Duration of Permit

1. Personnel listed in Condition C.1 of this permit (hereinafter "Researchers") may conduct activities authorized by this permit through December 31, 2024. This permit may be extended by the Director, National Marine Fisheries Service (NMFS) Office of Protected Resources or the Chief, Permits and Conservation Division (hereinafter Permits Division), pursuant to applicable regulations and the requirements of the MMPA and ESA.

2. Researchers must immediately stop permitted activities and the Permit Holder or Principal Investigator must contact the Chief, NMFS Permits and Conservation Division (hereinafter "Permits Division") for written permission to resume:

   a. If serious injury or mortality[9] of protected species reaches that specified in Tables 1-5 of Appendix 1.

   b. If authorized take[10] is exceeded in any of the following ways:

      i. More animals are taken than allowed in Tables 1-5 of Appendix 1.
      ii. Animals are taken in a manner not authorized by this permit.
      iii. Protected species other than those authorized by this permit are taken.

   c. Following incident reporting requirements at Condition E.2.

B. <u>Number and Kinds of Protected Species, Locations and Manner of Taking</u>

1. The tables in Appendix 1 outline the authorized species and stock; number of animals to be taken; number of animals from which parts may be received, imported and exported; and the manner of take, locations, and time period.

2. Researchers working under this permit may collect images (e.g., photographs, video) and audio recordings in addition to the photo-identification, behavioral photo-documentation, and audio recordings authorized in Appendix 1 as needed to document the permitted activities, provided the collection of such images or recordings does not result in takes.

---

[9] This permit allows for unintentional serious injury and mortality caused by the presence or actions of researchers up to the limit in Table 3 of Appendix 1. This includes, but is not limited to: deaths of dependent young by starvation following research-related death of a lactating female; deaths resulting from infections related to sampling procedures; and deaths or injuries sustained by animals during capture and handling, or while attempting to avoid researchers or escape capture. Note that for marine mammals, a serious injury is defined by regulation as any injury that will likely result in mortality.

[10] By regulation, a take under the MMPA means to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild. Under the ESA, a take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to do any of the preceding.

3. The Permit Holder may use visual images and audio recordings collected under this permit, including those authorized in Appendix 1, in printed materials (including commercial or scientific publications) and presentations provided the images and recordings are accompanied by a statement indicating that the activity was conducted pursuant to NMFS ESA/MMPA Permit No. 22677. This statement must accompany the images and recordings in all subsequent uses or sales.

4. The Chief, Permits Division may grant written approval for personnel performing activities not essential to achieving the research or enhancement objectives (e.g., a documentary film crew) to be present, provided:

   a. The Permit Holder submits a request to the Permits Division specifying the purpose and nature of the activity, location, approximate dates, and number and roles of individuals for which permission is sought.

   b. Non-essential personnel/activities will not influence the conduct of permitted activities or result in takes of protected species.

   c. Persons authorized to accompany the Researchers for the purpose of such non-essential activities will not be allowed to participate in the permitted activities.

   d. The Permit Holder and Researchers do not require compensation from the individuals in return for allowing them to accompany Researchers.

5. Researchers must comply with the following conditions related to the manner of taking:

Counting and Reporting Takes of Hawaiian Monk Seals

   a. For seals observed on land during ground, vessel, and aerial surveys, and audio broadcasts (i.e., playbacks) count 1 take per animal per day for those animals that react to the permitted activities in these ways:

i. Movements of twice the animal's body length or more,

ii. Changes of direction greater than 90 degrees, or

iii. Retreats (flushes) to the water.

b. For seals observed in water during ground, vessel, and aerial surveys, and audio broadcasts (i.e., playbacks), count 1 take per animal per day for those that exhibit a noticeable adverse behavioral response from your activities.

c. If directing sound (i.e., playbacks) at seals, count and report noticeable adverse behavioral reactions.

d. Count every animal netted or captured even if immediately released.

e. Do not count takes of seals as you are transiting between locations and not actively conducting research or enhancement.

Counting and Reporting Takes of Cetaceans

f. Count and report a take of a cetacean following the guidance below regardless of whether you observe a behavioral response to the permitted activity.

g. During unmanned aircraft system (UAS) and manned aerial surveys flown at an altitude lower than 1,000 feet, count and report 1 take per cetacean flown over per day, regardless of the number of passes.

h. For all cetacean approaches[11] in water, count and report 1 take per cetacean per day.

i. Do not count takes of cetaceans as you are transiting between locations and not actively conducting research or enhancement.

---

[11] An "approach" is defined as a continuous sequence of maneuvers involving a vessel, equipment, or researcher's body, including drifting, directed toward a cetacean or group of cetaceans closer than 100 yards for baleen and sperm whales and 50 yards for all other cetaceans.

j. Researchers must carry out activities efficiently and use biologists experienced in capture and sampling techniques to complete the activities as quickly and safely as possible to reduce disturbance and minimize handling time.

k. To the maximum extent feasible to minimize disturbance:

   i. Take target animals, retrieve carcasses, or collect opportunistic samples (e.g., scat) when other seals are not in the immediate vicinity, particularly mother/pup pairs; and

   ii. Move carcasses to a secure area away from other seals for necropsies.

l. Efforts to approach and/or capture a particular seal or lactating female and pup must be immediately terminated if there is any evidence that the activities may be life-threatening to the animals.

m. Researchers must take reasonable steps to identify pups of lactating females before attempting to immobilize a lactating female during permitted activities.

n. Researchers must minimize the time lactating females are removed or otherwise separated from their dependent offspring as a result of permitted activities.

o. Researchers must use sterile disposable needles, biopsy punches, and other sampling tools to the maximum extent practicable (always use disposable needles for blood sampling and injections). Researchers must thoroughly clean and disinfect non-disposable equipment between animals and, as needed, immediately prior to each use.

p. For activities involving the use of anesthesia and sedatives, researchers must ensure that an experienced marine mammal veterinarian or veterinary technician is present.

q. Researchers must immediately cease permitted procedures if a seal is showing signs (e.g., overexertion, constant muscle tension, abnormal respiration or heart rate) that may lead to serious injury, capture myopathy, other disease conditions, or death; and monitor and treat the animal as determined appropriate by the Principal Investigator (PI), Co-Investigator (CI), or attending veterinarian.

r. Researchers must ensure that seals that have been captured and anesthetized or administered immobilizing drugs have an opportunity to recover after release without undue risk of drowning or injury from other animals.

s. For health assessment sampling and instrumentation, annually up to 10 animals may be captured, released/not fully processed, and recaptured for full processing (to account for failed capture/processing attempts).

Remote Sedation

t. Researchers must halt the use of remote sedation and in-water capture/sedation techniques and consult with NMFS if three or more seals are sedated and disappear so that their fate cannot be determined or suffer unanticipated adverse effects, including entering the water and drowning.

Manned Aerial Surveys

u. Manned aerial surveys must be flown at a distance of approximately 500 feet. Descents for necessary close approaches must be no closer than 300 feet for fixed-wing aircraft and 250 feet for helicopters.

Unmanned Aircraft Systems (UAS) and Remote Vehicles

v. Researchers are authorized to us fixed wing or vertical take-off and landing UAS.

w. UAS must be flown at an altitude of 32-200 feet. Descents for necessary close approaches must be no lower than 25 feet (7.5 meters).

x. If animals react to the presence of unmanned vehicles, Researchers must slowly increase the altitude/distance to minimize disturbance.

y. The Permit Holder must submit with the annual report data on disturbance rates of seals specific to unmanned vehicles in addition to other disturbances.

Disentanglement

z. For any animals disentangled, the Permit Holder must submit a Level A data sheet (https://www.fisheries.noaa.gov/national/marine-mammal-protection/level-data-collection-marine-mammal-stranding-events), or a report with enough information to prepare a Level A data sheet, to the NMFS Pacific Islands Regional Stranding Coordinator (phone: 808-725-5161) within 30 days of the end of any field effort where entangled animals are handled.

Mortalities

aa. To the maximum extent practical without causing further disturbance, researchers must monitor study sites following any disturbance (e.g., surveys or sampling activities) to determine if any animals have been seriously injured or killed, or if any pups have been abandoned. Any observed serious injury to or death of a marine mammal or observed abandonment of a dependent pup is to be reported as indicated below and in Condition E.2.

bb. In the rare event a nursing pup is orphaned as a result of any activities authorized in this permit, the pup must be humanely provided for (i.e., placed in a Stranding facility for rehabilitation or humanely euthanized). Rehabilitation must be done in consultation with the Marine Mammal Health and Stranding Response Program (MMHSRP) and under the authority of the MMHSRP permit. Pups that are euthanized count against the total number of animals authorized for unintentional mortality in Appendix 1, Table 3.

Euthanasia

cc. Over the duration of the permit, up to 10 moribund seals may be humanely euthanized if an experienced on-site veterinarian determines that there is a high probability of the death of the animal due to its condition.

dd. Over the duration of the permit and as a last resort after consideration of translocation and removal to permanent captivity, up to 10 adult male seals may be humanely euthanized if they are known or strongly suspected of causing serious injury or mortality of conspecifics.

ee. An experienced veterinarian must conduct the euthanasia. An exception may be made in rare cases necessitating immediate action if highly trained and qualified Researchers are available and consult with an experienced veterinarian. After necropsy, parts not retained from seals chemically euthanized must be collected for environmentally safe disposal.

ff. In the event a seal is euthanized, a written incident report must be submitted to the Chief, Permits Division in accordance with Condition E.2.

Non-target Species

gg. This permit does not authorize takes of any protected species not identified in Appendix 1, including those species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). Should other protected species be encountered during the research and enhancement activities authorized under this permit, researchers must exercise caution and remain a safe distance from the animals to avoid take, including harassment.

hh. Researchers working in Northwestern Hawaiian Islands must adhere to the following USFWS conditions:

i. Walking is prohibited on all beaches, from dusk to dawn, where adult sea turtles rest.

ii. All field camps must use maximum light control (shading, minimum wattage, etc.).

iii. All field camps must avoid disorienting hatchling turtles.

iv. Researchers must follow USFWS mitigation measures to minimize injury or mortality of Laysan finch and other endangered bird species, and report injuries or mortalities as required in the Biological Opinion issued by the USFWS on February 20, 2014.

6. The Permit Holder must comply with the following conditions, and the regulations at 50 CFR 216.37, for biological samples[12] acquired[13] or possessed under authority of this permit.

---

[12] Biological samples include, but are not limited to: carcasses (whole or parts); and any tissues, fluids, or other specimens from live or dead protected species; except feces, urine, and spew collected from the water or ground.
[13] Authorized methods of sample acquisition are specified in Appendix 1.

a. The Permit Holder is ultimately responsible for compliance with this permit and applicable regulations related to the samples unless the samples are permanently transferred per Conditions at B.6.d.

b. Samples must be maintained according to accepted curatorial standards and must be labeled with a unique identifier (e.g., alphanumeric code) that is connected to on-site records with information identifying the following:

   i. Species and, where known, age and sex;

   ii. Date of collection, acquisition, or import;

   iii. Type of sample (e.g., blood, skin, bone);

   iv. Origin (i.e., where collected or imported from); and

   v. Legal authorization for original sample collection or import.

c. For temporary transfers:

   i. The Permit Holder may designate Authorized Recipients (ARs) for analysis and curation of samples related to the permit objectives. The Permit Holder must maintain a record of the transfer including the following:

      1. Name and affiliation of the AR;

      2. Address of the AR;

      3. Types of samples sent (species, tissue type);

      4. Type of analysis; and

      5. Whether samples will be consumed in analysis, returned to the Permit Holder, curated, or destroyed.

   ii. The Permit Holder must provide a written copy of the AR designation and the permit per Condition D.3 when transferring samples to the AR.

iii. Samples remain in the legal custody of the Permit Holder while in the possession of ARs. The Permit Holder remains responsible for the samples, including any reporting requirements.

d. For permanent transfers:

i. If the Permit Holder wishes to permanently transfer marine mammal samples (i.e., relinquish custody), recipients must have separate authorization pursuant to 50 CFR 216.37 (e.g., permit, regional authorization letter) prior to transfer.

e. Samples cannot be bought or sold.

f. After meeting the permitted objectives, the Permit Holder may continue to possess and use biological samples acquired under this permit, including after permit expiration, without additional written authorization. The samples must be maintained as specified in the permit.

7. Researchers must comply with the following conditions related to methods of captive supervision, care, and transportation for animals transferred to permanent captivity and/or used in captive research, as applicable:

a. Hawaiian monk seals must be transported and maintained in captivity in compliance with the Animal Welfare Act (AWA) and AWA implementing regulations "Specifications for the Humane Handling, Care, Treatment, and Transportation of Marine Mammals" (9 CFR Part 3, Subpart E).

b. Prior to removing adult male seals from the wild for permanent captivity, the Permit Holder must provide:

i. Confirmation that a facility has agreed to permanently house the seals, the facility's specifications and AWA license or registration, and whether such facility has a permit to obtain the animal(s); and

ii. Plans for temporary care of the animals prior to transfer to the permanent facility, if applicable.

c. Animals undergoing research in captivity must be closely monitored to determine if research activities are having an adverse effect on the individuals.

An attending veterinarian must be available for emergencies, illnesses, and for treating any health problems associated with the research.

C. Qualifications, Responsibilities, and Designation of Personnel

1. At the discretion of the Permit Holder, the following Researchers may participate in the conduct of the permitted activities in accordance with their qualifications and the limitations specified herein:

   a. Principal Investigator – Charles Littnan, Ph.D.

   b. Co-Investigators – See Appendix 2 for list of names and corresponding activities.

   c. Research Assistants – personnel identified by the Permit Holder or Principal Investigator and qualified to act pursuant to Conditions C.2, C.3, and C.4 of this permit.

2. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities. The roles and responsibilities of personnel operating under this permit are as follows:

   a. The Permit Holder is ultimately responsible for activities of individuals operating under the authority of this permit. Where the Permit Holder is an institution/facility, the Responsible Party is the person at the institution/facility who is responsible for the supervision of the Principal Investigator.

   b. The Principal Investigator (PI) is the individual primarily responsible for the taking, import, export and related activities conducted under the permit. This includes coordination of field activities of all personnel working under the permit. The PI must be on site during activities conducted under this permit unless a Co-Investigator named in Condition C.1 is present to act in place of the PI.

c. Co-Investigators (CIs) are individuals who are qualified to conduct activities authorized by the permit, for the objectives described in the application, without the on-site supervision of the PI. CIs assume the role and responsibility of the PI in the PI's absence.

d. Research Assistants (RAs) are individuals who work under the direct and on-site supervision of the PI or a CI. RAs cannot conduct permitted activities in the absence of the PI or a CI.

3. Personnel involved in permitted activities must be reasonable in number and essential to conduct of the permitted activities. Essential personnel are limited to:

a. Individuals who perform a function directly supportive of and necessary to the permitted activity (including operation of vessels or aircraft essential to conduct of the activity),

b. Individuals included as backup for those personnel essential to the conduct of the permitted activity, and

c. Individuals included for training purposes.

4. Persons who require state or Federal licenses or authorizations (e.g., veterinarians, pilots – including UAS operators) to conduct activities under the permit must be duly licensed/authorized and follow all applicable requirements when undertaking such activities.

5. Permitted activities may be conducted aboard vessels or aircraft, or in cooperation with individuals or organizations, engaged in commercial activities, provided the commercial activities are not conducted simultaneously with the permitted activities.

6. The Permit Holder cannot require or receive direct or indirect compensation from a person approved to act as PI, CI, or RA under this permit in return for requesting such approval from the Permits Division.

7. The Permit Holder or PI may designate additional CIs without prior approval from the Chief, Permits Division provided:

   a. A copy of the letter designating the individual and specifying their duties under the permit is forwarded to the Permits Division by facsimile or email on the day of designation.

   b. The copy of the letter is accompanied by a summary of the individual's qualifications to conduct and supervise the permitted activities.

   c. The Permit Holder acknowledges that the designation is subject to review and revocation by the Chief, Permits Division.

7. Where the Permit Holder is an institution/facility, the Responsible Party may request a change of PI by submitting a request to the Chief, Permits Division that includes a description of the individual's qualifications to conduct and oversee the activities authorized under this permit.

8. Submit requests to add CIs or change the PI by one of the following:

   a. The APPS system at https://apps.nmfs.noaa.gov;

   b. An email attachment to the permit analyst for this permit; or

   c. A hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Room 13705, Silver Spring, MD 20910; phone (301)427-8401; fax (301)713-0376.

D. Possession of Permit

1. This permit cannot be transferred or assigned to any other person.

2. The Permit Holder and persons operating under the authority of this permit must possess a copy of this permit when:

a. Engaged in a permitted activity.

b. A protected species is in transit incidental to a permitted activity.

c. A protected species taken under the permit is in the possession of such persons.

3. A duplicate copy of this permit must accompany or be attached to the container, package, enclosure, or other means of containment in which a protected species or protected species part is placed for purposes of storage, transit, supervision or care.

E. Reporting

1. The Permit Holder must submit incident and annual reports containing the information and in the format specified by the Permits Division.

a. Reports must be submitted to the Permits Division by one of the following:

i. The APPS system at https://apps.nmfs.noaa.gov;
ii. An email attachment to the permit analyst for this permit; or
iii. A hard copy mailed or faxed to the Chief, Permits Division.

b. You must contact your permit analyst for a reporting form if you do not submit reports through the APPS.

2. Incident Reporting

a. If the total number of mortalities is reached, or authorized takes have been exceeded as specified in Conditions A.2 and B.5, the Permit Holder must:
i. Contact the Permits Division by phone (301-427-8401) as soon as possible, but no later than 2 business days of the incident;
ii. Submit a written report within 2 weeks of the incident as specified below; and
iii. Receive approval from the Permits Division before resuming work. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.

b. Any time a serious injury or mortality of a protected species occurs, a written report must be submitted within two weeks.

c. The incident report must include 1) a complete description of the events, and 2) identification of steps that will be taken to reduce the potential for additional serious injury and research or enhancement-related mortality or exceeding authorized take.

3. Annual reports describing activities conducted during the previous permit year (from January 1 to December 31) must:

   a. Be submitted by March 31 each year for which the permit is valid, and

   b. Include a tabular accounting of takes and a narrative description of activities and their effects.

   c. Include data on disturbance rates of marine mammals specific to UAS operations. Details should include, but not be limited to: species, altitude and angle of approach, context of exposure (e.g., behavioral states), and observed behavioral responses to the UAS.

   d. Include data on seals that have been remotely sedated or are sedated during in-water captures, specifically reporting on (1) their behavioral response and any activities that put them at heightened risk of injury or death and (2) whether remotely sedated seals entered the water and their fate could not be determined.

4. A joint annual/final report including a discussion of whether the objectives were achieved must be submitted by (March 31, 2025), or, if the research and enhancement conclude prior to permit expiration, within 90 days of completion of the research and enhancement.

5. Research results must be published or otherwise made available to the scientific community in a reasonable period of time. Copies of technical reports, conference abstracts, papers, or publications resulting from permitted activities must be submitted the Permits Division upon request.

F. <u>Notification and Coordination</u>

1. NMFS Regional Offices are responsible for ensuring coordination of the timing and location of all permitted activities in their areas to minimize unnecessary duplication, harassment, or other adverse impacts from multiple researchers.

2. The Permit Holder must ensure written notification of planned field work for each project is provided to the NMFS Regional Office listed below at least two weeks prior to initiation of each field trip/season.

   a. Notification must include the following:

      i. Locations of the intended field study and/or survey routes;

      ii. Estimated dates of activities; and

      iii. Number and roles of participants (for example: PI, CI, veterinarian, boat driver, animal restrainer, Research Assistant "in training").

   b. Notification must be sent to the Assistant Regional Administrator for Protected Resources:

      Pacific Islands Region, NMFS, 1845 Wasp Blvd., Building 176, Honolulu, HI 96818; phone (808)725-5000; fax (808)973-2941

      Email *(preferred)*: Jeff Walters (Jeff.Walters@noaa.gov) and Nicole Davis (Nicole.Davis@noaa.gov);

3. Researchers must coordinate their activities with other permitted researchers to avoid unnecessary disturbance of animals or duplication of efforts. Contact the Regional Office listed above for information about coordinating with other Permit Holders.

G. Observers and Inspections

1. NMFS may review activities conducted under this permit. At the request of NMFS, the Permit Holder must cooperate with any such review by:

a. Allowing an employee of NOAA or other person designated by the Director, NMFS Office of Protected Resources to observe and document permitted activities; and

b. Providing all documents or other information relating to the permitted activities.

H. Modification, Suspension, and Revocation

1. Permits are subject to suspension, revocation, modification, and denial in accordance with the provisions of subpart D [Permit Sanctions and Denials] of 15 CFR Part 904.

2. The Director, NMFS Office of Protected Resources may modify, suspend, or revoke this permit in whole or in part:

a. In order to make the permit consistent with a change made after the date of permit issuance with respect to applicable regulations prescribed under Section 103 of the MMPA and Section 4 of the ESA;

b. In a case in which a violation of the terms and conditions of the permit is found;

c. In response to a written request[14] from the Permit Holder;

d. If NMFS determines that the application or other information pertaining to the permitted activities (including, but not limited to, reports pursuant to Section E of this permit and information provided to NOAA personnel pursuant to Section G of this permit) includes false information; and

[14] The Permit Holder may request changes to the permit related to: the objectives or purposes of the permitted activities; the species or number of animals taken; and the location, time, or manner of taking or importing protected species. Such requests must be submitted in writing to the Permits Division in the format specified in the application instructions.

e. If NMFS determines that the authorized activities will operate to the disadvantage of threatened or endangered species or are otherwise no longer consistent with the purposes and policy in Section 2 of the ESA.

3. Issuance of this permit does not guarantee or imply that NMFS will issue or approve subsequent permits or amendments for the same or similar activities requested by the Permit Holder, including those of a continuing nature.

I. <u>Penalties and Permit Sanctions</u>

1. A person who violates a provision of this permit, the MMPA, ESA, or the regulations at 50 CFR 216 and 50 CFR 222-226 is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the MMPA, ESA, and 15 CFR Part 904.

2. The NMFS Office of Protected Resources shall be the sole arbiter of whether a given activity is within the scope and bounds of the authorization granted in this permit.

a. The Permit Holder must contact the Permits Division for verification before conducting the activity if they are unsure whether an activity is within the scope of the permit.

b. Failure to verify, where the NMFS Office of Protected Resources subsequently determines that an activity was outside the scope of the permit, may be used as evidence of a violation of the permit, the MMPA, the ESA, and applicable regulations in any enforcement actions.

J. <u>Acceptance of Permit</u>

1. In signing this permit, the Permit Holder:

a. Agrees to abide by all terms and conditions set forth in the permit, all restrictions and relevant regulations under 50 CFR Parts 216, and 222-226, and all restrictions and requirements under the MMPA, and the ESA;

b. Acknowledges that the authority to conduct certain activities specified in the permit is conditional and subject to authorization by the Office Director; and

c. Acknowledges that this permit does not relieve the Permit Holder of the responsibility to obtain any other permits, or comply with any other Federal, State, local, or international laws or regulations.

______________________________ ____________________

Donna S. Wieting

Director, Office of Protected Resources

National Marine Fisheries Service

Date Issued

______________________________ ____________________

Charles Littnan, Ph.D.

Director, Protected Species Division

Responsible Party

Date Effective

Appendix 1: Tables Specifying the Kinds of Protected Species, Locations, and Manner of Taking

Tables Key: Main Hawaiian Islands (MHI) = Hawaii, Maui, Molokai, Kahoolawe, Lanai, Oahu, Kauai, Niihau, and all smaller islands and offshore islets, including, but not limited to, Kaula Rock, Lehua, Molokini, etc. Northwestern Hawaiian Islands (NWHI)=Nihoa Island (Is.), Necker Is., French Frigate Shoals, Laysan Is., Lisianski Is., Pearl and Hermes Reef, Midway Atoll, Kure Atoll, and Gardner Pinnacles.

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)

Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Wild	All	Male and Female	1500	5	Harass	Other	Observation, mark resight; Observation, monitoring; Observations, behavioral; Photo-id; Photograph/Video; Remote vehicle, aerial (fixed wing); Remote vehicle, aerial(VTOL);	1. MONITORING IN IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Disturbance from visual obs., photo-ID, ground monitoring , vessel (including ROVs) and aerial surveys (includes UAS).

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
									Remote vehicle, aquatic;	
2	Seal, Hawaiian monk	Wild	All	Male and Female	300	3	Capture/ Handle/ Release	Other	Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, vibrissae (clip); Ultrasound	2A. TAGGING IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Restrain, flipper and PIT tag (retain flipper plugs), cut vibrissae, measure (length and girth), ultrasound; excludes obviously pregnant and lactating females; includes any remaining nursing pups at end of field season

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Wild	All	Male and Female	100	1	Capture/ Handle/ Release	Other	Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, vibrissae (clip)	2B. RE-TAGGING IN THE HAWAIIAN ARCHIPELAGO: Restrain, flipper tag to replace tags (retain flipper plugs), cut vibrissae, measure (length and girth); excludes obviously pregnant and lactating females; includes remaining nursing pups at end of field season
4	Seal, Hawaiian monk	Wild	All	Male and Female	1200	4	Harass	Other	Mark, bleach/dye	3. BLEACH MARKING IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Close approach to apply temporary bleach/dye marks; includes pregnant and lactating females and nursing pups; only rarely 4 takes per animal anticipated

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
5	Seal, Hawaiian monk	Wild	All	Male and Female	60	2	Capture/Handle/ Release	Other	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh; Acoustic, passive recording	4A. HEALTH SCREENING IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Capture, sedation; tagging (flipper and PIT if not already); sampling; weigh, measure, ultrasound; recapture to resample; acoustic recording; excludes obv. pregnant or lactating females and nursing pups

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
6	Seal, Hawaiian monk	Wild	All	Male and Female	40	3	Capture/ Handle/ Release	Other	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound;	4B. HEALTH SCREENING AND FORAGING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Same as above AND instrument; recapture to resample/remove instruments; acoustic recording; may have acoustic recording tag attached; excludes obv. pregnant or lactating females and nursing pups. 3rd take allow for rare eventuality that attempt to remove instrument fails on first recapture

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
									Weigh; Acoustic, passive recording	

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
7	Seal, Hawaiian monk	Wild	All	Male and Female	40	3	Capture/ Handle/ Release	Other	Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Restrain, hand; Restrain, net; Sample, blood; sample, swab all mucus membranes; Sample, vibrissae (cut); Weigh; Acoustic, passive recording	4C. FORAGING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Same as above EXCEPT no Anesthesia/sedation. Flipper-tag mounted instrument; recapture to resample/remove instruments; acoustic recording; excludes obv. pregnant or lactating females and nursing pups; 3rd take allow for rare eventuality that attempt to remove instrument fails on first recapture

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
8	Seal, Hawaiian monk	Wild	All	Male and Female	10	5	Harass/ Sample	Other	Sample, remote biopsy (blubber, skin, hair) using biopsy pole or remote darting (crossbow, rifle).	4D. HEALTH SCREENING AND FORAGING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Sample blubber, skin and hair without capture and restraint using purpose-designed biopsy system delivered via pole or dart/projectile; excludes nursing females and nursing pups.
9	Seal, Hawaiian monk	Wild	All	Male and Female	80	6	Harass/ Sample	Other	Acoustic, passive recording	5. VOCALIZATION STUDIES IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Passive acoustic recording in air using microphone on boom; underwater using deployed passive recorder or manual hydrophone.

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
10	Seal, Hawaiian monk	Wild	All	Male and Female	Unlimited	1	Handle/ Release	Other	Salvage (carcass, tissue, parts)	6. NECROPSY IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Necropsy any seal found dead, that died during restraint, or that was euthanized. After, use seal tissue as bait for permitted shark removals.
11	Seal, Hawaiian monk	Wild	All	Male and Female	1100	Un-limited	Harass/ Sample	Other	Collect, molt; Collect, scat; Collect, spew; Other	7. OPPORTUNISTIC RETRIEVAL OF SAMPLES IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Collect parts (placentae, scat, spew, molted fur/skin) from haul out sites; incidental harassment covered in Table 3
12	Seal, Hawaiian monk	Wild	All	Male and	Unlimited	Un-limited	Import/ export/	Other	Import/export/receive, parts	8A. EXPORT/RE-IMPORT SAMPLES WORLD-WIDE: Export and re-import Hawaiian

Table 1: Pacific Ocean; State/Territory: HI (Annual research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll.)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Take	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
				Female			receive only			monk seal samples taken under permit for analyses.
13	Seal, Mediterranean monk	All	All	Male and Female	Unlimited	Un-limited	Import/ export/ receive only	Other	Import/export/receive, parts	8B. 7. EXPORT/RE-IMPORT SAMPLES WORLD-WIDE: Import and re-export Mediterranean monk seal samples taken under other permit for analyses.

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Wild	All	Male and Female	30	3	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Administer drug, oral; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, milk; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	1A. HEALTH SCREEN / TREATMENT ENHANCEMENT/ FORAGING RESEARCH ON UNHEALTHY SEALS in Hawaiian Archipelago and Johnston Atoll; sedation for health screening & instrument; other = treat as warranted (e.g., lance abscess, antibiotic, deworm); any age/sex condition. Adult females may be injected with oxytocin.

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
2	Seal, Hawaiian monk	Wild	All	Male and Female	As Warranted	As Warranted	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Administer drug, oral; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, hand; Restrain, net; Sample, vibrissae (clip); Sample, vibrissae (pull)	1B. TREATMENT ENHANCEMENT / RESEARCH ON UNHEALTHY SEALS in Hawaiian Archipelago and Johnston Atoll: As warranted (est. 30 seals/yr); all procedures above except full health screening or attaching instrument with epoxy; flipper-tag mounted instrumentation allowed; treatment enhancement any age/sex/condition. Adult females may be injected with oxytocin.

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Wild	Pup/ Juvenile	Male and Female	300	8	Capture/ Handle/ Release	Other	Administer drug, IM, oral, subcutaneous; Collect, scat; Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, hand; Restrain, net; Sample, fecal loop; Ultrasound; Weigh	2. INTESTINAL PARASITE TREATMENT (DEWORMING RESEARCH AND ENHANCEMENT): Up to 4 treatments using injectable; up to 4 post treatment recaptures to repeat weight, morphs, ultrasound, and fecals; pups 120 days post-weaning and juv. up to 3 yr; any cond. Includes control seals who are treated identically except no drug administered.

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
4	Seal, Hawaiian monk	Wild	Pup/ Adult female	Male and Female	As Warranted	As Warranted	Capture/ Handle/ Release	Other	Acoustic, passive recording; Administer drug, IM; Restrain, handle, Captive, maintain temporary	3A. TRANSLOCATION ENHANCEMENT - ESTABLISHING/RE-ESTABLISHING MATERNAL ASSOCIATION: As warranted (est. 20/yr), capture and translocate abandoned nursing pups to natural or foster mother. Typically fewer than 6. Adult females will not be translocated but may be held temporarily in beach pens and/or injected with oxytocin.

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
5	Seal, Hawaiian monk	Wild	All	Male and Female	As Warranted	As Warranted	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, flipper tag; Measure (standard morphometrics); Other; Restrain, cage; Restrain, hand; Restrain, net; Restrain, other; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	3B. TRANSLOCATION ENHANCEMENT - RISK ALLEVIATION: As warranted (est. 60/yr) , translocate within or between any subpopulation in the NWHI or Johnston Atoll or within or between any MHI or from MHI to NWHI via boat, ship, vehicle, or air craft; other = hazing from harmful situation; includes pups near weaning at high risk of mortality

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
6	Seal, Hawaiian monk	Wild	Pup	Male and Female	20	1	Capture / Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Measure (standard morphometrics); Restrain, cage; Restrain, hand; Restrain, net; Restrain, other; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	3C-1. TRANSLOCATION ENHANCEMENT - ONE WAY OR 1st STAGE of 2-STAGE Translocation of weaned pups; within the NWHI or from the MHI to NWHI but NOT from NWHI to MHI; via boat, ship, vehicle, or aircraft; other = treat if warranted; includes health screen and temporary holding

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
7	Seal, Hawaiian monk	Wild	Juvenile/ Subadult	Male and Female	30	1	Capture/ Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Mark, bleach/dye; Measure (standard morphometrics); Restrain, cage; Restrain, net; Restrain, other; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull); Ultrasound; Weigh	3C-2 TRANSLOCATION ENHANCEMENT - 2nd STAGE of 2-STAGE Translocation; within or between any subpop.; seals born in MHI and previously taken to NWHI may go back to MHI; surviving seals translocated in 3C1 above returned to natal or other site

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
8	Seal, Hawaiian monk	Wild	Adult	Male	20	1	Capture/ Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Captive, maintain permanent; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Other; Restrain, cage; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull)	4. ADULT MALE REMOVAL (ENHANCEMENT) - Aggressive males translocated or removed from the wild to permanent captivity; temp captivity for quarantine; other = treat if warranted

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
9	Seal, Hawaiian monk	Wild	All	Male and Female	As Warranted	As Warranted	Capture/ Handle/ Release	Other	Acoustic, passive recording; Administer drug, IV, IM, SC; Anesthesia, gas w/intubation; Anesthesia, injectable sedative; Captive, maintain temporary; Other; Restrain, cage; Restrain, hand; Restrain, net; Sample, vibrissae (clip); Sample, vibrissae (pull)	5. DISENTANGLE AND DEHOOK (ENHANCEMENT) - Disentangle/dehook with or without sedation; other = may require surgery w anesthesia and/or treatment; as warranted (est. < 75 seals)

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
10	Seal, Hawaiian monk	Wild	Pup/ Juvenile	Male and Female	12	As Warranted	Release captive animals	Other	Other	6. SUPPLEMENTAL FEEDING (ENHANCEMENT) - Supplemental feeding of post-rehabilitated seals in the NWHI; seals may be fed at daily or longer intervals for up to a year; seals rehabilitated under MMHSRP permit

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
11	Seal, Hawaiian monk	Wild	All	Male and Female	50	As Warranted	Harass/ Capture/ Handle/ Release	Other	Anesthesia, injectable sedative; Captive, maintain temporary; Instrument, external (e.g., VHF, SLTDR); Other; Restrain, cage; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull), translocation (including MHI to NWHI), acoustic, active playback/broadcast	7A. BEHAVIORAL MODIFICATION IN MHI (RESEARCH AND ENHANCEMENT) - Displace or translocate seals from dangerous locations (e.g., roads). Disrupt/ prevent seals from socializing with humans; alter behavior of seals socialized to humans or behaving in a manner dangerous to the seal or public safety. I; aversive conditioning and other methods including but not limited to hazing, herding, tactile and acoustic harassment, etc.

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
12	Seal, Hawaiian monk	Wild	All	Male	As Warranted	As Warranted	Harass	Other	Other	7B. ADULT MALE HAZING (ENHANCEMENT) - Aggressive males hazed away from conspecific victims in cases of immediate risk of injury or death or when specific males repeatedly attack conspecifics. Intentional harassment for behavioral modification; aversive conditioning and other methods including but not limited to hazing, herding, tactile and acoustic harassment, etc.

Table 2: Pacific Ocean; State/Territory: HI (Annual enhancement and research takes in the Hawaiian Archipelago [Main Hawaiian Islands (MHI) and adjacent islets and smaller islands, Northwestern Hawaiian Islands (NWHI)], and Johnston Atoll)										
Line	Species	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
13	Seal, Hawaiian monk	Wild	All	Male and Female	1500	4	Capture/ Handle/ Release	Other	Administer drug, IM ; Anesthesia, injectable sedative; Restrain, hand; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, swab all mucus membranes; Sample, vibrissae (pull)	8. VACCINATIONS IN MHI AND NWHI (RESEARCH AND ENHANCEMENT) - Vaccinations and sampling for antibody testing in wild and rehabilitating seals; prophylactic vaccinations and vaccinations in response to outbreaks

Table 3: Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/Origin	Life stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Wild	All	Male and Female	200	1*	Harass	Other	Incidental disturbance	1. INCIDENTAL HARASSMENT DURING ANY RESEARCH OR ENHANCEMENT ACTIVITY IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Incidental disturbance to seals during field research and enhancement including opportunistic sample collection, necropsy, captures, remote camera installation and maintenance, etc.
2	Seal, Hawaiian monk	Wild	All	Male and Female	2	1	Unintentional mortality	Other	Unintentional mortality	2A. UNINTENTIONAL MORTALITY DURING RESEARCH IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 4 unintentional mortalities over a 5-year period not to exceed 2 deaths in any one year. During any research activity in the wild. Includes euthanasia for humane purposes.

Table 3: Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/Origin	Life stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Wild	Pup	Male and Female	2	1	Unintentional mortality	Other	Unintentional mortality	2B. UNINTENTIONAL MORTALITY DURING ENHANCEMENT IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 4 unintentional mortalities of weaned pups over a 5-year period not to exceed 2 deaths in any one year. During any enhancement activity. Includes euthanasia for humane purposes.
4	Seal, Hawaiian monk	Wild	Juv-enile/Sub-adult	Male and Female	4	1	Unintentional mortality	Other	Unintentional mortality	2B. UNINTENTIONAL MORTALITY DURING ENHANCEMENT IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 8 unintentional mortalities of juveniles or subadults over a 5-year period not to exceed 4 in any one year. During any enhancement activity. Includes euthanasia for humane purposes.

Table 3: Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/Origin	Life stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/Collect Method	Procedures	Details
5	Seal, Hawaiian monk	Wild	Adult	Male	2	1	Unintentional mortality	Other	Unintentional mortality	2B. UNINTENTIONAL MORTALITY DURING ENHANCEMENT IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL: Up to 4 unintentional mortalities of adult males over a 5-year period not to exceed 2 in any one year. During any enhancement activity. Includes euthanasia for humane purposes.
6	Seal, Hawaiian monk	Wild	Adult	Male	10	1	Intentional (Directed) Mortality	Other	Intentional (directed) mortality	3A. INTENTIONAL MORTALITY OF ADULT MALES IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL (ENHANCEMENT): Humane killing or euthanasia of up to 10 aggressive adult males over a 5-year period.

Table 3: Pacific Ocean; State/Territory: HI (Incidental harassment, unintentional mortalities, and intentional mortalities of Hawaiian monk seals in the Hawaiian Archipelago and Johnston Atoll. Annually unless otherwise specified.)										
Line	Species	Production/Origin	Life stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/Collect Method	Procedures	Details
7	Seal, Hawaiian monk	Wild	All	Male and Female	10	1	Intentional (Directed) Mortality	Other	Intentional (directed) mortality	3B. INTENTIONAL MORTALITY OF MORIBUND OR SEVERELY INJURED SEALS IN THE HAWAIIAN ARCHIPELAGO AND JOHNSTON ATOLL (ENHANCEMENT AND RESEARCH): Humane euthanasia of up to 10 moribund or severely injured seals over a 5-year period at discretion of veterinarian.

Table 4: Pacific Ocean; State/Territory: HI (Annual takes of non-releasable Hawaiian monk seals in permanent captivity in the U.S.)										
Line	Species	Production/Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe / Collect Method	Procedures	Details
1	Seal, Hawaiian monk	Captive	All	Male and Female	20	20	Captive animals (research, enhancement, public display)	Captive	Other	1. BEHAVIORAL MODIFICATION RESEARCH: Intentional harassment for behavioral modification; aversive conditioning and other methods including but not limited to hazing, herding, and tactile harassment, etc.
2	Seal, Hawaiian monk	Captive	All	Male and Female	20	5	Captive animals (research, enhancement, public display)	Captive	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Restrain, net; Sample, blood; Sample, nasal swab	2. VACCINATION RESEARCH: Vaccinations on day 0 and 14; serum and nasal sampling on days 0, 24, 42, and 365. Seals injected 2x/yr and sampled 4x/yr; first sampling combined with first injection for a total of 5 takes per animal per year.

Table 4: Pacific Ocean; State/Territory: HI (Annual takes of non-releasable Hawaiian monk seals in permanent captivity in the U.S.)										
Line	Species	Production/Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe / Collect Method	Procedures	Details
3	Seal, Hawaiian monk	Captive	All	Male and Female	20	As Warranted	Captive animals (research, enhancement, public display)	Captive	Administer drug, IV, IM, SC; Anesthesia, injectable sedative; Instrument, external (e.g., VHF, SLTDR); Instrument, internal (e.g., PIT); Mark, bleach/dye ; Mark, flipper tag; Restrain, net; Sample, blood; Sample, blubber biopsy; Sample, vibrissae (pull)	3. VALIDATION STUDIES (RESEARCH): Research to validate or test field methods.

Table 4: Pacific Ocean; State/Territory: HI (Annual takes of non-releasable Hawaiian monk seals in permanent captivity in the U.S.)										
Line	Species	Production/Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe / Collect Method	Procedures	Details
4	Seal, Hawaiian monk	Captive	Adult	Male	10	1	Captive animals (research, enhancement, public display)	Captive	Captive, maintain temporary	4. ADULT MALE REMOVAL (ENHANCEMENT): Temporary holding at any APHIS-approved facility of adult males removed into permanent captivity until recipient facility is permitted.

Table 5: Pacific Ocean; State/Territory: HI (Annual incidental harassment of cetaceans during Hawaiian monk seal research and enhancement activities.)											
Line	Species	Stock/ Listing Unit	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
1	Dolphin, spinner	Hawaiian Islands Stock Complex	Wild	All	Male and Female	500	5	Harass	Survey, vessel	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE HAWAIIAN ARCHIPELAGO.

Table 5: Pacific Ocean; State/Territory: HI (Annual incidental harassment of cetaceans during Hawaiian monk seal research and enhancement activities.)											
Line	Species	Stock/ Listing Unit	Production/ Origin	Life Stage	Sex	Authorized Takes	Takes Per Animal	Take Action	Observe/ Collect Method	Procedures	Details
2	Dolphin, bottlenose	Hawaiian Islands Stock Complex	Wild	All	Male and Female	20	1	Harass	Survey, vessel	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE HAWAIIAN ARCHIPELAGO.
3	Dolphin, spinner	Hawaiian Islands Stock Complex	Wild	All	Male and Female	200	1	Harass	Acoustic playback (to seals)	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE MHI.
4	Dolphin, bottlenose	Hawaiian Islands Stock Complex	Wild	All	Male and Female	200	1	Harass	Acoustic playback (to seals)	Incidental harassment	1. INCIDENTAL HARASSMENT IN THE MHI.

* Animals may be incidentally taken more than once but this will not always be identifiable

Appendix 2: NMFS-Approved Personnel and Authorized Recipients for Permit No. 22677.

The following individuals are approved to act as the Principal Investigator (PI) and Co-Investigators pursuant to the terms and conditions under Section C (Qualifications, Responsibilities, and Designation of Personnel) of this permit.

Name of Co-Investigator	Activities[15]
Charles Littnan (PI)	All activities except blood sampling and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Co-Investigators	
Jason Baker	All activities except UAS operation, blood sampling, and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Michelle Barbieri	All activities except remote biopsy by crossbow or rifle and UAS operation.
Brenda Becker	All activities except UAS operation, blood sampling, remote biopsy, and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Jessica Bohlander	All activities except remote biopsy and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration). Can draw blood from non-sedated seal independently.
Thea Johanos	All activities except remote biopsy, UAS operation, blood sampling and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Lizabeth Kashinsky	All activities except remote biopsy, UAS operation, blood sampling and those that must be performed by a veterinarian

[15] All CI's may be trained to do any activities other than those that require special credentials (e.g., DMV or UAS pilot). Individuals are trained, often in the field, to conduct specialized tasks and only allowed to conduct them without supervision when they are deemed sufficiently capable by the PI or expert CI.

Name of Co-Investigator	Activities[15]
	(sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Gregg Levine	All activities except remote biopsy by crossbow and UAS operation.
Tracy Mercer	All activities except remote biopsy, UAS operation, blood sampling and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Stacie Robinson	All activities except remote biopsy, UAS operation, blood sampling and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Hope Ronco	All activities except remote biopsy, UAS operation, and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).
Claire Simeone	All activities except remote biopsy by crossbow and UAS operation.
Mark Sullivan	All activities except remote biopsy, blood sampling and those that must be performed by a veterinarian (sedation, chemical euthanasia, gas anesthesia, IV drug administration).

16.2 Appendix B: Appendix B of NMFS (2019)

HMSRP Animal Handling Risk Management Tool (GAR Model)

Risk Factor	Risk Factor Category						Risk Level
	Very Low - 1	Low - 2	Medium - 3	Medium High - 4	High - 5	Very High - 5	
Environment: Land, in-water, remote, surf zone, slippery/jagged substrate, weather, proximity to other hazards including seals. Consider changes during evolution.	**Very Acceptable** Sandy beach, easy vehicle access, cool/overcast weather. Seal >10' from shoreline - weaners excluded.	**Acceptable** Remote site, limited access, sandy beach with coral rubble. Tolerable weather. Seal <6' from shoreline.	**Moderately Acceptable** Off-shore islets, rubble beach, <15 knot winds, <3' seas. Disturbance to other seals and nat./cultural resources in area. IW herding <1m depth all sand.	**Moderately Dangerous** Rocky landing, reef flats, slippery substrate, 15-20 knot winds, 3-6' seas. Other seals and natural/ cultural resources possibly at risk. IW herding >1m depth or on reef.	**Dangerous** Surf landing, >20 knot winds, >6' seas, bad weather, changes in weather. IWC <1m depth.	**Very Dangerous** Heavy weather, coral/ tide pool, large rocks, sharp objects, multiple hazards. IWC >1m depth.	
Team Selection & Fitness: Experience, training, physical/ mental fitness.	**Excellent Team**	**Good Team**	**Appropriate Team**	**Marginal Team**	**Poor Team**	**Very Poor Team**	

Endurance/ availability throughout evolution. Number of people. Non-HMSRP involvement.	Experienced personnel that can do every aspect of the mission tasks/ roles. Mentally and physically fit. Extra people available.	All involved are experienced in assigned roles. Mentally and physically fit. Sufficient number of team members.	Majority of personnel are experts in assigned roles. New staff in training or non experienced volunteers assisting. Good team leader. Sufficient number on team.	New staff/ non experienced volunteers or cooperators assigned primary tasks. Team lead not experienced in task. Fatigued or injured personnel.	Team leader with all new staff /non experienced volunteers or cooperators. Need to ask public for help.	No qualified staff on site. Directions are being given over the phone.	
Seal Selection & Condition: Health Assessment checklist complete. Molt status, pregnant/nursing. Make effort to ID seal prior to capture.	**Healthy**	**Healthy**	**Sick/Injured/Compromised**		**Highly Compromised**		
	Weaned pup (>P3 size) . No known injuries, uncompromised. Healthy history. Observed normal behavior.	Non-pup. Minor entangle/injury, superficial hooking. Otherwise uncompromised. Obs. normal behavior.	Serious entanglement, externally hooked, serious but not life threatening injury such as small shark bite or abscess. Seal may be sick, injured (severity <3), in poor body condition (includes P1-P2), lethargic or otherwise compromised. (all age classes)		Severe entanglement, ingested hook, possibly lethal or severity 3 wound such as amputation, lg shark bite, puncture, head trauma. Seal moribund, pregnant, nursing or "spent" after weaning pup. Near molt, molting, or <2 wks post-molt. In very poor body condition.		
Permission: Permit and HMSRP protocol compliance, notifications	**Excellent**		**Good**		**Poor**		

and authorizations, team agreement, non-HMSRP involvement.	Compliant with permits and protocols, all notifications and authorizations obtained, unanimous team agreement, no external NGO/agency coordination needed.		Permit and protocol compliance, appropriate notifications and authorizations obtained, unanimous team agreement, some external NGO/agency coordination needed.	A breach in any of the following - permit, protocol, notification, authorization, total team agreement. External NGO/agency use not totally appropriate.		
Resources: Equipment, PPE, communication, support, instruments, platforms.	**Excellent**		**Good**	**Not Prepared**		
	All necessary resources available. Ideally (but not necessary) you have extra equipment and personnel available.		Missing some resources but entire team is confident that they can still complete mission safely.	Missing key resources to safely complete mission.		
Mission Complexity: New or experimental, time sensitive, response or research, mission briefing, non-HMSRP presence.	**Simple**	**Standard**	**Moderately Complex**	**Very Complex**	**Extremely Complex**	
	Non-invasive. Not touching seal. Safe location. Necessary personnel and gear.	Pop assess tagging, instrument removal, VAX, pole syringe or less complicated. Expected handling time < 10min.	Sedation, epi-sampling, instrumentation, behavioral modification, public present, translocation or moving the seal. IW herding.	Extensive holding in pen or cage, rehabilitation, surgical procedures, euthanize. IWC.	UME, multiple seals, locations and teams. Seal's life depends on immediate capture. IWC.	

If any risk level equals:	**Any Medium-High**	Contact project lead or immediate supervisor before proceeding.	**Total**	
	Any High - Very High	Contact Charles Littnan (808) 220-3601 or Michelle Barbieri (443) 834-8612 immediately.		
If total score equals:	> 10 in MHI or > 15 in NWHI, contact project lead for advance approval (unless time critical to save seal).			

Key considerations or questions to be asked

Molt:	Non-pups showing signs of molt, molting, or < 2-weeks past completion of molt will not be captured unless it is a lifesaving intervention. If molt completion date is unknown, team will assume seal just completed molt. Seals that are thought to be immediately pre-molt (including 2 week window before projected molt begin date) should also be given extra consideration.
Pregnancy:	There will be no capturing of obviously pregnant females except for emergency interventions. If a seal is believed to be in its first trimester it can be captured. Outside of the first trimester capture should be avoided.
Previous Capture History:	Make a good effort to ID the seal prior to (and during if necessary) capture and determine previous capture history. If there were any complications or concerns noted during previous handlings consult with veterinarian or program lead.
Health and Behavior assessment	Observe body condition, responsiveness (responds normally to natural stimulus), or if there are any external or behavioral abnormalities.
Weather Concerns:	Does weather pose a threat to the seal or researchers (i.e. heat stress or hypothermia)? If so, is there a way to mitigate it? Captures during the middle of the day should be avoided unless overcast/ cool. Consider the seal's body temperature before, during, and after, handling.
Habitat Concerns:	Habitat should be assessed for hazards to seals and researchers. Rocky platforms with ledges and bouldery habitat should be avoided unless absolutely necessary. Mitigate potential threats where possible. Consider crowding to a safer area or use of padding.
Equipment:	Is all necessary gear functional, available and ready? Including but not limited to crowding, capture, tagging, sampling, instrumentation, disentanglement and emergency equipment. Temperature mitigation gear (shade, bucket for water). Transport gear (cage, truck, boat).

Presence of other seals:	Are there other seals in the area that may be disturbed by the handling? Is there a potential for other seals to approach and disrupt during capture? Consider other natural and cultural resources nearby.
Team Composition:	Is there sufficient staff to safely complete the mission and unforeseen situations? If a veterinarian is necessary, have a sufficient team to assist so the vet can monitor the seal. Ensure that all involved fully understand their roles throughout the evolution. Make sure everyone understands warning signs to look for. Designate someone to monitor fatigue, injury, availability of seal and personnel throughout evolution.
Public Presence:	Is the capture going to be in a public area? Ensure sufficient crowd control and outreach. Consider a public briefing before and after the event. Expect to be recorded and ensure that all involved look and behave appropriately.

16.3 Appendix C: Appendix C of NMFS (2019)

APPENDIX C: MONK SEAL HANDLING PROTOCOL

A. INTRODUCTION

Monk seals are handled primarily for tagging and measuring. Other reasons for handling include survival enhancements (e.g., mother-pup reunites, disentanglements, and veterinary treatments), health assessments, captive care/rehabilitations, instrumentations, directed studies, and other activities. Seal handlings may include human restraint, a restraining device, chemical immobilization, or a combination of these. Chemical immobilization is performed with an on-site veterinary and is typically used for more complicated procedures. All monk seal handlings are conducted under the NMFS Research or Stranding permits. Familiarize yourself with the specific authorized activities for each permit. The following protocols are to ensure that handling events are conducted as safely as possible for both seals and humans.

B. DISEASE TRANSMISSION

Disease transfer among individuals of a species and between species occurs though five basic routes: direct, aerosolization, ingestion, injection, and absorption. There are no confirmed disease outbreaks in Hawaiian monk seals, though a mass die-off occurred on Laysan in1978 when at least 50 seals died from an undetermined cause. All wild seals, especially those on the same island, are considered ‘in-contact’ and a potential transmissible disease outbreak (e.g., morbillivirus) could spread rapidly with catastrophic results.

There are no known cases of diseases being transmitted between humans and live monk seals. However, monk seal bites inflicted during handling events are the most common field injury and pose a high infection risk. Always consult a medical professional for seal bites and file an injury report. There is a single case of a field person contracting “seal finger” from a cut by a contaminated scalpel during a monk seal necropsy. *Seal finger* is a bacterial infection of the fingers/*hand* that may be transmitted by a seal bite or handling seal tissue. Information on potential diseases Hawaiian monk seals may transmit is found in the *Specimens/Zoonotic Disease* section of the Master Field Log. This list is not allinclusive, as some disease agents may have gone undetected while others may emerge at any time.

Proper sanitation and appropriate personal protective equipment can prevent or minimize disease transmission and human injury. To address this, use the following standard procedures whenever there may be physical contact between humans and live monk seals.

C. SEAL HANDLING AND DISINFECTING SUPPLIES

All handling supplies, except for chemical restraint, are listed below. See specific protocols for additional supplies required for tagging, measuring, weighing, epidemiological sampling, instrumentation, and other handling activities.

** Denotes Northwestern Hawaiian Islands (NWHI) site specific items per quarantine protocol

Data Supplies

Tag/Handling card/form

Survey form

Pencil

Clipboard

Watch with timer (includes seconds)

Camera and/or video camera (e.g., GoPro) (optional)

Protective Clothing

**Coveralls

**Footwear appropriate for substrate

Gloves, nitrile

Optional items:

Eye wear (includes sunglasses)

**Knee pads

**Gloves, cotton

Continued on next page

Capture/Restraining Gear and Herding Devices (optional)

**Stretcher net

**Hoop net (includes fiberglass poles, connector with screws, and allen head wrench)

Note: Do not use duct tape to secure hoop net poles together between uses; tape damages the poles.

Crowding boards

Cleaning/Disinfecting Supplies

Antibacterial soap/Hand sanitizer

Rescue/Accel (or bleach) disinfectant solution (see section F for formula)

Spray bottle for disinfectant solution

Garbage bag(s) or other container(s) to separate gear and clothing into 3 categories:

Clean, *Dirty*, and *Used-Unsoiled* (specific for overalls and cloth gloves – see section D)

Miscellaneous Supplies

Backpack (to carry supplies)

Bucket (to carry supplies and/or to hold water to cool seals)

Towel to cover seal's eyes (optional)

First aid kit (betadine, gauze, band aids, etc.)

Disentangling Tools (as needed)

Cutting instruments (seat belt cutter, wire cutters, snips, hacksaw, etc.)

Pole

Soldering iron (optional)

D. PROTECTIVE CLOTHING (*NWHI items are site specific, per quarantine protocol)*

Seal restrainers (includes anyone who may have physical contact with the seal) are required to wear coveralls and appropriate footwear, primarily for their own protection. Handlers who may come into contact with bodily fluids must wear nitrile gloves. Cloth gloves may be worn over nitrile gloves if added grip is needed. Other recommended protective gear includes eye wear (including sunglasses) and knee pads.

Non-handlers (includes seal taggers and others that may come into contact with bodily fluids) are required to wear nitrile gloves and appropriate footwear. It is optional to wear all of the other protective gear (coveralls, eye wear, and knee pads). However, it is good practice to wear *all* the protective gear, as the designated non-handlers may end up restraining during the capture event.

Appropriate footwear is dependent not only on the substrate where the seal is located, but also the terrain that must be traversed to reach the seal. It is acceptable to be barefoot during handling activities on sandy beaches without toe stubbing or tripping hazards.

All protective reusable clothing (coveralls, footwear, knee pads, and cloth gloves) that are not soiled by bodily fluids, may be re-used for handling multiple seals in a single day. Once these items are soiled or at the end of the day, they must be cleaned and disinfected before reuse.

E. SEAL HANDLING

To improve safety and minimize injury to seals and humans, the Hawaiian Monk Seal Research Program (HMSRP) developed the ***Animal Handling Risk Assessment Tool using the GAR Model*** (Green, Amber, Red) (see appendix) to objectively assess all relevant risk factors when deciding if a seal will be captured. The 6 risk categories include Environment, Team Selection and Fitness, Seal Selection and Condition, Permission, Resources, and Mission Complexity and each risk category is rated from 1-5 (lowest to highest). For each handling, the risk level value for each category is decided by group consensus and recorded on the handling data form/card. For any category rated as a 4 or 5 (medium-high to high/very high) risk level, mitigations must be discussed and leader contacted before any handling would proceed. Also, **GAR totals of >10 in the main Hawaiian Islands or >15 in the NWHI require advance approval, unless time critical to save a seal.** The higher total GAR threshold for the NWHI is because the lowest risk level for the Environment category is a 2, because these islands are all remote sites. Detailed risk and other handling considerations are listed below.

1. Seal Considerations

Each seal is evaluated on size, body condition, reproductive and molt status, injury and severity, previous response to handlings, behavior, and appropriateness for the handling purpose. The team lead has the ultimate decision on which animals to handle, as long as the seal meets the handling criteria.

For non-emergency handlings *do NOT* handle the following seals

a. **Adult females nursing, obviously pregnant, or "spent" after lactation.** Preferably, wait until after the end of the breeding season/post-molt to handle them. Use reproductive histories to predict birth dates and avoid any captures after the first trimester in a pregnancy.
b. **Non-pups showing signs of molt, molting, or "spent" from molt.** This includes the 2 week window before projected molt begin date and 2 weeks after molt end. Molted seals with an unknown molt end date are considered to have just completed their molt. Use previous molt records to predict molt dates.
c. **Compromised seals** (old, emaciated, injured (survival factor severity $\geq$2), or behaving abnormally), also includes *weaned* P1-P2 sized pups (irrespective of molt status)
d. **Seals with known significant issues related to capture/handling stress.** Review capture histories and do not capture these seals. Record capture/handling stress issues in the seal's *"Seal Memo Field"* in the seal population database *(SPA).*

For all medical interventions (e.g., abscess treatments), consult with Michelle Barbieri, DVM or designee for advice and authorized treatment plan. Consult with Thea Johanos for non-medical interventions (e.g., pup reunites and exchanges, disentanglements).

2. Other Considerations:

a. Temperature/Weather
Consider how weather may impact seals and the team, including temperature related issues (primarily heat stress, but also hypothermia) and how inclement weather may affect the environment and proposed activity. Pups are less affected by warmer temperatures and can be handled most any time. However, larger animals (and fatter weaned pups) have less surface area relative to body mass and are more susceptible to heat stress. Therefore, limit handling of larger (and fatter) animals to periods of cooler ambient temperatures, i.e., early morning, late afternoon, or when skies are overcast. Consider the seal's temperature before, during and after the handling. For longer handling/holding of seals in warm temperatures, use a shade

structure and cool the animal by pouring water on its hind flippers and on the substrate under/around the seal).

b. Disturbance (other seals and wildlife)

The seal to be handled should be alone. **Avoid disturbance of nearby animals, including non-seals**. **DO NOT DISTURB MOTHER/PUP PAIRS**. For adult seals, if the target animal is paired with an animal of the opposite sex, then wait for a better opportunity. Since weaned pups tend to congregate and are less disturbed by handlings, it is reasonable to handle a weaned pup near other weaned pups. Additionally, since adult male seals may be aggressive towards pups, it is reasonable to inadvertently disturb adult males in close proximity when handling a pup. Monitor nearby seals, as they may be attracted to the handling activity and need to be diverted away. Alternatively, nearby seals may be disturbed and must have a clear and safe escape path. A weaned pup targeted for handling, may be moved away from an area in a stretcher net to minimize disturbing other animals.

c. Environmental hazard assessment

Survey the surroundings for at least a minute to identify any environmental hazards that might pose a threat to the seal, the handling team, or may impact the capture. Consider the potential hazards to seals and other animals that may flush into the water, such as high surf, shark predation, or aggressive male seals. Sticks, rocks, overhangs, drop offs, and hard and/or slippery substrates may cause injury, particularly if the seal thrashes or resists restraint. If using a net, be aware of the seal's **proximity to the water** and the potential of becoming submerged while held in the net. A pup can be moved away from the water's edge using a stretcher net, or moved a short distance (few meters) by grasping both ankles (may take 2 people, each holding an ankle) and dragging the pup to a safer location. If the hazard cannot be mitigated (e.g., removal of the rock or padding a hard substrate), then wait for the seal to move or herd the animal to a more favorable spot.

Be conservative when assessing threats. The seal can almost always be captured at another time and it isn't worth the risk of injury or worse.

d. Equipment and Supplies

Confirm all equipment is appropriate, present, ready, and functional. This includes protective wear (coveralls, gloves, etc.), stop watch, capture/restraining gear (nets, crowding boards), gear for specific procedures (tagging, measuring, sampling, instrumentation, disentanglement, etc.), temperature mitigation gear (canopy, buckets with water, water sprayer, etc.), holding/transport gear (cage, pen supplies, etc.), emergency equipment & drugs, and appropriate data forms and camera. Recheck again!

e. Team Composition

Are there enough members with appropriate skill sets for required roles (e.g., head restrainers, veterinarian, assistant(s) to veterinarian), including backups for different roles to accomplish a safe handling? Designate someone to monitor seal and/or personnel for fatigue, injury, etc. Is team fit and well-rested? Can they mentally focus on mission?

f. Presence of public/other bystanders

If capture is in a public area, is there sufficient crowd control and outreach? Consider having a public briefing pre- and post-event. Maintain professionalism (attire and behavior) and recognize that the activities will be recorded.

Prior to capture, confirm all are in agreement. Is there any reason to NOT catch the seal? If anyone on the team has doubts, SPEAK UP. Err on the side of caution. If there is *any* question about safety, abort the capture and wait for a safer situation.

The optimal capture situation is when the seal is:

- On a beach without any hazards
- Solitary – minimizing disturbance to other seals, particularly adult male-female pairs; **DO NOT DISTURB mother/pup pairs**
- Sleeping – element of surprise can be advantageous
- Lying on its ventrum – a seal's greatest range of motion is curving its head forward towards its belly rather than arching back towards its tail.
- Away from the water's edge – seals will attempt to escape into the water, become slippery to handle when wet (it's harder to apply tags to wet/sandy flippers), and the water may pose a drowning risk
- Facing inland and uphill if beach is sloped – it is harder for a seal to move uphill than downhill EXCEPTION: For pups that may have suckled within 4-6 hrs, orient their heads downhill to reduce risk of aspiration.

3. After GAR has been completed and decision to capture has been made:

a. Modify protective clothing and personal effects to minimize getting caught in net during handling event

Remove rings from fingers or wear gloves and tie hair up. Check clothing for buttons (even pant cuffs) and modify as appropriate to reduce entanglement/tripping risks.

b. Review/Mental preparation

Before handling *any* seal, be sure everything is ready. Double check all the equipment and supplies. Identify the team leader for the handling event and review the capture scenario, what procedures will be undertaken, any emergency response, and the sequence of the activities. Discuss when a handling would be aborted and who makes the call. Assign roles for each team member (and backups) for every part of the handling event, and confirm the team members fully understand, are capable, and are mentally prepared. Review seal warning signs to monitor and the appropriate emergency response actions.

4. Seal capture and restraint

Monk seals are not aggressive and typically flee into the water. However, all seals have teeth and may bite, including pups (though their teeth may not be fully erupted, their bites can hurt). In the water, the seal's primary means of locomotion is by swaying its hips and hind flippers side to side and on land by undulating forward on its belly.

a. Time limits

For all handlings, record the time of day and the total restraint time (from when the seal was first touched until released). **For most handlings of unsedated seals, a maximum restraint time of $\leq$10 minutes (including herding) is recommended.** However, other factors to consider include stress level of the seal, ambient temperature, condition of seal and handlers, and reason for the restraint. **Most weaned pup capture, tagging, and measuring events are completed within 2-4 minutes.**

b. Moving a seal to better handling location

A pup can be moved away from the water's edge using a stretcher net, or moved a short distance (few meters) by grasping both ankles (may take 2 people, each holding an ankle) and dragging the pup to a safer location. Seal's may also be herded by clapping hands and/or using boards to encourage a seal to go to a better location. Herding also is advantageous as it may tire the seal and the seal may resist less during restraint. Be aware of hazards when herding. Usually, it helps to herd the seal higher up the berm to an open, sandy area, but be mindful of very hot sand. Communicate continuously with the herding team to safely coordinate the herding activity. **When herding, give the seal space (~6'), otherwise the seal will likely roll onto its back in a defensive posture and won't move.** Backing off will usually remedy this. If herding is for a longer distance and/or complicated, give the seal short breaks. **Herding should be limited to 5 minutes.**

c. Minimize stress

To prevent additional stress to the seal throughout the capture, restraint and release activities, **minimize being in the seal's field of view**. **When working around a restrained seal, stay behind the seal's fore flippers as much as possible.** This is safer, because the restrainer can't always control the seal's head completely and people have been bitten. A towel may be placed over the seal's eyes to reduce stress. However, monitor the seal's nares (nostrils) and check eyes regularly. A seal is more likely to go into a breath-hold dive response if there is extra pressure on its face, so use towels with caution.

Also, **avoid any unnecessary talking and speak quietly.** Throughout the process the restrainers must communicate when they don't have control of the seal and the people performing the procedures should inform the team when they are beginning and completing the various procedures, particularly as some procedures may cause the animal to struggle more (e.g. punching holes and threading tags) and the restrainers can be prepared.

d. Restraint devices and capturing/restraining seals

Recommendations for restraint team size and restraining devices:

Seal Size	*Minimum* # of Restrainers	Restraining Device
Pup	1	Stretcher net (*optional for newly weaned pups*),

		Hoop net can also be used
Juvenile	2	Stretcher or Hoop Net
Subadult/Adult	3	Hoop Net

Hoop Nets come in different sizes, use appropriate size for body size of animal to be captured.

How to capture/restrain a seal

To improve capture success, care should be taken to quietly approach a target seal from downwind, out of the seal's field of view, and crouching down in case the seal happens to look up. Some or all of the capture team should be between the seal and the water, to block its escape route.

It is optional to waken a sleeping seal. Each restrainer has their own preference and may approach it differently for each situation and size of seal. However, sometimes having the seal asleep does give you the advantage to catch the seal before it is aware of what is going on.

Upon capture, the controlling the seal's head is the most critical part of the restraint. Thus the head restrainer directs the actual capture and handling and is the first person on and last off the seal. The head restrainer primarily calls the shots as s/he is on the biting end. The best way to control the head is by grasping the skin on the sides of the seal's neck, just behind the head. When there is more than 1 restrainer, the order of restrainers getting on the seal is from the head to the tail, and in reverse order when releasing the seal.

Use the minimal amount of body weight, never your full weight, to restrain the seal. During restraint, the seal should ideally be lying on its ventrum, and the fore flippers restrained so the seal can't use them as leverage to roll. **Do not stand or kneel on the seal's flippers**. If the seal rolls, the restraining team may need additional assistance from others (including non-designated restrainers) to bring the animal back onto its ventrum and/or to prevent the seal from "cork screwing" its hips (rotating its posterior body and hind flippers in a circle). Therefore, it is a good idea for *all* team members to wear protective clothing. Additionally, it may be helpful to maneuver/keep the seal's head facing uphill.

For most handling operations it is not absolutely essential that the seal be lying flat on its ventral, but it is safer that way, and for tagging, the tagger is less likely to make a mistake by putting the tag in upside down. Avoid obstructions under the seal like coral rubble, sticks, your arm, even divots and bumps in the sand and edges of berms should be avoided. **Keep the seal's body in alignment.** Monitor so the seal's muzzle isn't squashed in the net or buried in the sand or its flippers are tweaked out of alignment. It is impossible to immobilize the seal completely. **Any restraint can be called off at any time.**

Confirm that the restrainers have control over the seal before conducting any procedures on the animal. Typically a seal does not struggle the entire time under restraint, and will often take a deep breath just prior to struggling. The head restrainer monitors the seal's breathing and response level, and alerts the team when the seal takes a deep breath, so the other restrainers can increase their grip in preparation, and the other procedures can be held off temporarily. Seals may lift their heads abruptly so beware of the head butt. Additionally, seals may jerk in response to hole punching, inserting (threading) a temple tag in the hind flipper, implanting a PIT tag, inserting a needle for a blood draw, and other procedures. Therefore, the person performing these activities quietly states what is going on so the restrainers can prepare for the seal's reaction. Subadult and adult seals can be harder to tag, because the hind flipper webbing is thicker and the punched hole tends to bleed more. These seals also "jump" more to a hole punching than weaned pups. However, they respond less to being PIT tagged.

<u>For weaned pups and juveniles</u>, the head (or sole) restrainer typically straddles the seal's body at the shoulders, and uses his/her hands, knees, and lower legs to hold the animal in position. For newly weaned pups, the head restrainer may only need to keep his/her hands on the seals' neck and then increase pressure/grip when the seal struggles (see left image below). The fore flippers can be held in place by the restrainer's knees, to prevent the seal from using its flippers as leverage to roll over. A net may be used for older, more wiry seals or for less experienced restrainers. A second restrainer may face the seal's rear and restrain the hind end by holding the ankles or flippers (see right image below).

For subadult and adult seals, the restrainers usually do not straddle the animal, but will lie along the sides of the seal's body holding the seal down as seen in the photos. The second person on the seal after the head restrainer will restrain the fore flippers so the seal can't use them as leverage to roll over. Typically the restrainers from the seal's head to the tail alternate which side they are on, i.e., the second restrainer would be on the opposite side of the seal from the 1st (head) and 3rd restrainers.

Restraining with a Net

When using a net for restraint, **watch that the seal's fore flippers and teeth are not caught in the mesh and that the head is not in an unnatural angle or the muzzle squished.** Adjust as necessary. Use care that the handling team's fingers do not get caught in the netting as well. Seals may still roll while in a net, but the net does provide some control over the animal.

Stretcher net: Stretcher nets are used for restraining and/or moving smaller animals. See images below. Before capturing a thinner seal, the netting between the poles can be made narrower by rolling one or both sides of the poles so the netting wraps around them. To capture, one restrainer holds the poles at each end of the net and then they simultaneously lay the net over the seal so the end of the netting is a minimum of 1-1.5 feet past the nose of the seal. This provides a buffer in case the seal moves forward in the net. Typically the person closest to the seal's head will then straddle the seal in the usual way, holding the seal's head and using her/his knees and lower legs to hold the side poles of the net against the seal's body. Check that the fore flippers don't get tweaked along the net poles. Once the animal is under control, the net may then be moved up towards the seal's head so the hind flippers and more posterior body can more easily be accessed for tagging or other procedures. For more accurate measurements, it is better for seals to be out of the net.

To move a seal in a stretcher net, two people hold the ends of the poles and place it over the seal as described above and in one motion the seal is rolled onto its side and the poles brought together. The lines of rope woven through each end of the netting are then cinched so the seal's head and hind flippers are held in the net. The ends of these lines can then be wrapped around the poles to secure the poles together. The seal can then be carried by 2 people. See images below.

Hoop Net restraint: One person, typically the head restrainer, holds the large open end of the net and pulls the net over the seal's head and down its body. A team members may assist by stretching out the end of the net so it doesn't collapse closed, to facilitate the capture. A capture team member may also assist in pulling the net over the seal. Once inside the net and the handling team restrains the seal (the head restrainer on first), the two fiberglass poles that hold open the net can be pulled out of the net to avoid injury to the seal and the team if the seal struggles. One way to prevent the seal's muzzle from being smooshed at the end of the net, is to not have the seal go all the way into the net before manually restraining. Alternatively, tie off about 1 foot of the narrow end of the net with a quick release knot so that after the seal is in the net, the line can be removed and the net will become longer, giving the seal’s muzzle more space. To release the seal from the net, 1-2 people pull the net forward towards the seal’s head and off its body.

5. Monitoring Seal

For most handlings, the head restrainer is responsible for monitoring the seal’s level of alertness and respirations throughout the restraint period. For sedated animals the vet or other dedicated person will continuously monitor the seal’s respiration and heart rate. The team will be notified if the seal’s vitals change. The seal's breathing pattern will probably be somewhat irregular, and it may only breathe through one nostril. However, if there is a sudden change in breathing pattern, either a rapid increase or sudden decrease, this raises concern. For example, if a pup holds its breath for 20 seconds or more, immediate release should be considered. Check the seal's eyes to see if they are responsive; i.e., is the seal looking around, does it respond to your hand or something that you move into its field of view? Tap its head gently behind the eye with your finger. If it doesn't show some response or its response is slow and the seal does not appear to be attentive, then abandon the procedure, stimulate the seal and/or add cool water and immediately, release the animal and monitor it. **Be conservative in your decision-making and err on the side of caution.**

6. Seal stress

a. **Restraint stress**. Tagging operations typically take a few minutes, so the seal should not be too stressed, however, there have been a few older seals that have gone into a dive response and the handling event was aborted and the seal stimulated and released.

b. **Heat stress**. Because tagging is relatively quick and the pups are relatively small, the chances of heat stress are reduced. Nevertheless, heat stress is possible and potentially lethal, especially on a hot afternoon and for larger/older animals. Make sure you have water handy to cool the animal. The animal is best cooled by gently pouring water over its hind flippers (highly vascularized) and to the substrate around and under the seal. Don't sit on the animal. Try to minimize the amount of the seal's surface that is covered with a warm human body. If in doubt, always err on the side of keeping a seal cooler, as cooling an overheated seal is difficult and often unsuccessful.

c. **Exceptionally cold.** May use heating pads and keep seal dry to prevent getting over chilled.

7. Releasing a Captured Seal

If appropriate, pour water on the seal's hind flippers to cool it down just prior to release. Confirm the seal has a safe and clear escape route. For sedated seals, the vet directs the seal release. For unsedated seals, the head restrainer directs the release, and the restrainer closest to the seal's tail is the first off after the head restrainer gives the okay, followed in order up to the head restrainer who is last off. During release, each restrainer quietly says when s/he is off the seal, so the next restrainer knows when to get off. All handling and other gear is collected, and the team quickly leaves the area. **Always monitor the seal post-release from a distance for at least 10 minutes** (or until seal swims away), while keeping a low profile, particularly for non-pups, as older animals may become more easily stressed from a handling. Weaned pups may approach the team post-release, that is why we leave the area. Most seals go into the water shortly after release.

8. Post Capture Debriefing

Review with team members what went well and what didn't. Give constructive feedback and brainstorm on ways to make improvements. This step is often left out, but is just as important as the rest of the handling.

F. DISENFECTING PROTOCOLS FOR HANDLING GEAR

a. **Be mindful and avoid contamination of "clean" items, yourself and others after the handling event.**
Remove protective wear once the contaminated items no longer need to be handled. Do not touch clean items while wearing contaminated gloves. When removing of soiled gloves and coveralls take them off so these items are inside out to avoid spreading contamination.

b. **Use different containers or bags to separate gear into 3 categories: soiled items** (clothing/gear/equipment), **reusable non-soiled protective clothing,** and **clean items. All** protective reusable clothing (coveralls, footwear, knee pads, and cloth gloves) that are not soiled by bodily fluids, may be re-used for handling multiple seals in a single day. Once these items are soiled or at the end of the day, they must be cleaned and disinfected before reuse.

c. After each handling, ***all*** **contaminated reusable equipment and gear must be treated** including restraining gear (nets), measuring gear (tape measures and scales), tagging supplies (PIT tag applicators, tagging pliers/hole punchers), specimen supplies (specimen cooler, ice packs) and other miscellaneous items (buckets, clipboards, writing implements, Ziplock bags used to protect PIT tag reader and garbage bags for holding soiled protective clothing etc.).

   i. **Dispose** of used nitrile gloves in the trash. Place used needles /scalpels in a **"SHARPS" container** (do not recap needles).

   ii. **Clean** all reusable items by washing thoroughly **with soap and water, disinfect** using either of the following solutions (except tagging pliers/hole punchers, see below) **and dry items.**

      i. <u>Accel (accelerated hydrogen peroxide) solution</u>: 1-2 ounces of Accel concentrate per gallon (128 ounces) of **fresh** water. Soak for 5 minutes and ideally rinse off. The Accel solution will last up to 30 days if kept at room temperature or in the shade. Waste Accel is non-toxic and may be disposed in the sand above the high tide line.

      ii. <u>Bleach is an alternate disinfectant</u> if Accel is not available. Bleach solution: 1 part bleach: 20 parts water (can use salt water). Soak for a minimum of ten minutes and then rinse with water. Bleach solution may be re-used within a 24 hour period, unless contaminated with organic material including dirt or blood. Once the solution no longer smells like bleach, the bleach has evaporated and the remaining liquid can be poured into the sand above the high water line.

      iii. U**se 70% isopropyl alcohol to disinfect the tagging pliers/leather punchers instead of the Accel or bleach solution** which causes these tools to rust. Note alcohol will fix blood, so clean first with soap and water or betadine. Run a Q-tip (moistened with rubbing alcohol) through the hole punch before and after each tagging to be sure all fur and other tissue remnants are removed between uses. Sharpen the hole punch tip and sand off any rust and treat with WD-40 (or corrosion block) as needed.

d. **Afterwards,** thoroughly **clean hands** with anti-bacterial soap/hand sanitizer.

G. POST-HANDLING PROTOCOL

1. Process samples collected according to current Specimen Collection Protocol.
2. Complete appropriate handling and data collection forms: tag/handling/epi card/form, survey form, and other appropriate forms for the specific handling procedure.
3. Clean and disinfect, or dispose of equipment used during the seal handling event.
4. Log data into the appropriate Master Field Log sections. See *Steps: Field data collection and editing/ Tagging/Handling Section* (filed in the Master Field Log) for data logging/documentation of the event.
5. Restock the handling supplies and any kits used for the procedures (e.g., tagging).

H. SUMMARY OF STEPS FOR SEAL HANDLING

1. Identify candidate seal – ideally take ID photos of seal prior to handling if not readily identifiable
2. Visually assess seal and situation – Complete GAR
3. Assign team roles & review plan
4. Prepare equipment and supplies for capture and procedures
5. Capture seal and continuously monitor seal response//alertness during capture
6. Release seal and observe seal minimally 10 minutes (or until seal swims away) post-handling
7. Debrief after event-focus on how to improve and avoid blame
8. Process samples
9. Complete tag/handling card/form, survey form & other data forms (translocation, survival factor, etc.)
10. Clean/disinfect(or dispose) of handling and other gear

11. Log data into the appropriate Master Field Log sections
12. Restock handling and other gear

HMSRP Animal Handling Risk Management Tool (GAR Model)

March 08,2018

Risk Factor	Risk Factor Category						Risk Level
	Very Low - 1	Low - 2	Medium - 3	Medium High - 4	High - 5	Very High - 5	
Environment: Land, in-water, remote, surf zone, slippery/jagged substrate, weather, proximity to other hazards including seals. Consider changes during evolution.	**Very Acceptable** Sandy beach, easy vehicle access, cool/overcast weather. Seal >10' from shoreline - weaners excluded.	**Acceptable** Remote site, limited access, sandy beach with coral rubble. Tolerable weather. Seal <6' from shoreline.	**Moderately Acceptable** Off-shore islets, rubble beach, <15 knot winds, <3' seas. Disturbance to other seals and nat./cultural resources in area. IW herding <1m depth all sand.	**Moderately Dangerous** Rocky landing, reef flats, slippery substrate, 15-20 knot winds, 3-6' seas. Other seals and natural/ cultural resources possibly at risk. IW herding >1m depth or on reef.	**Dangerous** Surf landing, >20 knot winds, >6' seas, bad weather, changes in weather. IWC <1m depth.	**Very Dangerous** Heavy weather, coral/ tide pool, large rocks, sharp objects, multiple hazards. IWC >1m depth.	
Team Selection & Fitness: Experience, training, physical/ mental fitness. Endurance/ availability throughout evolution. Number of people. Non-HMSRP involvement.	**Excellent Team** Experienced personnel that can do every aspect of the mission tasks/ roles. Mentally and physically fit. Extra people available.	**Good Team** All involved are experienced in assigned roles. Mentally and physically fit. Sufficient number of team members.	**Appropriate Team** Majority of personnel are experts in assigned roles. New staff in training or non experienced volunteers assisting. Good team leader. Sufficient number on team.	**Marginal Team** New staff/ non experienced volunteers or cooperators assigned primary tasks. Team lead not experienced in task. Fatigued or injured personnel.	**Poor Team** Team leader with all new staff /non experienced volunteers or cooperators. Need to ask public for help.	**Very Poor Team** No qualified staff on site. Directions are being given over the phone.	
Seal Selection & Condition: Health Assessment checklist complete. Molt status, pregnant/nursing. Make effort to ID seal prior to capture.	**Healthy** Weaned pup (>P3 size). No known injuries, uncompromised. Healthy history. Observed normal behavior.	**Healthy** Non-pup. Minor entangle/injury, superficial hooking. Otherwise uncompromised. Obs. normal behavior.	**Sick/Injured/Compromised** Serious entanglement, externally hooked, serious but not life threatening injury such as small shark bite or abscess. Seal may be sick, injured (severity <3), in poor body condition (includes P1-P2), lethargic or otherwise compromised. (all age classes)		**Highly Compromised** Severe entanglement, ingested hook, possibly lethal or severity 3 wound such as amputation, lg shark bite, puncture, head trauma. Seal moribund, pregnant, nursing or "spent" after weaning pup. Near molt, molting, or <2 wks post-molt. In very poor body condition.		
Permission: Permit and HMSRP protocol compliance, notifications and authorizations, team agreement, non-HMSRP involvement.	**Excellent** Compliant with permits and protocols, all notifications and authorizations obtained, unanimous team agreement, no external NGO/agency coordination needed.		**Good** Permit and protocol compliance, appropriate notifications and authorizations obtained, unanimous team agreement, some external NGO/agency coordination needed.		**Poor** A breach in any of the following - permit, protocol, notification, authorization, total team agreement. External NGO/agency use not totally appropriate.		
Resources: Equipment, PPE, communication, support, instruments, platforms.	**Excellent** All necessary resources available. Ideally (but not necessary) you have extra equipment and personnel available.		**Good** Missing some resources but entire team is confident that they can still complete mission safely.		**Not Prepared** Missing key resources to safely complete mission.		
Mission Complexity: New or experimental, time sensitive, response or research, mission briefing, non-HMSRP presence.	**Simple** Non-invasive. Not touching seal. Safe location. Necessary personnel and gear.	**Standard** Pop assess tagging, instrument removal, VAX, pole syringe or less complicated. Expected handling time < 10min.	**Moderately Complex** Sedation, epi-sampling, instrumentation, behavioral modification, public present, translocation or moving the seal. IW herding.		**Very Complex** Extensive holding in pen or cage, rehabilitation, surgical procedures, euthanize. IWC.	**Extremely Complex** UME, multiple seals, locations and teams. Seal's life depends on immediate capture. IWC.	
If any risk level equals:	**Any Medium-High**	Contact project lead or immediate supervisor before proceeding.				**Total**	
	Any High - Very High	Contact Charles Littnan (808) 220-3601 or Michelle Barbieri (443) 834-8612 immediately.					
If total score equals:	> 10 in MHI or > 15 in NWHI, contact project lead for advance approval (unless time critical to save seal).						

Key considerations or questions to be asked	
Molt:	Non-pups showing signs of molt, molting, or < 2-weeks past completion of molt will not be captured unless it is a lifesaving intervention. If molt completion date is unknown, team will assume seal just completed molt. Seals that are thought to be immediately pre-molt (including 2 week window before projected molt begin date) should also be given extra consideration.
Pregnancy:	There will be no capturing of obviously pregnant females except for emergency interventions. If a seal is believed to be in its first trimester it can be captured. Outside of the first trimester capture should be avoided.
Previous Capture History:	Make a good effort to ID the seal prior to (and during if necessary) capture and determine previous capture history. If there were any complications or concerns noted during previous handlings consult with veterinarian or program lead.
Health and Behavior assessment	Observe body condition, responsiveness (responds normally to natural stimulus), or if there are any external or behavioral abnormalities.
Weather Concerns:	Does weather pose a threat to the seal or researchers (i.e. heat stress or hypothermia)? If so, is there a way to mitigate it? Captures during the middle of the day should be avoided unless overcast/ cool. Consider the seal's body temperature before, during, and after, handling.
Habitat Concerns:	Habitat should be assessed for hazards to seals and researchers. Rocky platforms with ledges and bouldery habitat should be avoided unless absolutely necessary. Mitigate potential threats where possible. Consider crowding to a safer area or use of padding.
Equipment:	Is all necessary gear functional, available and ready? Including but not limited to crowding, capture, tagging, sampling, instrumentation, disentanglement and emergency equipment. Temperature mitigation gear (shade, bucket for water). Transport gear (cage, truck, boat).
Presence of other seals:	Are there other seals in the area that may be disturbed by the handling? Is there a potential for other seals to approach and disrupt during capture? Consider other natural and cultural resources nearby.

Team Composition:	Is there sufficient staff to safely complete the mission and unforeseen situations? If a veterinarian is necessary, have a sufficient team to assist so the vet can monitor the seal. Ensure that all involved fully understand their roles throughout the evolution. Make sure everyone understands warning signs to look for. Designate someone to monitor fatigue, injury, availability of seal and personnel throughout evolution.
Public Presence:	Is the capture going to be in a public area? Ensure sufficient crowd control and outreach. Consider a public briefing before and after the event. Expect to be recorded and ensure that all involved look and behave appropriately.

16.4 Appendix D: Appendix D of NMFS (2019)

Appendix D: Hawaiian Monk Seal Research Program In-water Capture Protocol

Introduction

The Hawaiian Monk Seal Research Program (HMSRP) has been confronted with situations in which monk seals that have sustained natural or anthropogenic trauma or disease are reluctant or unable to haul out on land due to discomfort or weakness caused by the injury or condition. Instead, these seals have been observed logging at the water surface, sometimes drifting with near-shore currents and other times finding protected bays and harbors for several days at a time. For critically compromised seals, this complicates capture for treatment or other intervention (*e.g.,* fish hook removal, treatment of abscesses or injuries from conspecific aggression) because in-water captures are inherently risky to both people and seals. To date, in-water captures beyond depths of 1-3 feet (near shore) have not been attempted by the HMSRP, but the program recognizes that the benefits of having the ability to capture a seal in both deep and shallow water may outweigh the risks if done in a safe and well thought out manner. This document will describe ways to reduce seal and human safety concerns related to in-water captures by addressing past HMS cases, drawing from the experience of other pinniped programs, and considering a variety of techniques in order to facilitate preparedness for future life-threatening emergencies.

HMSRP cases where in-water capture was considered

Case 1. Temp 222 Use of snare net in tide pool
In 2011 weaned pup Temp 222 on Niihau displayed two open abscesses that required treatment. A NOAA team arrived with a hoop net, but Niihau residents under the lead of Keith Robinson, suggested a technique that was safer for people and seal alike. The Niihau team used a simple snare net made from a single piece of small mesh trawl net debris about 15 x 20 feet in size. The team of 6 handlers set the net in a tide pool near the seal, herded the seal onto the net, then lifted the perimeter and carried the seal over rocks and onto a sandy area to be treated. Though this capture was done in a shallow and confined tide pool, it demonstrates the effectiveness of the snare net technique.

Weaned pup Temp 222 captured with a snare net and moved a short distance to be treated for infected bite wounds.

Case 2. RK36 Shallow water herding

In 2012, adult male RK36 was reported logging for multiple days just off of Lawai Beach, Kauai. Photos confirmed line trailing from his mouth, suggesting hook ingestion. Upon responding, HMSRP staff determined that the seal was in a compromised condition and not fully alert, slowly swimming ~30m diameter circles in a semi contained lagoon area 1-3 feet deep.
In addition to the normal response gear, the response team had crowding boards, a play-pen, cage, and many volunteers. A team was deployed to the ocean side of the seal. Each person had their own crowding board or play-pen panel (play-pen info below). As the seal swam towards the shoreline, the barrier was drawn in and the seal was slowly corralled onto the beach. Once on the beach, the play-pen was closed around the animal and it was herded into a cage without any direct handling. RK36 was transported to Oahu for surgery to remove an ingested hook, and treatment for infection and swelling.
This in-water herding technique worked well thanks to the large number of people, shallow water, calm conditions, and the lethargic demeanor of RK36.
The decision was thoroughly discussed, appropriately approved, and carefully led by experienced field staff.

Case 3. R5AY Hooked and anchored in rough water
In 2012, adult female R5AY was reported hooked and anchored to the substrate in 10-15 feet of water 50-100 feet offshore of Malaekahana beach, Oahu. HMSRP was not able to locate her via jet ski search. If R5AY had been located anchored in the water, HMSRP may have been able to attempt an in-water capture, or at least cut her free. Though R5AY hauled out days later and was successfully captured, this situation could have benefitted from an existing in-water capture protocol.

Case 4. R4DF Injured and logging in boat harbor
In 2013, adult female R4DF was observed in Ko'olina small boat harbor, Oahu with a severe traumatic wound to her mid dorsal thorax and abdomen with matted hair, discharge, abscessation, and appeared lethargic. She was logging just inside the breakwater but did not haul out for days. HMSRP suspected that she was not hauling out because floating at the surface reduced pain by putting less pressure on her wounds. Having the option for an in-water capture may have been useful in the case of R4DF as she was in fairly deep, calm, accessible water, and in a compromised state. It was determined that she was not in immediate risk of death, and her large open wound may have been exacerbated by a capture. R4DF eventually hauled out and was given antibiotics via pole syringe without restraint.

2013-9-17 Injured adult female R4DF logging in Ko'olina small boat harbor for five days before hauling out onto a beach where she could be treated.

Case 5. RB24 Logging in lagoon for weeks
Adult female, RB24 was first observed logging in Ko'olina lagoon #4 on February 6, 2015. She was observed multiple times over the next month logging in Ko'olina lagoons and Maipalaoa canal. On March 5th she aborted a fetus in lagoon #4. RB24 favored the center of the 10-20 feet deep lagoon but was captured on March 16th when she swam to an area of the lagoon shallow enough for the HMSRP team to wade in with

pen panels and herd her to the beach. Factors that helped the capture were the animal's lethargy, calm conditions of the lagoon, and a coordinated execution of deploying a barrier quickly and quietly.

2015-3-17 RB24 herded to shore at Ko'olina lagoon #4 and transported for medical treatment.

Lessons learned from past HMS cases

- A sick or injured seal may not haul out because it feels more comfortable resting in the water, may not have the energy, or may be in pain. Likewise, a hooked seal may be trailing fishing gear which may prevent it from hauling out of the water because the gear is pulled on as the seal hauls over it.
- Compromised seals have in the past hauled out on the swim steps of boats. It may be considered appropriate to take advantage of this behavior using floating mats, small boats or similar.
- If a seal is trailing fishing gear, responders must pay attention to the possibility of it snagging anything. Consider cutting it in advance of herding, netting, or moving the seal at all.
- No action may be the best action. Sometimes waiting for the seal to haul out makes for a safer situation for both seal and capture team. The collection of as much information as possible (seal activity level, condition, injury status, weather conditions, etc.) can help inform the decision to wait for a seal to haul out or attempt capture.
- A seal may swim to an ideal capture location for only a short time. Be prepared to act fast if given an opportunity. Have team and gear ready.
- Having seals bleach marked ahead of time assists in identifying target individuals.
- Some situations are fluid and require flexibility and constant communication. Be prepared with phones, radios and even hand signals to assist with communications. Keep non-present parties informed as necessary.
- Many hands make light work. Volunteers are valuable and should be trained to participate if called upon.
- Knowing individual seal histories and habits is invaluable. Sometimes it is the volunteers that provide the most valuable insight and suggestions about an individual.
- While the safety of the response team and seal in each situation is of utmost importance, the bigger picture of population recovery should always be considered.

Non-HMSRP in-water capture of Pinnipeds

"Dive capture technique" of Steller Sea Lions (SSL) in Alaska

Alaska Department of Fish and Game has captured 746 juvenile SSLs from 1998-2009. A capture skiff crew of 4-6 and a dive crew of 2-3 divers and 2-3 tenders are usually employed. Divers take advantage of natural tendencies of juvenile SSLs to approach and investigate divers. Divers get a looped line around the animal's head in the water, sometimes using bait.

The animal is pulled to the capture boat by the line then wrapped in a sling and parbuckeled onto the boat and into holding cage. No sedation is used during capture.

McAllister, 1997.

National Marine Mammal Laboratory Bearded Seal Tagging Project in Alaska
NMML researchers use tangle nets to sample and instrument adult bearded seals in Alaska. NMML and native subsistence hunters developed methods for capturing bearded seals in shallow coastal waters. They employ large-mesh (12-22" stretched eye size) twisted-filament nets made of 1 to 3 net panels, each 90 ft. long x 24 ft. deep. The net's float line is made of a 3/4" dia. foam core wrapped in nylon and the lead line is 1/4" diameter, light enough to allow a captured seal to reach the surface. Entangled seals are restrained alongside one of the small boats and moved to a nearby ice floe for work on the seal (Boveng and Cameron 2013).

Norwegian Polar Institute uses tangle nets on Ringed and Bearded seals in Svalbard, Norway
An excerpt from Kovacs and Lydersen's field report describes the process of using tangle nets:
"When we are trying to catch ringed seals we set out 100 m long, 8 m deep nets that are quite light and entangle things easily. We set a net out between two zodiacs a bit away from the seal's resting place. We then gently pull the net toward the floe at the nose-end of the seal (see picture). We drive up behind the seal quickly with one or both boats, putting the seal into the water – and with some luck the seal strikes the net. They can weigh over 400 kg, so we need to tow entangled seals to shore between the boats (carefully – so that they are safely held at the surface so that they can always breath when they choose to) and then we must get them up the shore a bit so that we can do the gluing and flipper tagging." (Kovacs and Lydersen 2011).


Tangle net deployment from two zodiacs. Releasing seals from a handling net and from a zodiac. PC: Kovacs and Lydersen / NPI

Similar stretch mesh nets have been used on ringed and bearded seals by the NOAA Northeast Fisheries Science Center. These nets may be easier to deploy than plastic-float topped line nets and are typically light enough for seals to remain near the surface to breathe (Frost, 2013).

Adult male Steller sea lion disentanglement attempt from boat
June, 2013 near Juneau, AK
Entangled Sea Lion H80 with packing strap around his neck was hauled out with ~30 other sea lions. Sedation was administered via dart gun ("New drug combination" not specified (presumably midazolam, butorphanol, medetomidine)) from boat. H80 went into water within 1 minute of darting. The response team waited 20 minutes for drugs to take effect before approaching. The team managed to safely approach, restrain, and examine the entangled animal, but was not able to disentangle because the strap was overgrown. Drug reversal was administered and the animal was released alongside boat. The response was considered a success. (Woodford, 2013).

TMMC Harbor seal capture attempt
On 10/4/2012, a team from TMMC responded to an adult harbor seal with a neck entanglement. The seal was hauled out on a dock and successfully sedated via dart gun. The seal entered the water and within 3-5 minutes of darting, the seal was observed breathing and floating at the water surface nearby. The animal's

eyes were closed and it was breathing at the water surface, but when approached within 2m, it opened its eyes and swam away. At each surfacing, the seal's nostrils could be observed above the water, but the head did not fully clear the surface. Approximately eight attempts to catch the seal were made from the zodiac using a hoop net. The seal became progressively more alert and less approachable with each attempt. When the seal was deemed to be too alert to warrant further attempts, the effort was discontinued (Barbieri, pers. comm).

Specific Considerations for Hawaiian monk seal In-water capture attempt

- Seal variables - size, sex, condition, nutritional state, pregnancy status, behavior, patterns, temperament and alertness.
- Urgency of case – evaluate the need for capture vs. waiting for seal to haul out on its own.
- Risks to seal and people - Go / No-go protocol will be followed and risk analysis matrix completed (see appendix).
- Potential for exacerbating injuries - sensitive injuries or attachments such as fishing gear or entanglements. Injury severity to be evaluated according to normal HMSRP protocol. Potential for other injuries to be considered. Consider the possibility of line or entanglement snagging and consider cutting or mitigating it at any stage.
- Human resources – Number of people available and their training, capabilities, and experience with in-water captures.
- Extraction resources – Vessels, vehicles, beach carts, nets, cages, pens, boards, mats.
- Depth of water – Where seal is, where it will be captured, where it will need to be transported to.
- Substrate and distance from shore- Offshore, shoreline, and on land. Where is the ideal location for capture?
- Current and Forecasted Weather conditions - Wind, surf, swell, current, tide, temperature, remaining daylight.
- Proximity to hazards - Substrate, reef, rocks, boat traffic, docks, other animals, people.
- Possibility of takes to other protected species- area to be monitored before, during and after capture to insure no incidental takes. Stand down or mitigate accordingly.
- Containment - Is seal in a contained area such as a harbor or lagoon? Can this area be closed?
- Public perception – How will the operation or lack thereof be perceived or interpreted by others and the media?
- Interagency or political pressures – Are there motives to include certain people, their gear, their suggestions?
- Authorization – If stranding permit is necessary, submit the capture approval request form before acting (see appendix).
- Emergency medical contingencies – Availability of equipment and emergency medications, including euthanasia preparedness. All activities performed under trained DVM supervision. At least one vet tech or DVM on site. DVM to be present for any capture involving sedation.
- Treatment contingencies – Ability to transport animal to appropriate facilities. Space availability and readiness of facilities.
- Post-release monitoring – Application of tags, bleach marks, and instruments. Identification photos. DVM to decide if and when seal is releasable.
- Proper documentation – Certain personnel to lead appropriate documentation of events. Report to be compiled and submitted (when appropriate) within 72 hours of event.

Risk Management Assessment

This section outlines and assesses risks specific to HMSRP in-water capture activities and how they will be mitigated or managed should they occur. A risk analysis matrix should be completed prior to any in-water capture activity. If use of the stranding permit is necessary, approval will be requested appropriately. (Risk analysis matrix and approval request form located in appendix.)

Risks to humans

Risk:
- Injury or death to personnel by drowning, falling or stepping on hazards.

Risk mitigation:
- Appropriate personnel to investigate and decide if location is safe for herding.
- Herders to wear appropriate PPE such as strong, non-slip footwear, gloves, coveralls, PFDs and helmets as necessary.
- Designated safety persons will be assigned to continually watch over all personnel involved and be able to communicate to the team to adjust strategy or call off the effort as necessary.
- Designated personnel to be watching for and warning team of hazards like waves, and other animals.

Risk:
- Injury to personnel from crowding boards or pen panels.

Risk mitigation:
- Herders to wear appropriate PPE such as strong, non-slip footwear, gloves, coveralls, PFDs and helmets as necessary.
- Herders to use crowding boards with appropriate handles to avoid pinch points.
- Herders to be trained and to maintain an impenetrable barrier when near seal and actively herding.
- All herding materials to be inspected for hazards prior to use.

Risk:
- Injury to personnel from net.

Risk mitigation:
- Herders to wear appropriate PPE such as strong, non-slip footwear, gloves, coveralls, PFDs and helmets as necessary.
- Net handlers to be trained in techniques that minimize injury to themselves and others during in-water capture.
- All nets to be inspected for hazards prior to use.

Risk:
- Injury to personnel from seal bite or scratch.

Risk mitigation:
- Personnel to wear appropriate PPE such as strong, non-slip footwear, gloves, coveralls, PFDs and helmets as necessary.
- Personnel to be trained and to maintain an impenetrable barrier when near seal and actively herding.
- Personnel to use crowding boards and pen panels in a manner that the seal cannot reach through gaps.
- Personnel will consider connecting panels together as necessary before approaching seal.

Risks to animals

Risk:

- Injury to seal from crowding boards and/or from seal having to haul itself out, especially if the seal is trailing fishing gear.

Risk mitigation:

- Proper evaluation of existing seal injuries and potential for injuries to be conducted before capture attempt.
- Consider cutting any foreign attachments to the seal before or during crowding to reduce injury to the seal.
- Seal should be herded in a slow and controlled manner towards a good capture/holding area using the safest route possible.
- Designated personnel to continually communicate to the team and be able to adjust strategy or call off the effort as necessary.
- Herders to be trained on use of crowding boards.

Risk:

- Injury to seal from net.

Risk mitigation:

- Personnel to be trained in techniques that minimize injury to seal.
- Use of adequate number of net handlers will increase safety.
- Proper evaluation of existing seal injuries and potential for injuries to be conducted before capture attempt.
- Medical care capacity (emergency resuscitation, rehabilitation, euthanasia) will be evaluated prior to capture.

Risk:

- Injury to seal from crowding boards, pen panels.

Risk mitigation:

- Personnel to be trained in techniques that minimize injury to seal.
- Use of adequate number of personnel will increase safety.
- Proper evaluation of existing seal injuries and potential for injuries to be conducted before capture attempt.
- Medical care capacity (emergency resuscitation, rehabilitation, euthanasia) will be evaluated prior to capture.

Risk:

- Injury to seal from nearby objects.

Risk mitigation:

- Hazards in area to be identified and removed or mitigated by experienced personnel.
- If a hazard cannot be removed, it may be mitigated by assigning someone to guard it with a crowding board or pad.
- Proper evaluation of existing seal injuries and potential for injuries to be conducted before capture attempt.
- Medical care capacity (emergency resuscitation, rehabilitation, euthanasia) will be evaluated prior to capture.

Risk

- Incidental capture or disturbance of non-target protected species including other Hawaiian monk seals, sea turtles and cetaceans.

Risk mitigation:

- Possibility of incidental take of non-target animals to be evaluated before and during capture evolution.
- Appropriate take approval and documentation to be completed.
- Efforts to minimize disturbance to non-target seals should always be considered.
- Designated personnel will continuously watch for the presence of non-target protected species in and around the capture area throughout the evolution, and communicate with team appropriately.

Sedation
The use of sedation to reduce anxiety and facilitate seal handling and safe capture may be considered in cases of in-water capture where life-saving actions cannot otherwise be conducted safely. Drugs used would include midazolam (0.15-0.3 mg/kg) or a combination of midazolam and butorphanol (0.05-0.2 mg/kg). Administering sedatives to seals in the water will likely be done either by pole syringe or remotely. Dosages would be determined by a blind poll of at least three experienced monk seal animal care/biologists to estimate the seal's weight. Sedative reversal agents would be available to be quickly administered should the seal appear to be escaping confinement or having an adverse reaction to the sedative(s). All drugs (midazolam, butorphanol) proposed for in-water use are reversible, though administering a reversal agent will also require the presentation of a safe and reasonable shot which may not always be the case with a fleeing animal. Any use of remote sedation (by dart projector) will follow the HMSRP Remote Sedation Protocol.

Other groups are working to better understand the effects and risks of appropriate drug combinations for phocid in-water and remote sedation, and we will revise our approach per the latest research in communication with the permit office. Delivery systems available include pole syringe, hand injection, cartridge-fired dart gun.

Only if in-water remote sedation proves safe and effective for monk seals in life-threatening circumstances, they may also be applied rarely in certain research contexts. For example, there have been a few cases where seals with attached telemetry devices have not landed in safe places for standard capture and restraint. Remote sedation or in-water capture/sedation could allow for retrieval of important data stored in telemetry device memory.

Risks:

- Compromised animals may be more susceptible to the effects of sedatives and drugs should be dosed accordingly.
- The depth of understanding of the effects of these sedatives on otariids that flush into the water is good; however, our understanding of these factors in phocids is poor. More specifically, different phocid species react differently to sedatives.

Risk mitigation:

- An experienced veterinarian will select the drugs, doses and will administer sedatives. All drugs proposed are reversible and the reversal drugs will be available if needed.
- Veterinary staff will communicate regularly with other field response teams that are using these drug combinations in pinnipeds in order to increase the understanding of drug effects on animals in different situations.
- Initially, a conservative approach will be to administer single-agent sedation with midazolam IM, as benzodiazepines are routinely used for sedation in HMS and are reversible with flumazenil IM.
- Any administration of sedation for a seal in the water will be paired with in-water support and an ability to hold the animal at the water surface should it lose its capacity to maintain its position at the surface while under sedation (e.g., floating Navy mat, vessel, net or combination of these tools).

Capture Techniques

Herding to shore

As in case 2 above, with a seal being close to shore in calm, shallow water, it can often be safely herded onto shore. This is usually always preferred as it minimizes risks to both the seal and team involved. The HMSRP has many years of experience with this technique on all sizes of monk seals.

Generally, a barrier is deployed to the ocean side of an animal and drawn in, bringing the animal to the beach. Crowding boards are normally used for herding, but play pen panels may be considered as they move through the water well. Other possibilities would be different types of fencing material or large objects such as plywood, kayaks, or other types of boards or small nets. Deployment of the barrier is easiest by wading if the water depth, conditions, and substrate are suitable. Other deployment options would likely be via small vessel, kayak, paddleboard, or swimmers depending on conditions, personnel available, and type of barrier.

It is important to note that crowding boards and the like will result in each herder having control of their own board and therefore constant communication and teamwork are required to create a barrier without gaps.

Tools - crowding boards, play pen panels, cage, stretcher net, beach seine net, kayak, other boards

Beach Seine Net

Similar to the traditional Hawaiian hukilau net used for near shore fishing, beach seine nets are meant for use in shallow, near shore waters and are long and relatively shallow themselves. They are not intended to entangle seals like tangle nets listed below and should have relatively small eye size. Monk seals may present themselves in a small cove or other cramped areas and a variety of lengths and widths should be available. Sections of approximately 50-100 feet could be connected to increase length if necessary.

Similar to shallow water herding, beach seine nets create a barrier around the seal while bringing it towards the shore for capture. For an HMS in-water capture the net would be deployed via wading or vessel around the ocean side of the seal similar to that described in Jeffries et al (1993) and pulled in to the shoreline from the ends. A weighted bottom and floating top are usually helpful. Vertical poles/bars may be attached to the net at intervals to keep it open. Straps, velcro, or bungees may be used during deployment to hold the net together to keep the weighted bottom from snagging substrate. Using many people spaced out along the net would help to deal with snags on the substrate and hold the top of the net above the surface to keep the animal from breaching the top. People comfortable in the water should be considered for these tasks. They should be equipped with masks and knives to be able to untangle or cut the net from the substrate if caught. Attaching a containment boom or similar to a beach seine net may improve its effectiveness in keeping a seal from breaching over the top of the net.

Tools – beach seine net, snorkel gear, knives, crowding boards, jet ski, kayak, small boat

Scoop Net

The scoop net is a flat, circle, square or similar net with minimal attachments meant to be handled at the perimeter by a team. The scoop net is meant to be placed under a seal or set on or near the substrate for the seal to swim over it before the edges are lifted and the seal is contained. It can be used in conjunction with herding a seal over the scoop net, or with a large containment net set around the area first. Due to its simplicity, it can be adapted to be set by divers or from a vessel or a combination. Weights, floats, carabineers or line can be added anywhere on the net to increase its chance of success. The scoop net can be used delicately on an injured seal by controlling net tautness and how high the perimeter is lifted. It can be used to contain and then safely transport the seal to the shore or a boat while supporting the seal at the surface and allowing it some freedom of movement. It could be used to lift or parbuckle a seal into a boat by itself or in conjunction with a floating mat, straps, tarp, backboard, stretcher net, or similar tool.

This technique requires a sufficient amount of people to attend the perimeter of the net to keep it from dipping below the surface and allowing a seal to escape.

If the seal is relatively alert and wary of the net and people using it, a smaller team of 3-6 people could attempt the initial approach while other net handlers stand by. Efforts to avoid scaring the seal should be made by all net handlers and depending on the conditions, swimming may be appropriate.

A scoop net may be handled from boats controlling the perimeter and eventually lifting a seal into a boat or driving/floating a seal to the shore. This makes it easier for handlers to keep the net perimeter above the seal and pulling the net in with control.
Tools – scoop net, clip-on weights and floats, extra line, snorkel gear, knives, jet ski, kayak, small boat, fenders

Surprise Net
The surprise net is 100 feet long by 12 feet deep with a floating top and a chain weighted bottom. It is designed to be set while contained in a nylon strip fastened with Velcro that releases when an air tube is inflated via scuba tank. The air tube is connected to the top of the net and the chain and nylon strip are connected to the bottom of the net. Its main advantage is its ability to be set prior to a seal entering an area. Once a seal enters the area, the net can be fully deployed in ~12 seconds.
Tools – Surprise net, full scuba tank, regulator, extra line, snorkel gear, knives, jet ski, kayak, small boat, fenders

Tangle Net
Also called lay nets or gill nets, tangle nets are commonly used outside of Hawaii for capturing pinnipeds for scientific research. See "non-HMSRP in-water capture" section above for details. Generally, tangle nets are long (300-500 ft.) and shallow (10-30 ft.) meant to be used at the surface. Tangle nets can be made of light gage monofilament, mesh, nylon twine or similar with relatively large eye size.
The NOAA Northeast Fisheries Science Center, National Marine Mammal Laboratory, Alaska Fisheries Science Center and the Norwegian Polar Institute use tangle nets for in-water capture of bearded and ringed seals.
Techniques described by above programs are for capturing healthy animals. This speaks to the restraint effectiveness of tangle nets. A seal tangled and wrapped in a tangle net would likely be better restrained than a seal simply being herded by a beach seine net.
A tangle net may be set for a monk seal to tangle itself in, or deployed around a seal and moved towards it until tangled. Once a seal is tangled it can either be left in the tangle net for transport to shore, or disentangled in the boat and restrained in another tool such as a hoop net or stretcher net. If not brought aboard, the tangled seal can be carefully towed to shore between boats, secured alongside a boat, or pulled onto a boat or floating haul-out mat for transport.
Tools – tangle net, snorkel gear, possibly dive gear, knives, jet ski, kayak, small boats

Purse Seine Net
For use in deep water, the purse seine net would likely be deployed off the side of a boat driving around the seal. Once the circle is complete and the ends of the net are connected, the bottom can be cinched closed. The net and seal can then be hauled onto a boat. If large enough, a purse seine net can be deployed without the seal's awareness, or at least while maintaining a distance from the seal so as not to scare it. The net should be cinched shut while the seal is at the surface to avoid alarming the seal and having it escape out of the open bottom. The purse seine net is used to catch large schools of fish from relatively large boats with cranes and usually requires the coordination of multiple boats. It may be unrealistic to purchase, and employ a full sized purse seine net with HMSRP resources. However insight can be gained from the general technique and it may be possible to duplicate on a smaller scale. It could also be used to set around a seal as an initial containment net before attempting other techniques and tools.
Tools – purse seine net, snorkel gear, knives, crowding boards, jet ski, kayak

Dive capture technique
This technique should be employed with maximum caution after careful consideration and planning. Whether in a contained area or not, a line must be looped around the seals head. This is meant to be accomplished by a dive team of 2-3 SCUBA or free divers, but may also be attempted from any vessel and may require bait to attract the seal. The animal is gently pulled to the capture boat by the line then parbuckeled onto the boat. Extreme caution must be taken to avoid injury to staff and the seal throughout the evolution.

If the target animal is wary of people in the water, it may be more effective to lay a lasso of floating line at the surface to be pulled around the seals neck when it lifts its head.
This technique has previously been used on otariid species that have a neck that is thinner than their head, thus, allowing the lasso to cinch in a way that it does not slip over the head. It may not be effective with HMS since most monk seals have thick necks in comparison with their skulls. Additionally, a HMS captured in the water will most likely be injured or in distress and not curious or playful enough to approach a dive team. However, should the seal be conditioned to humans and need to be captured for aversive conditioning, translocation, or removal, this technique may be more appropriate. Dive captures can be considered in conjunction with other techniques such as herding a seal towards a lasso line or modified to use a type of capture net such as a purse seine net with line attached.
Tools – lasso or capture net, snorkel gear, possibly dive gear, knives, crowding boards, jet ski, kayak, small boats

Parbuckle seal onto boat or haul-out mat
The parbuckle technique could be used to roll a heavy seal into a boat. The seal must be secured alongside a small boat with a low gunwale. Lines, straps, or net (possibly the capture net itself) should be secured to the boat and wrapped under the seal then pulled up and towards the boat while rolling the seal into the boat.
If this is not possible, a floating haul out mat could be employed along with the parbuckle technique to achieve similar results. Once the seal is secure on the mat, it can be towed to shore. This is most likely to be used after the seal is contained and under control with another technique. Sliding a seal head or tail first onto the mat may also be considered, depending on the size and mobility of the seal. It is important to consider the boat platform when attempting this technique. The uneven weight distribution of the seal and responders in the vessel may make the boat unstable and proper precautions should be taken to avoid capsizing.

Small Boat Transport

HMSRP small boats including RHIBs, inflatables and whalers are useful in transporting monk seals. They have been used extensively in the NWHI for translocating weaned pups and juveniles with great success. Water transport of live seals in the MHI is rare, but sometimes necessary. (See appendix for small boat details.)

Extra tools that could be helpful when using boats to assist with in-water captures include boat hooks and long poles, line, straps, clips, weights, floats, fenders and pads.

Once the seal is secure in a net, backboard, mat, or kennel, it can be secured on a small boat to be driven to shore for treatment or transport. Inside the boat seals may be secured against the gunwale or other object to avoid excess movement. As with any transport, one person, usually the DVM or vet tech on scene should devote their attention to the seal and monitor it constantly. Seals should not be transported in any vessel through a surf zone or in rough conditions where there is a possibility of capsizing because of the risk of the seal drowning if contained in a net or cage.

If necessary, the boat with the seal in it can be towed by another boat or jet ski. Controlled towing can increase safety, allowing for the animal to be transported in a boat with minimal people and gear. A jet ski towing a boat with no motor (or a trimmed motor) allows access through very shallow areas.

If a seal cannot be lifted into a boat, it may be necessary to rig it so that it can be safely towed slowly alongside. Multiple boats can be used together to transport a seal contained in a net in the water. Fenders or ridged poles may be used to maintain a safe space between the boats.
In the case of a delicate seal captured in a net, with a short water transport, it may be least stressful to slowly drive the seal to a suitable shoreline to be eased into a cage without having to lift the seal into a boat. NMML researchers capture Bearded seals in a tangle net then restrain them alongside one of the small boats and drive to a nearby ice floe for sampling and instrumentation. (Boveng and Cameron. 2013)

The Norwegian Polar Institute tows entangled seals to shore between two zodiacs slowly to allow seals to breathe while restrained in the net during transport. They drive the zodiacs to the shoreline where researchers can pull the netted seal onto the beach. Anesthetic is not used for this process and animals are healthy and not compromised before capture. (Kovacs and Lydersen. 2011.)

Jet ski sled transport
Once the seal is secure in net and or backboard, secure it to the jet ski sled for transport. A stretcher net may work well to limit the seals movements and keep it straight. Any assortment of ties, straps, or bungee cords could be used to secure the seal to the jet ski sled.
This transport technique could be complicated and dangerous to both seal and rescuers. The seal's condition would be an important factor in risk assessment. Jet ski transport could be necessary in a situation where it may be difficult to get a seal into a vessel or in an area where launch and recovery of small boats is not feasible. A jet ski may also be preferred in rough conditions, shallow water, tight spaces, and shore break.

NOAA Small Boat Details

	Whalers (Montauk, Alert)	**RHIBs (Pisces, Steel Toe, Iwa)**	**Inflatables (Aquarius, Combat)**	**Jet Ski**
Max persons	5, 5	5, 7, 5	10, 8	2-3
Draft	24"	24"	24"	8"
Stability	Fair	Excellent	Good	Bad
Launch capability	Need boat ramp	Need boat ramp	Can be carried by a team at certain beaches.	Can be launched at many beaches with buggy.
Pros	Relatively "dry" boats good for observations, gear, and transporting seals.	Large, dry, stable, smooth ride. Good deck space for all around work.	Great deck space for nets or full size cage. Stable when one side is over weighed.	Can operate in rough and shallow water. Sled adds platform for seal transport. Clean hull for working with nets.
Cons	Less deck space because of center console. Tippy if too much weight on one side.	Heavy, not ideal for near shore, shallow water. Can puncture.	More bouncy ride. More difficult to stand in for obs. Can puncture.	Little room. Unstable when not in motion. Difficult to work on.

Training and Testing
HMSRP will conduct personnel trainings and thoroughly test all in-water capture techniques and gear before consideration in the field. Most techniques described above are existing HMSRP activities that would require modifications. Techniques may be tested by HMSRP staff in a controlled environment such as the IRC LSS rehab pools or various beaches during favorable conditions that are uncrowded, and easily accessible. Staff safety and environmental sensitivity will be emphasized during training and testing of all techniques.

Future Considerations

- HMSRP will train and test each modality thoroughly and move forward in refining modalities and possibly developing or aborting others.

- Testing of available nets should be done before new nets are purchased. Necessity of specific types of nets should be considered before purchase. A large purse seine net may not be appropriate for most in-water captures. If approved, great care should be invested in choosing a tangle net.
- Certain boats may need modifications to be efficient in setting nets.
- Counsel from or collaboration with other programs may be beneficial.
- HMSRP personnel to have appropriate access to in-water capture gear.
- All in-water capture events are to follow current ICS.

Appendix

HMSRP Animal Handling Risk Management Tool – To be used for every capture. See attached.

Capture Approval Request Form – To be submitted if use of stranding permit is necessary.

IWC Approval Request Form
Date/ Time/ General history of case:
General location:
Specific location:
Proposed date/ time of capture:
Number of affected animals, size and sex:
Emergency medical contingencies:
Number of boats necessary:
List of all personnel and training levels:

Capture Technique Analysis Matrix – To be used as a guide to aid decision of which capture technique to employ with regards to the seal's condition. Consider other factors including weather conditions and personnel available. Exercise caution when using nets in poor conditions.

Capture technique	**Seal's condition**

1 = Ideal 5 = No-go	Alert and mobile	Lethargic/limited	Delicate wounds or gear attached
Herding to shore	2	1	1
Beach Seine Net	2	1	1
Snare Net	4	1	2
Parbuckle	4	3	4
Tangle Net	4	3	5
Purse Seine Net	4	2	3
Dive capture	5	4	5

Tools

Crowding boards – Used as a barrier to safely herd seals. Handles should be used to prevent injuries. Play pen panels should be considered as they move through water easier. See case #5 above.

Hoop net – To capture any size seal for safe handling on land. Fiberglass poles hold the net open and can be easily removed once a seal is inside the net. Not meant for use with in-water capture, but may be needed to restrain seal once landed. (not pictured)

Cage – To contain and transport a seal. Doors lift completely out and can be used as crowding boards. Cage can be lifted by a team or forklift and has bridle attachment points to be lifted by crane or helicopter. Placing a cage in shallow (<2 feet) water may aid a compromised seal with entry/ exit in conjunction with other tools such as crowding boards. Three different cage sizes pictured above.

Kennel – For smaller seals up to ~5 ft. DSL the Kennels are appropriate for transport in small spaces such as helicopters and small airplanes.

Floating haulout mat – Can be used as flat surface or closed to contain seal. Can be paddled by person in good conditions. Adding material to close ends may be considered. Easily floats adult bottlenose dolphin and person (do we have a #lbs. capability?) Shown above being used by Dolphin Quest Kahala.

Play pens consist of 4' x 6' aluminum fence panels connected with bungees or line. An EZ-up or other shade can be erected over the play pen. Crowding boards, shade cloth, sand, rocks or the like can be added to the perimeter to increase security and minimize stress on the seal. Seals should be constantly monitored while inside play pens because they are lightweight and much less secure than cages. Panels can also be used individually for crowding or herding as in case #5 above.

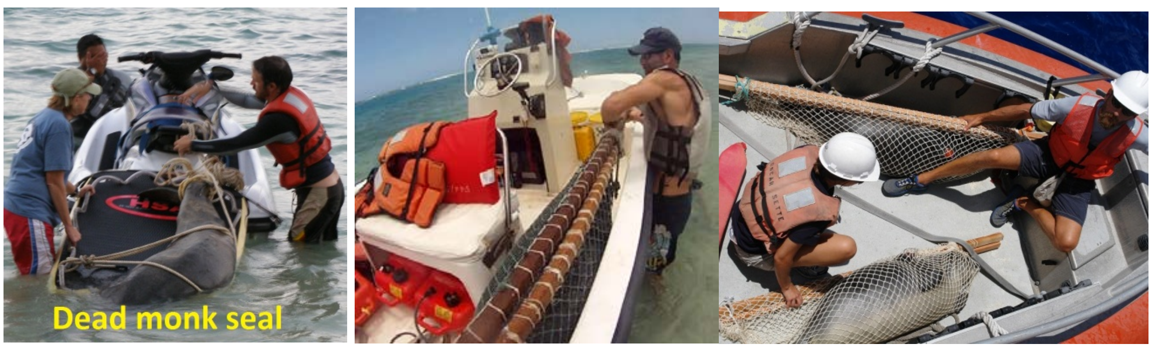
Stretcher nets are used to capture, restrain, and transport small seals. They have been used by HMSRP for shallow water captures and can assist with controlling a seal that may be struggling in another type of net. Very useful for restraining small seals in boats.

Beach Seine Net – 120’ x 20’ floating top and weighted bottom. 1 inch mesh is heavy and catches current. May require people in the water to deal with substrate snags and keep a seal from jumping the top or diving under.

Cargo net (not pictured) – 25’ x 15’ works well for “scoop net” application. 4" mesh size may be too big and cause injury to seal. 2" mesh may be better. Light weight polyethylene moves through water well, but small weights may be needed to offset positive buoyancy.

Scoop net – Floats or weights can be added as necessary. 10’ x 15’

Nearshore Shark Net – Set as a compact tube prior to an animal being in position, the shark net sits weighted on the substrate inconspicuously until deployed via scuba tank releasing the floating tube and capturing a seal.



Small Boat Transport – HMSRP small boats including RHIBs, inflatables and Whalers are useful in transporting monk seals. They have been used extensively in the NWHI for translocating weaned pups and juveniles with great success. Transporting live seals in the MHI is rare, but sometimes necessary. The jet ski has only been used for dead animals, but could be considered for live animals if necessary.

Specific Oahu locations and considerations

Portlock/ Lanai lookout/ Spitting caves – SE Oahu - Coastal cliffs prohibit vehicle access, and restrict all shoreline usefulness besides as a vantage point to visually assist teams in small boats. Boat access is ~15 minutes from Hawaii Kai small boat ramp. Relatively deep water (20-100 ft.) and usually choppy onshore conditions would make this a difficult area to extract a seal from. Numerous seals, fishermen, cliff divers, free divers and scuba divers use the area. There is fair potential for a seal to be hooked and anchored to the substrate on "slide bait" gear with the ability to breathe at the surface. This type of situation would most likely warrant cutting the seal free from the gear and letting it haul out on its own volition to be captured and further treated.

Kaena Point – NW Oahu - Rocky, unpaved shoreline prohibits vehicle access. Boat access is ~12 miles from both Haleiwa and Waianae boat harbors. Very few sandy beaches are suitable to land and transfer a seal from boat to vehicle. Seal would most likely have to be transported to either above harbor to be transferred to vehicle. USCG helicopter evacuation plans are being finalized and may be useful in transporting a caged seal to/from Kaena Point.

White Plains Beach – SW Oahu - Sandy shoreline and relatively flat, sandy rubble substrate directly offshore make this location suitable for an in-water capture attempt. Normal conditions are small to moderate surf and shore break with offshore breeze. Often very crowded with beach goers and many surfers in the water. Multiple seals use this beach regularly. Water depth drops to 3-5 feet just beyond shoreline so not ideal for in-water herding. Vehicle access is good. Boat access is ~5.5 n.m. from Ko'olina boat harbor and ~7.5 n.m. from IRC.

Sandy Beach – SE Oahu – A sandy shoreline and sandy substrate offshore are complicated by very rough shore break. In-water captures should only be considered on very calm days with extreme caution. Beach and water are usually very crowded. Vehicle access is good. Boat access is ~4.5 n.m. from Hawaii Kai BH and ~3.75 n.m. from Makai pier.

Rabbit Island – SE Oahu – The area used by seals is a small beach on the SW side of Rabbit Island. On average, 2-5 seals will be present daily and HMSRP has responded to multiple injured seals on the beach but never in the water. The shoreline is rocky with patch reef just off shore that is dangerous and often too rough to walk on safely. An in-water capture may be considered with extreme caution. Vehicle access is best from Makai pier. Boat access is ~.75 n.m. from Makai pier and ~5.6 n.m. from Kailua small boat ramp.

References:

Woodford, R. 2013. Sea Lion Capture Attempting to Help Sea Lion H80. Alaska Fish and Wildlife News. July 2013.

McAllister, D. C. A dive report for a Steller sea lion capture method development project. 29 January – 8 March 1997. Anchorage, Alaska: Division of Wildlife Conservation, Alaska Department of Fish and Game. 1997.

Marine Mammal Health and Stranding Response Program. In-Water Pinniped Disentanglement Capture Protocol. NOAA Fisheries Service. 2014.

Jeffries SJ, Brown RF, Harvey JT; Techniques for capturing, handling and marking harbor seals; Aquatic Mammals. 1993, 19.1, 21-25

King, J. C., Gelatt, T. S., Pitcher, K. W. and Pendleton, G. W. A FIELD-BASED METHOD FOR ESTIMATING AGE IN FREE-RANGING STELLER SEA LIONS (*EUMETOPIAS JUBATUS*) LESS THAN TWENTY-FOUR MONTHS OF AGE. Marine Mammal Science, 23: 262–271. 2007.

LYNCH, M., TAHMINDJIS, M. and GARDNER, H. Immobilization of pinniped species. Australian Veterinary Journal, 77: 181–185. doi: 10.1111/j.1751-0813.1999.

Frost, Kathy. kjfrost@hawaii.rr.com. Personal Communication via SEG, regarding stretch mesh nets used for in-water captures in Alaska. 2013.

Boveng, P.L. and M.F. Cameron. Pinniped movements and foraging: seasonal movements, habitat selection, foraging and haul-out behavior of adult bearded seals in the Chukchi Sea. Final Report. 2013.

Barbieri, M. 2012 TMMC Harbor seal capture attempt report. Personal Communication. 2014.

16.5 Appendix E: Appendix E of NMFS (2019)

Appendix E: Remote Sedation Protocol for Hawaiian Monk Seals

Abstract

Remote sedation, also referred to as darting, is the process of using a remote delivery system (a dart projector, typically pressurized with carbon dioxide or air) to deliver a dart that contains a drug, or drug combination, capable of sedating or anesthetizing an animal. This method can greatly aid researchers when attempting to capture wildlife for either research or medical reasons. When properly applied, this approach has a number of advantages over other methods (physical restraint and capture, in-water capture) in that it can lower capture stress, reduce physical risk to both researcher and animal and allow difficult animals to be caught. However, there are inherent risks associated with remote sedation that necessitate serious deliberation and consideration before deployment in the field. This paper attempts to categorize the best applications to use remote sedation on the Hawaiian monk seal (*Neomonachus schauinslandi*) as well as outline a field protocol as derived from primary literature, the experiences and expertise of the Hawaiian Monk Seal Research Program (HMSRP) staff, and material provided by the International Fund for Animal Welfare (IFAW) and The Alaska Department of Fish and Game (ADFG); both which have already established pinniped darting programs. Also discussed is the potential for future areas of study in relation to remote sedation, as well as other applications for this equipment that could greatly benefit the endangered Hawaiian monk seal.

Introduction

Remote sedation has been around since the pre-Columbian era when aboriginal natives used darts to paralyze animals but didn't become an accepted practice for wildlife research until the 1950's when it was shown that nicotine darts and a modified rifle could be used to sedate deer (Crockford *et al*. 1957). Since that time, the field has made incredible advances in regards to the equipment, pharmacology, and viable species. Remote sedation is now commonly used to sedate ungulates, canids, felids, some primates, rodents, reptiles, and pinnipeds to name a few, due to the relative ease and safety it affords researchers (Kreeger and Arnemo, 2012). Pinnipeds on which darting has been used to administer sedation include leopard (*Hydrurga leptonyx*) and crab eater seals (*Lobodon carcinophagus*), grey seals (*Halichoerus grypus*), ice seals including: bearded (*Erignathus barbatus*), ribbon (*Histriophoca fasciata*), and hooded (*Cystophora cristata*), as well as stellar sea lions (*Eumetopias jubatus*) (Dierauf *et al*. 2018).

The pharmacology field for wildlife sedation has been somewhat fluid since the 1980's and new developments are common. A brief, and by no means exhaustive list, of the drugs common in pinniped sedation was compiled to demonstrate the wide range of diversity found in pharmaceutical options, even when comparing across similar species (Table 1) and to highlight the need for a fluid and informed approach when considering which drugs to use.

Advantages

One of the primary advantages to using a dart gun for sedation is that capture stress can be lowered or even eliminated if done properly and no direct pre-sedation contact is made with the animal. Induced stress is an acknowledged issue when directly handling wildlife, and has been linked to capture related deaths across multiple species including: brown bears (*Ursus arctos)*, wolverines (*Gulo gulo)*, Eurasian lynx (*Lynx lynx)*, and gray wolves (*Canis lupus)*. Deleterious effects on post capture health and survival is also of concern (Arnemo *et al*. 2006). In relation to pinnipeds, capture stress specifically has been studied in northern elephant seals (*Mirounga angustirostris)* and grey seals (*Halichoerus grypus)*. Results demonstrated that animals that were chemically immobilized without physical restraint did not show a significant increase in stress (cortisol) levels compared to those that were physically restrained, which showed almost a 3-4 fold increase in stress levels (Champagne *et al*. 2012). Although capture stress has not been studied specifically in the monk seal, a similar result can likely be expected and it would therefore be in the animal's (and therefore the program's) best interest to try and eliminate the physical aspect from sedation operations.

Remote sedation can also reduce physical risk to both researchers and seals. Monk seal restraint commonly occurs on beaches that may be littered with coral, sharp rocks, or debris that present hazards to both researchers and animals when trying to physically restrain an animal. If the initial capture and restraint is avoided, then exposure to these hazards is minimized. Additionally, there is less risk of researchers being bitten by the animal, one of the biggest concerns of any method that involves physical restraint (Lynch *et al*. 1999), as well as the animal being accidently hurt when researchers are trying to manually restrain it.

Another notable benefit is that darting allows sedation of, and access to, animals or seals that may otherwise be effectively uncatchable. In the case of animals that aggregate in large groups such as some ungulate or pinniped species, it allows an individual to be singled out for sedation to minimize disruption to the entire group. In addition to the possibility of being in the middle of a group, an animal may be uncatchable due to individual behavior such as being particularly wary or skittish around humans, or environmental challenges such as being in an inaccessible area that would make hand restraint or stealth approach impossible. This circumstance seems to be fairly common for monk seals which exhibit individual preference for certain types of haul-outs, meaning some individuals may be consistently inaccessible for more traditional capture techniques. Additionally it has been noted that injured seals tend to behave erratically and may be less inclined to let a researcher get close to them. Being able to remotely sedate an injured animal that is positioned in an inaccessible area (such as a hooked seal) is advantageous to both animal and researcher.

Risk and Risk Mitigation

When dealing with marine mammal sedation one of the primary concerns is the potential for a darted animal to escape into the water, or if in the water, escape the perimeter set to contain it. A darted animal may not be able to surface unassisted after the drugs take effect. Additionally because of the shunting of blood that takes place, drugs in the system can have uncharacteristically potent effects, such as faster induction times, which could result in drowning or other water inhalation related issues (McKenzie *et al*. 2013).

Whenever possible, remote sedation will be administered when seals are at a sufficiently safe distance from water to prevent escape once darted (Higgins *et al*. 2002, and Pussini and Goebel 2015). In practice, a "sufficiently safe distance" varies by species and site conditions, and would be assessed on-site. It should also rely on input from multiple people to gather information about seal behavior, nearby animals or disturbances, as well as drug induction times. Among the programs that are attendant to this consideration are researchers with leopard seals and New Zealand fur seals, both of which have good success rates with remote sedation (Higgins *et al*. 2002, and McKenzie *et al*. 2013).

Another important safeguard is to have a sedative reversal agent(s) loaded in a dart so that it can be quickly administered should the seal appear to be escaping into the water (Higgins *et al*. 2002). Due to the uncertainty of being able to re-locate and successfully administer a second dart to the same individual, as well as the possible loss of the dart into the environment, this would likely be a last ditch effort should other preventive measures appear to be failing. This consideration would be a reason to limit use of sedatives to only those that have a fast acting reversal agent. Most reversal agents tend to have a fairly wide safety margin and therefore do not require as precise of a weight estimation for dosage (see Table 1 for antagonist information). Obviously, administering a reversal agent will also require the presentation of a safe and reasonable shot which may not always be the case with a fleeing animal.

In some situations, it may be preferable to have one or more people positioned out of sight between the water and the darted seal to help herd it back to the beach should an escape appear imminent. The downside to this would be that stress levels, as well as internal body temperature may be elevated so herding should remain a last resort rather than a regular component of the field operation. Human safety should also be considered, as slippery footing or other environmental hazards may make this mitigation tool unsafe or poorly effective in some circumstances.

There are a few other physical dangers that should be taken into account. First, a seal that has been darted may not be fully aware of its surroundings and could lose partial orientation and mobility control on land as the drugs start to take effect. This could be particularly problematic if the seal is positioned in a setting with hazards that might result in physical injury (rocks, entrapments, cliffs, etc.) or are situated near dangerous surf or currents. The best means to ensure that this doesn't happen is for field operatives to take the time to fully evaluate all environmental hazards before determining whether darting is appropriate in each situation.

Another risk is the chance that a dart misses the intended target zone and penetrates a vital organ, which could happen if trajectory; or power is miscalculated, or if animal movement occurs during firing. The risk of this is greater for smaller or thinner seals. This consideration may make it tempting to err on the side of less power to minimize the risk of organ penetration, however under-powered injections may result in subcutaneous, or fatty layer, injection where drug absorption is slow and unpredictable (Kreeger and Arnemo 2012). The preferred target for darting is either over the hips and tibia lumbar muscle, or into the shoulder muscle (also termed the O-Zone™ by Pneudart) (IFAW Game Response Protocol, and IFAW Phocid Sedation and Disentanglement Protocol) Therefore it is necessary to find the middle ground between excessive and insufficient power when darting which requires diligent practice with the rifle and the avoidance of risky shots.

The loss of darts after they have been fired is yet another concern. In addition to the obvious dangers of having needles/sharps on the beach where the public or other animals may accidently come into contact with them, darts that fail to inject, or release their contents, could potentially contain restricted substances that if found could be used in unintended ways. Kreeger (2002) showed that carfentanil and xylazine, when stored in aluminum darts, deteriorated to the point of not being able to immobilize elk after 14 days of storage. However, the latent potency of midazolam (which will likely be a key part of the standard protocol for monk seal sedation) remains untested at this time. It should be noted that darts typically have brightly colored or feathered tips to help in spotting. Having "a spotter" whose sole job it is to watch the darts, as well bringing a metal detector to aide in reacquiring the darts, is preferable.

While the risks outlined above are standard considerations whenever remote sedation is employed, there are undoubtedly other issues that may arise, such as adverse drug reactions, human error, or equipment failure to name a few. In line with what has already been demonstrated by members of the HMSRP when preforming field capture operations, careful planning and expertise will help to minimize both the amount of unforeseen issues that could arise, as well as the major ones discussed above.

Materials and Procedure

The equipment list for a well-designed darting operation is extensive and should be periodically modified/updated to best fit the program's needs. An extensive list of equipment required for darting operations can be found in Baylis *et al*. (2015), and Kreeger and Arnemo (2012). A more basic list, as modified from IFAW and ADFG, is shown below (Table 2). It should be noted that in addition to the equipment unique to a darting operation, equipment required for more standardized operations such as in-water captures, biomedical sampling or veterinary procedures is also typically required, but is not be discussed in this protocol. This makes the required equipment list very extensive and once again highlights the need for advanced preparation and communication between personnel.

Personnel Qualifications and Responsibilities

A minimum team of six members will be required, each having a clearly assigned and predetermined role as discussed below.

The first, and perhaps most obvious role, is the operator of the dart projector (designated *S* in Figure 1). This person should have a thorough knowledge of how to load, operate and maintain the darts and dart projector, as well as the requisite knowledge to address unexpected issues that may arise in the field, such as clogging and dirt/sand buildup. This person must have an in-depth knowledge of firing mechanism and be able to consistently, and accurately, hit within a fairly narrow target zone within varying ranges and conditions.

A second role which was discussed earlier, is having a designated spotter whose sole job it is to watch for and track the trajectory of misfired darts (D in Figure 1). Obviously, HMSRP personnel would strive to avoid situations that might lead to unrecovered darts.

Another role is that of a shooter's assistant (A in Figure 1) whose task it is to confer with the shooter and veterinarian to aid in estimation of weight of the seal, identify the range to the target, check environmental factors that may influence the shot, and check for anything in the backdrop that a misfired shot could potentially hit. While the shooter should independently be assessing all of these factors, having an assistant to jointly evaluate these factors can help to ensure that nothing is overlooked. This assistant should be equipped with a rangefinder that preferably doubles as a strong pair of optics. They may also be charged with having a backup dart containing the reversal agent, ready to hand to the shooter if deemed necessary. In general, this person should have all of the same training and experience as the primary shooter so that they are fully equipped to assess every factor that might influence the darting outcome.

A fourth role, involving multiple people, (figure 1) is to have designated people waiting in reserve to assist in the corralling, netting or otherwise containing the seal. Ideally, these people would be in place on either side of the seal between the water line and the animal itself but should remain out of sight until needed. Whether this is feasible or not would likely be determined on a case-by-case basis but these individuals could prove indispensable in the event that a partially sedated animal attempts to enter the water. This role could also involve having additional people in the water ready to perform or assist those already in place with in-water captures (see HMSRP in-water capture protocol, Appendix D).

The fifth role would be filled by a knowledgeable veterinarian and assisting team (V Figure 1) who could help with any medical issues that may arise as well as drug dosage determination. The veterinarian will perform a pre-operation visual inspection on the animal and monitor its condition throughout the entire process.

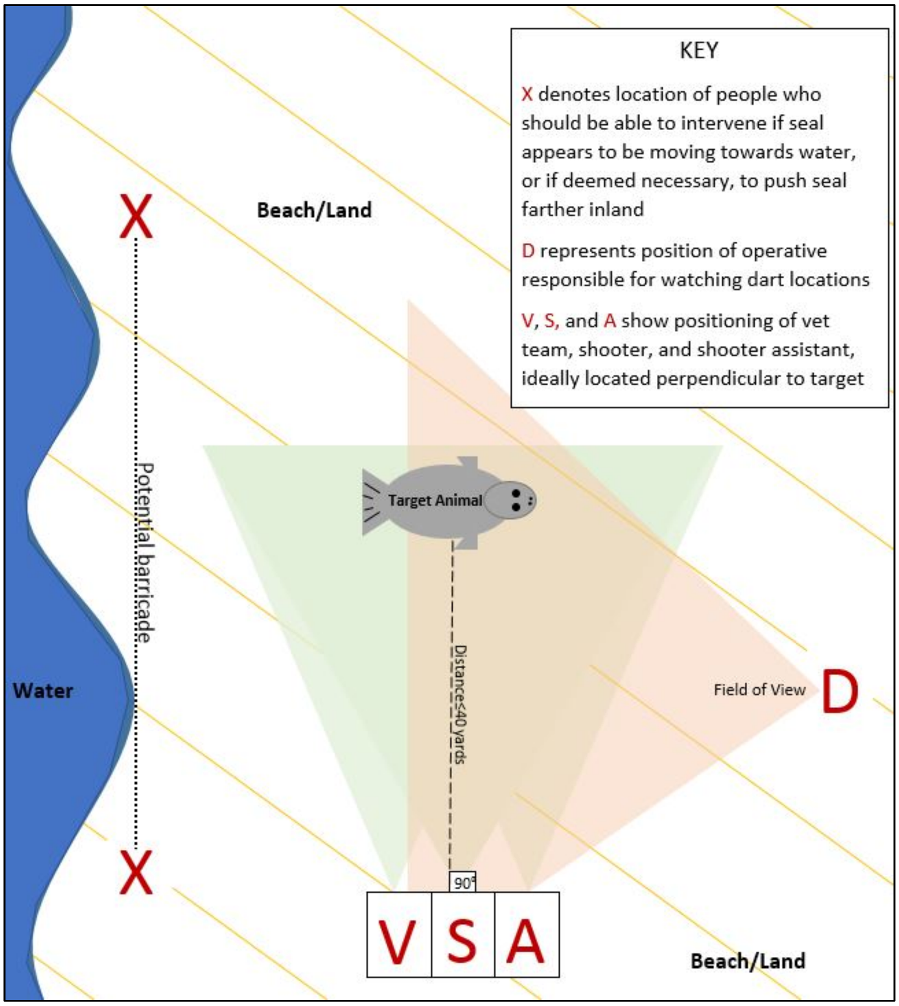


Figure 1: Ideal set up for a darting operation with 6-8 people. Note this is a minimum and additional personnel may be needed to properly perform procedures such as erecting a barricade. Field of views are included for roles where having clear visibility is imperative and to show a suggested *minimum* line of sight. It is essential that the person responsible for watching darts is able to see past the seal in case of an overshoot.

Pre-operation Preparation

Prior to any darting operation, equipment, location, personnel, permissions, and plans will all be checked. The GAR risk assessment tool will also be used to evaluate risks to human and seal safety as well as the go/no-go decision flowchart below (Figure 2). The equipment checklist will also be reviewed to make sure that nothing has been forgotten, and all components will be inspected to ensure that they are capable of performing at a satisfactory level in the field. When checking darting equipment, the projector should be checked for sticking parts and debris buildup as well as cleaned in the same fashion as a standard firearm. The darts should be checked to look for cracks in body housing or defective needles. The type of dart, sedative (or sedative combination), and needle length that will be used should be determined. For most operations, a gel collared dart with or without a tracker will likely be the most useful. The location will also be scouted as soon as possible to look at best approach for darting and determine possible obstacles to the operation. Weather should also be checked to anticipate the window of opportunity and to help with gauging wind speeds. Potential nearby disturbance factors such as incoming waves, other seals, or bystanders will be evaluated. Outreach will be performed to bystanders as necessary. Prior to the operation, all necessary permissions should be obtained (as, for example, to traverse private property) and ensure that all actions are consistent and approved under applicable permits.

Once in the Field:

Selection Criteria

A stop/go flowchart for the HMSRP was modified from those developed by IFAW and ADFG and is shown below (Figure 2) to provide a visual representation of the checks that should be considered to determine if a darting operation should proceed. The checks are not necessarily listed in order of importance and all should be evaluated once in the field.

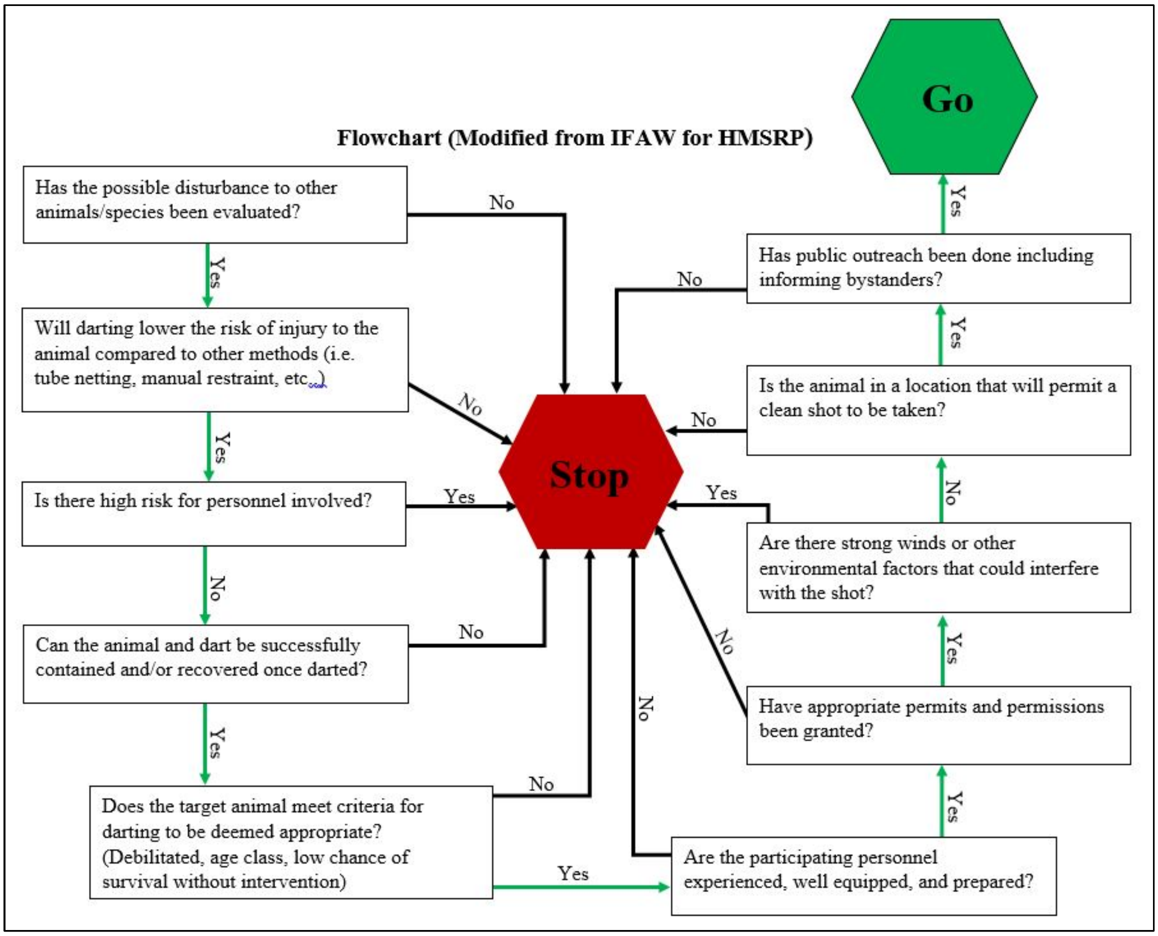


Figure 2. Field flowchart to assess whether conditions are suitable for remote sedation.

Determining Dosage

Determining how much of each drug to use will be heavily reliant on the weight estimation of the seal. Additionally any previous knowledge of the target animal will be used in these judgments. For example, knowing that the subject is a 3-year old (subadult) male from the main Hawaiian Islands who was on the heavier side when last weighed and showed affinity for sedatives will allow researchers to adjust dosage accordingly. The target animal’s mass should be assessed by as many different people as possible which will then be followed by a group discussion and an agreed upon final estimate. It should be noted that at least initially the only seals that will be considered for darting by the HMSRP will likely be debilitated and therefore seal body condition and health status will need to be factored in when calculating drug dosage.

Drug Administration

When it is time to administer the injection, everyone should be in position with necessary equipment ready. The sedative and reversal darts should be loaded and contingency plans for an unexpected response established and in place. This will include awareness of where the dart could go if missed, at what point the people responsible for physical restraint will intervene, and a well formulated plan of action for when the animal is sedated. All resuscitation equipment or supplies that may be needed in the event of a non-target strike should be prepared. Additionally, pre-shot details such as animal condition, status, drug dosage, and location will all be recorded. Video recordings of all operations will be standard for HMSRP darting activities.

Post Darting

Immediately after a successful injection, the seal will be monitored. Once the animal has reached a stage of sedation where it is deemed acceptable to be approached (determined by the veterinarian) then it will be relocated if necessary to a location conducive to assessment, veterinary care, and transport (if necessary). Also at this time dart recovery will occur. Throughout all stages of this operation, emergency equipment such as resuscitation and reversal drugs will be on hand as to be easily administered if needed.

In the event that emergency procedures fail and the animal doesn’t survive, the carcass will be collected for necropsy and appropriate notifications will be undertaken. Careful documentation including written and video records of the operation will be reviewed as part of standard stand-down procedures and used to modify existing protocols.

Regardless of the outcome, after the operation has commenced, an internal review will be conducted to analyze every factor discussed above, in addition but not limited to: team efficiency, drug combinations and amounts, operation plans, and other post operation factors.

While the plan outlined above has been carefully constructed from available literature, internal discussions with members of the HMSRP, and both ADFG and IFAW protocols, adjustments will undoubtedly be necessary.

Discussion and Conclusions

There are a number of advantages for remote sedation that could prove useful for HMSRP activities, most notably being the ability to capture monk seals that may otherwise be inaccessible for life-saving intervention. The remote sedation protocols described above were largely derived from other successful darting programs (IFAW and ADFG), along with advice and solutions presented in the primary literature. However, the endangered status of the Hawaiian monk seal renders this a unique case for which an unprecedented amount of caution and judgement must be factored in both before and while attempting remote sedation operations.

Protocols Referenced

Alaska Department of Fish and Game Response Protocol and Go/No-GO Criteria

International Fund for Animal Welfare Phocid Sedation and Disentanglement Protocol

16.6 Appendix F: Appendix F of NMFS (2019)

Appendix F: Hawaiian monk seal Drugs for Use During Research and Enhancement Activities

The following table lists the drugs currently used or proposed to be used in Hawaiian monk seals, possible adverse effects including any observed in Hawaiian monk seals, and the pharmacokinetics of each drug (i.e., known information on how the body affects the drug, including how the drug is absorbed, distributed, the rate of action and duration of effect, chemical changes in the body, and effects and routes of excretion of metabolites).

In addition to the drugs in the table below, supportive fluids such as electrolytes, dextrose, and sodium bicarbonate may be administered at the discretion of the attending veterinarian in response to adverse reactions to capture, handling, and drug administrations. New drugs may become available or other drugs may be prescribed for use in Hawaiian monk seals by the attending veterinarian. Information on such new drugs would be provided by PIFSC to the OPR Permits Division and may be incorporated into the protocols if indicated by the attending veterinarian. Possible adverse effects of any new drugs would be weighed against the benefits of using the drugs for each case. Also, if any of the drugs listed in the table below or any new drugs are used and severe adverse effects are reported in Hawaiian monk seals, the drugs would be discontinued or dosages modified per recommendation by the attending veterinarian.

Information On Drugs Proposed for Use in Hawaiian Monk Seals During Research and Enhancement Activities

Drug Name	Dosage/Route of Administration	Use in Hawaiian monk seals	Possible Adverse Effects	Pharmacokinetics
Atropine Sulfate	0.02-0.04 mg/kg SC, IM, IV, (Simeone and Stoskopf 2018, Plumb 2008)	Anticholinergic used to treat bradycardia (slowed heart rate) or cardiac arrest; may be used as a pre-anesthetic to reduce respiratory secretions and block vagal mediated dive reflex.	Generally dose related; mild effects in healthy patients; severe effects with high or toxic doses include gastrointestinal (constipation, vomiting), central nervous system (CNS). Benzodiazepines may potentiate adverse effects (Veterinary Drug Handbook, 6th Ed., Plumb). Used on numerous occasions in Hawaiian monk seals with no adverse	Well absorbed with peak effects on heart rate within 3-4 minutes; metabolized in liver and 30-50% of dose excreted unchanged in urine. Half-life (the time required for the concentration of the drug to reach half of its original value) in humans is 2-3 hours.

			reactions reported, though also marginal effectiveness observed (NMFS unpubl. data). Used extensively in other pinnipeds during anesthesia with no observed side effects (Haulena and Schmidt 2018)	
Butorphanol	0.05-0.2 mg/kg PO, SQ, IV, IM (Haulena and Scmidt 2018)	Opiate partial agonist/antagonist. Used in combination with midazolam or diazepam to aid in deeper sedation, as necessary (e.g., for in-water capture and/or transport of large animals when cages are not feasible/available); mildly analgesic	Adverse effects in dogs/cats include ataxia, anorexia or diarrhea (rare) and are typically less severe than adverse effects reported in full opiate agonists. May cause CNS depression or excitation in dogs. Can increase parasympathetic tone and decrease blood pressure and heart rate; these cardiovascular effects are similar to but lesser than opiate agonists. (Plumb 2008) Should be used with caution in animals with compromised renal function, increased CSF pressure (head trauma) or other severe debilitation. Used in combination with benzodiazepines as pre-medication prior to general anesthesia in two stranded Hawaiian monk seals (NMFS, unpub. data).	Fully absorbed with oral administration but undergoes substantial first-pass effect. Fully metabolized in liver. Onset of action is 3 min. in horses with peak effect at 15-30 min and duration of action up to 4 hours. (Plumb 2008)
Ceftiofur crystalline free acid	6.6 mg/kg IM (Meegan et al. 2010)	Long-acting cephalosporin antibiotic for prophylactic treatment of injuries and	Usually not serious and low occurrence; mild transient pain and possibility of abscess at injection site; diarrhea; hypersensitivity reactions include rash, fever, or anaphylaxis.	Half-life in cattle is 8-12 hours with peak levels after 30-45 minutes of intramuscular (IM) injection. A study at The Marine Mammal Center (Sausalito,

		treatment of infections.	Used in Hawaiian monk seals with no adverse effects (Permit No. 10137-07, NMFS, unpub. data). No adverse reactions reported after use in humpback whales, California sea lions, northern elephant seals, and harbor seals (Gulland pers. comm.), abscesses have been reported in some species (not specified) after IM injection (Simeone and Stoskopf 2018)	CA) on 10 California sea lions resulted in maximum plasma concentrations at 24 hours post-IM injection; plasma drug levels at lower levels would likely be maintained for 5-8 days post-injection (Meegan et al. 2010).
Cefovecin	4-8 mg/kg IM SC (Garcia-Parraga et al. 2016; Simeone and Stoskopf 2018;)	Long-acting antibiotic (3rd generation cephalosporin)	No adverse effects reported (Garcia-Parragas et al. 2016; Simeone and Stoskopf 2018; NMFS, unpub. data). Used at 4 mg/kg IM in treatment of an adult female Hawaiian monk seal to treat severe dorsal abscessation; no negative effects (NMFS, unpub. data).	Pharmacokinetic studies conducted in Patagonian sea lions indicate that doses lower than that labeled for companion animals are equally effective. Plasma concentrations above 1.0 mcg/mL measured in harbor seals for >10 days (Simeone and Stoskopf 2018)
Cimetidine (Tagamet®)	5 mg/kg PO	H2 (histamine)-receptor blocker used to reduce gastric acid production; used in treatment of gastric ulcers	Used in treatment of gastric ulcers in California sea lions (Simeone and Stoskopf 2018); no adverse effects noted. Should be used with caution in patients with compromised kidney or liver function. Inhibits hepatic enzymes and may alter absorption of other drugs, including benzodiazepines, so needs to be administered separately. (Plumb 2008, Simeone and Stoskopf 2018)	Oral bioavailability in dogs is 95%, half-life 1.3 hr. Rapidly absorbed after oral administration in humans with 70-80% bioavailability (some is metabolized in the liver). Enters milk and crosses placenta.

Dexamethasone	Anti-inflammatory treatment: 0.1-0.2 mg/kg IM q24h Treatment of shock: 2.2 mg/kg IV, IM (Simeone and Stoskopf 2018, Stoskopf et al. 2001)	A glucocorticoid used for treatment of shock; may be used to treat adrenal insufficiency, inflammation, and other maladies.	Usually associated with long-term administration and manifested as clinical signs of hyperadrenocorticism; can retard growth in young animals; when given short-term, unlikely to cause significant harmful effects, even in massive doses. Few instances of use in Hawaiian monk seals with no adverse reactions reported (NMFS unpubl. data).	Half-life in dogs is 2-5 hours; biologic activity can persist for $\geq$ 48 hours.
Diazepam	0.1-0.3 mg/kg IV (up to 0.5 mg/kg IV for heavy sedation prior to euthanasia or lethal removal) (Haulena and Schmidt 2018, Plumb 2008)	A benzodiazepine used as a sedative (anxiolytic, muscle relaxant, hypnotic) for capture events; may be used as an appetite stimulant or anti-convulsant.	Dogs may exhibit CNS excitement; in horses may cause muscle weakness and ataxia; in cats may cause irritability, depression, aberrant demeanor. Routinely used sedative in Hawaiian monk seals with no adverse reactions reported (NMFS unpubl. data).	Highly lipid soluble and widely distributed throughout the body; readily crosses blood-brain barrier and is highly bound to plasma proteins; metabolized in liver to active metabolites nordiazepam, temazepam, and oxazepam, which are eliminated primarily in urine.
Doxapram HCL	2-4 mg/kg IV	A CNS/respiratory stimulant used to treat respiratory arrest; may also be administered during/after anesthesia.	Hypertension, arrhythmias, seizures, and hyperventilation, which are most probable with repeated or high doses. Increases myocardial oxygen demand and reduces cerebral blood flow. Few instances of use in Hawaiian monk seals with no adverse reactions recorded (NMFS unpubl. data).	After intravenous (IV) injection, onset of effect in humans and animals within 2 minutes; in dogs, rapidly metabolized and excreted as metabolites in urine within 24-48 hours after administration. Serum half-life in dogs is 2.5-3.2 hours and in humans is 20-50 hours.

Epinephrine	0.05-0.5 mg/kg IV, IM, SC, intracardiac, intratracheal	Treatment for cardiac arrest with resuscitation; may also be used to treat anaphylaxis.	Anxiety, tremors, excitability, vomiting, hypertension (with overdose), arrhythmias, high levels of uric acid in blood, and lactic acidosis (with prolonged use or overdosage). Few instances of use in Hawaiian monk seals with no adverse reactions reported (NMFS unpubl. data).	Well absorbed following IM or subcutaneous (SC) injection; onset of action following SC injection is 5-10 minutes; immediate action following IV injection; does not cross blood-brain barrier; actions end by uptake into sympathetic nerve endings; metabolism in liver and other tissues to inactive metabolites.
Famotidine (Pepcid®)	0.5-1.0 mg/kg PO, SC, IM, IV every 12-24 hours	H2 (histamine)-receptor antagonist for reducing gastric acid production, commonly used in supportive care	Adverse effects are uncommon but in humans, may cause anorexia, vomiting, diarrhea, headache, dry mouth/skin. May cause bradycardia if administered IV too rapidly. (Simeone and Stoskopf 2018, Plumb 2008)	Partially absorbed after oral administration. Drug is 40-50% bioavailable in humans; 13% in horses. Concentrates in liver, pancreas, kidney and submandibular gland in rats. Does not cross blood-brain barrier or placenta. Elimination half-life 2-3 hours. (Veterinary Drug Handbook 6th Edition, Plumb 2008)
Fenbendazole	10-50mg/kg PO (Simeone and Stoskopf 2018)	An antiparasitic agent for treating intestinal roundworms.	Generally no adverse effects at normal doses; hypersensitivity secondary to antigen release by dying parasites may occur, especially with high doses; vomiting reported infrequently in dogs and cats ; well tolerated at doses up to 100x recommended.	Marginally absorbed after oral administration; metabolized to active compound oxfendazole and sulfone; in sheep, cattle, and pigs, 44-50% of a dose is excreted unchanged in feces, and <1% in urine.

			Used in research field trial in Hawaiian monk seals and in captive care; no adverse effects reported from use but difficult to administer orally in field setting (NMFS Permit No. 10137 Hawaiian Monk Seal Deworming Project: Year One Summary).	
Flumazenil	0.05-0.1 mg/kg, IV, IM	A benzodiazepine antagonist used to reverse effects of sedative overdose (diazepam or midazolam).	In humans, injection site reactions, vomiting, cutaneous vasodilatation, vertigo, ataxia, and blurred vision; deaths have been associated with its use in humans having serious underlying diseases; large IV overdoses have rarely caused symptoms in otherwise healthy humans. Used in Hawaiian monk seals with no adverse reactions reported; trials with captive monk seals proved effective in reversing effects of midazolam (NMFS unpubl. data).	Administered with rapid IV injection with therapeutic effects within 1-2 minutes; rapidly distributed and metabolized in liver; half-life in humans is approximately 1 hour.
Furosemide	2-4 mg/kg PO, SQ, IM, IV (CRC Handbook 3rd)	A diuretic used to treat congestive heart failure or pulmonary edema.	May induce fluid and electrolyte imbalances; reported to cause hearing loss in cats and dogs given high IV doses; other effects include gastrointestinal problems, anemia, weakness, restlessness. Few instances of use in Hawaiian monk seals with no adverse reactions reported (NMFS unpubl. data).	In dogs, the elimination half-life is approximately 1-1.5 hours; in humans, the diuretic effect takes place within 5 minutes and peak effects 30 minutes after IV injection.
Lidocaine HCL	2-6 mg/kg SQ4 mg/kg SQ	A local anesthetic used to create	At usual doses, serious adverse reactions are rare; most common are dose-related	Lidocaine has a high affinity for fat and adipose tissue and

		nerve blocks to reduce pain from skin incisions such as blubber biopsies.	and rare, including CNS reactions, transient nausea and vomiting, and cardiac effects. Routinely used in Hawaiian monk seals during biopsy sampling with no adverse reactions reported (NMFS unpubl. data).	is bound to plasma proteins; rapidly metabolized in liver to active metabolites; less than 10% of an injected dose is excreted unchanged in urine.
Midazolam	0.15-0.3 mg/kg IV, IM	An injectable benzodiazepine used as a sedative for capture events or as a preanesthetic.	Few adverse effects have been reported in humans including effects on respiratory and cardiac rates and blood pressure; other effects reported in humans include pain on injection, local irritation, headache, nausea, vomiting, and hiccups. Possibility of respiratory depression is principal concern in veterinary patients. Used in wild and captive Hawaiian monk seals with no adverse reactions reported; trials with captive monk seals indicated midazolam safe and effective (NMFS unpubl. data; Annual report for Permit No. 455-1760).	Rapidly and nearly completely absorbed after IM injection; highly protein-bound and rapidly crosses the blood-brain barrier; metabolized in liver; elimination half-life in dogs averages 77 minutes and in humans is approximately 2 hours.
Naloxone	0.002-0.02 mg/kg IV, IM	Opiate antagonist (reverses effects of butorphanol)	Generally considered very safe with wide margin of safety. Should be used with caution in animals with preexisting cardiac abnormalities.	Very rapid onset of action (1-5 min.), duration of action 45-90 min. Distributed in multiple organs, crosses placenta. Metabolized in liver and metabolites excreted in urine.
Praziquantel	10-15 mg/kg PO, IM	An anticestodal antiparasitic used	In dogs, oral dosing can cause anorexia, vomiting, lethargy, or diarrhea but incidence is less than 5%; greater	Rapidly and nearly completely absorbed after oral administration; peak

		to treat intestinal tape worms.	incidences from injectable in dogs including pain at injection site, vomiting, drowsiness, and staggering gate. Used in research field trial (oral and IM) and in captive care (oral) of Hawaiian monk seals; no adverse effects reported from oral use; difficult to administer orally in field setting; swellings resulted from one IM injection in field use (NMFS unpubl. data; Gobush et al. 2011). 15 mg/kg dose used in Hawaiian monk seals in rehabilitation with no adverse effects; resulted in clearance of infection in some seals after multiple treatments (C. Simeone, unpub. data) and visible passage of worms in as little as 30-60 min. after oral treatment (NMFS unpub. data)	serum levels in dogs between 30-120 minutes; distributed throughout the body, crossing intestinal wall and blood-brain barrier into CNS; metabolized in liver and excreted primarily in urine; elimination half-life in dogs is 3 hours.
Prednisolone sodium succinate (Solu-delta-cortef)	5-10 mg/kg IM, IV	A glucocorticoid used for treatment of shock; may be used to treat adrenal insufficiency and other maladies.	Usually associated with long-term administration and manifested as clinical signs of hyperadrenocorticism; can retard growth in young animals; when given short-term for treatment of shock, unlikely to cause significant harmful effects, even in massive doses. Few instances of use in Hawaiian monk seals with no adverse reactions reported (NMFS unpubl. data).	Biologic half-life is 12-36 hours.

Sodium pentobarbital	60-120 mg/kg IVCRC Handbook, 6th Ed.)	Humane euthanasia by attending veterinarian of moribund seals, or as a last resort to remove aggressive male seals.	Barbiturates depress the CNS in descending order starting with the cerebral cortex and loss of consciousness progressing to anesthesia; with overdose, deep anesthesia progresses to apnea due to depression of the respiratory center, followed by cardiac arrest (AVMA 2013). Used to effectively euthanize one aggressive adult male in 1991.	Onset of action within 1 minute after IV administration. Distributes rapidly to all body tissues with highest concentrations in brain and liver.
Tiletamine/ Zolazepam (Telazol)	1 mg/kg IM, IV	Anesthetic/tranquilizer would be used for pre-medication to make animal more amenable to handling for euthanasia/lethal removal. Not proposed for routine sedation for research or enhancement activities.	Apnea, bradycardia, tremors reported in multiple phocid species; mortalities have occurred in small number of animals at higher doses (Haulena and Scmidt 2018). Can cause respiratory depression and apnea in most species, temporary pain is associated with IM injection (likely due to low pH).	Little pharmacokinetic information is available. Rapid onset of action (within 8 min in cats/dogs); mean duration of anesthesia is 27 min in dogs.

REFERENCES

AVMA Guidelines for the Euthanasia of Animals: 2013 Edition (2013). American Veterinary Medical Association, Schaumburg, IL.

Garcia Parraga, Daniel & Gilabert, Juan & Garcia Peña, Francisco & Álvaro, T & Ros-Rodríguez, J.M. & Valls, M & Encinas, Teresa. (2015). Long-lasting concentrations of cefovecin after subcutaneous and intramuscular administration to Patagonian sea lions (*Otaria flavescens*). The Veterinary Journal. 208. 10.1016/j.tvjl.2015.09.015.

Gobush, K.S., Baker J.D., & Gulland F.M.D. (2011).Effectiveness of an antihelminthic treatment in improving the body condition and survival of Hawaiian monk seals. Endangered Species Research 15: 29-37.

Haulena, M. and T. Schmitt. 2018. Anesthesia. In: CRC Handbook of Marine Mammal Medicine, Third Edition, L.A. Dierauf, F.M.D. Gulland, and K. L. Whitman (eds.), CRC Press LLC, Boca Raton. Pp. 587-606.

Meegan, J., W. Collard, G. S. Grover, N. Pussini, B. Van Bonn, F. Gulland. 2010. Ceftiofur pharmacokinetics. Abstract in the International Association for Aquatic Animal Medicine 2010 Proceedings.

Plumb, D.C. 2008. Veterinary Drug Handbook, Sixth Edition. Blackwell Publishing, Minnesota. 1120p.

Simone C. A., M. K. Stoskopf. 2018. Pharmaceuticals and Formularies. In: CRC Handbook of Marine Mammal Medicine, Third Edition, L.A. Dierauf, F.M.D. Gulland, and K. L. Whitman (eds.), CRC Press LLC, Boca Raton. Pp.607-673.

16.7 Appendix G: Appendix G of NMFS (2019)

Appendix G: PROTOCOL FOR FIELD ABSCESS TREATMENT OF HAWAIIAN MONK SEALS

NO INTERVENTION SHALL BE ATTEMPED WITHOUT VETERINARY APPROVAL AND PERMISSION PRIOR TO EACH AND EVERY ATTEMPT

Abscesses are relatively common in Hawaiian monk seals, particularly weaned pups. They often arise secondary to bite wounds from interactions with other seals. Abscesses can grow to the size of basketballs, thus impeding daily function, and occasionally cause systemic illness (septicemia, a bacterial infection of the blood) and death. Intervention in the field is aimed at reducing the risk of septicemia and includes monitoring, careful documentation, and with veterinary approval, lancing abscesses and/or administering antibiotics. The following document provides written guidance for field responders to intervene when hands-on veterinary assistance is not available, though no attempts should be made without veterinary consultation and approval.

WHAT IS AN ABSCESS?

An abscess is the body's way of walling off an infected region of tissue. In young monk seals, abscesses often arise from bite wounds or other trauma. Abscesses can occur in the skin, blubber, muscle, and lymph nodes and can thus range from being near the skin to deep within the tissues. Abscesses can be very large but may also have pockets, which sometimes makes finding the right spot for lancing difficult. Many abscesses are soft, but some are firm and cannot be expressed as easily. The material inside an abscess can be watery, bloody, milky, greenish, thick and even crumbly.


<u>PRIORITY CONSIDERATIONS</u>

Risks to human health and safety are to be minimized. The size, health and abilities of a restraint team relative to the size and behavior of the animal will be of paramount importance in deciding whether or not to attempt intervention. Interventions should only be performed by an experienced team and on an animal that can be safely restrained. All persons coming into direct contact with the seal or collecting specimens must be in **good health** and **wear gloves and protective eyewear**.

Animal safety. The need for intervention will be determined by a veterinarian based on the animal's behavior and alertness and should not be based solely on the size of an abscess or wound. Interventions (including failed attempts) should be kept within **10 minutes** and should be done during the **coolest hours of the day.** Handlings should be aborted immediately if the seal exhibits signs of stress.

Abscess maturity. Photographs and history will be used to determine the maturity of an abscess and subsequent likelihood of successful draining. Recognize that:

- Treatment may not be indicated in some cases, especially if the seal is behaving normally.
- Lancing may be instructed with or without antibiotic administration.

ABSCESS INTERVENTION PROTOCOL

VETERINARY APPROVAL PROCESS
Field responders complete the ***HMS field Health/Vaccination checklist*** and send to veterinarian for approval. Veterinarian will then give specific instructions.

SUPPLIES

Gloves
Protective eyewear
Scalpel blade (#12) curved
Scalpel handle (#3)
Syringes: 6, 12, 20 or 30, and 60 ml syringes (luer lock and curved tips preferred if available)
18g x 1.5” and 2” needles
16g x1.5” needles
Surgical scissors or forceps
Duct tape
Pole syringe
Antibiotics (if applicable)
Dilute betadine (1 part betadine to 10 parts water) or 3% hydrogen peroxide for flushing
Empty plastic container for drawing up dilute betadine or peroxide
Mineral oil

INSTRUCTIONS

1. Review the HMSRP’s ***Seal Handling Protocol*** prior to capture.

2. **Restrain** the animal. Touch the abscess to assess if it is soft or firm, and try to determine if/where the most fluid is present.
   a. If you can’t tell, insert a syringe and sterile needle (2” for fat animals) into the softest part of the abscess (or spot that looks like it might rupture) and try to draw out fluid. Sometimes, the skin overlying the part of the abscess that is closest to the surface is discolored or flaky.
   b. If no fluid or material (pus, etc) is extracted in 2 attempts, **STOP**.

3. **If fluid is present, lance the abscess**.
   a. Ensure that animal is adequately and safely restrained.
      i. If restraint is inadequate or becomes unsafe (for humans and the seal), **STOP**.
      ii. Discuss mounting scalpel on a pole with veterinarian (see #7, below).

   b. Ensure that the stress to the animal is within appropriate limits for continued restraint. (*See **Seal Handling Protocol**: section D. Seal handling, item 7. Seal stress)*
   c. Uncover the scalpel blade, keeping the cutting edge away from the animal’s body. Anticipate seal’s movements in response to the incision. Try to cut away from the seal to the greatest extent possible (insert the scalpel blade and cut outwards, not inwards) in case the seal makes a dramatic movement. Be sure to cut away from yourself as well, for safety.
   d. Insert blade quickly and firmly into the softest and most ventral (dependent) region of the abscess and cut deep through the skin, keeping blade oriented facing out and moving away from the animal’s body. The location of the incision should be low enough (towards the ground) so that the abscess will continue to drain by gravity alone.
   e. Make two incisions, forming an X-shape to facilitate adequate drainage.
   f. Generally speaking, incisions 1.5 to 2” long would be the *minimum* length for adequate

drainage of any large abscesses.

g. If drainage is slow or limited, put scissor points or forceps into hole and open them to widen the aperture of the hole. This may be the case for abscesses with thick or chunky contents. If you find an additional squishy spot, you may incise in a second location, provided that the seal and personnel remain safe, your time is within 10 minutes total, and the seal's level of stress is within acceptable bounds.

4. **Drain abscess:** After cutting, compress the abscess to express as much fluid as possible. There may be small chunks of tissue, clots or other debris that may need to be pushed out in order to fully express the pus. Fluid may also be bloody. Use caution to prevent fluid from contacting the eyes of the seal and responders.

5. **Flush abscess**: Use a large (preferably 60 ml) syringe filled with 10% dilute betadine (Create dilute betadine with 1 part betadine concentrate and 10 parts fresh water) or 3% hydrogen peroxide. Insert syringe tip into the incision, close skin around the tip and gently fill abscess "pocket" with fluid, then remove syringe and express it out the incision. If seal continues to be restrained safely and is not too stressed (per Seal Handling Protocol), repeat approximately 2-5 times (or until you see a reduction in the abscess fluid being extruded). Even if you don't express all of the fluid, seawater and gravity will continue to flush the wound naturally over time.

6. **Lancing abscesses without restraint:** In rare cases, if human and seal safety deems restraint inappropriate, we will consider mounting scalpel blade on a pole. **Pole lancing of abscesses WILL NOT be attempted without conferring with the designated NMFS veterinarian.**

   a. Pole should be of sufficient length to facilitate escape (ex: tent pole, marine debris, bamboo)
   b. Attach scalpel blade (#12 curved is preferred, or use #11 or 22) to scalpel handle and duct tape to pole, ensuring that no more than 1 to 1.5" of the blade extend beyond the end of the pole.
   c. Animal should be in a location that is safe for both humans and the seal (flat, sandy beach without rocks or obstacles).
   d. Keep the number of people that approach the seal at a minimum.
   e. To lance the abscess, keep the cutting edge of the blade facing out and away from the seal's body. Make a single, directed jab into the most fluid ("jiggly") portion of the abscess. Do not drive the scalpel deep into the muscle. Within the jiggly portion of the abscess, make your incision at the ventral-most aspect so that fluid will continue to drain after treatment.

7. **Administer antibiotics, if instructed** (see ***Medication Administration protocol***)
8. **Complete *Monk Seal Health/Vaccination Assessment Checklist*** post treatment report.

16.8 Appendix H: Appendix H of NMFS (2019)

Appendix H: PROTOCOL FOR MEDICATION ADMINSTRATION HAWAIIAN MONK SEALS

Only **trained** personnel are authorized to administer medications to wild monk seals (via pole syringe or otherwise), and **only** after consulting with the program veterinarian or designee.

IMPORTANT NOTES

- The type, dose, method and route will **ONLY** be determined by a veterinarian.
- Double check all labels before drawing up medications or vaccines. Also check expiration dates.
- Avoid contaminating needles or the top of the medication vial. Always inject seal with a fresh needle (not one used to draw up medications or vaccines).
- If it will not interfere with the response, photograph or use a head-mounted video camera to document.
- **Follow-up doses**: May be authorized by the veterinarian for some medications.

FOR ALL METHODS

Injection Location

- Right gluteal region- preferred location (behind the pelvis/hips but in front of the hind flippers).
- Left gluteal region- acceptable, if necessary
- Alternate location- The veterinarian may give an alternate to the gluteal region (ex: shoulder muscle, epaxial muscle on either side of spine) based on drug or situation. Use of alternate sites REQUIRES veterinary consultation for exact details on the location and appropriate precautions.

Types of Injections

- IM- Intramuscular- Insert full length of needle at 90 degree angle to the seal
- SQ- Subcutaneous- Insert full length of needle under the skin of the seal at 45 degree angle

Needle size

Select needle size based on viscosity of drug and seal size:

- Water-like viscosity, use 18G. For thicker substances (like Excede) use 16G
- Seal size: thin/emaciated seals-1”, all other seals-1.5” (2” ok for fat seals if available)

Syringe size

- Use a syringe that is close to (but larger than) the amount of medication you will be giving (ex: 8ml of drug in a 10ml syringe, 1.5 ml of drug in a 3 ml syringe).
- NOTE: For Excede (which is thick), using an even larger syringe (ex: 4 mL of drug in a 12 mL syringe) can make administration easier. However using a syringe that is too large will lead to inaccuracies in medication dosing (ex: do not use a 20 mL syringe to draw up 4 mL of drug).

COMMON MEDICATIONS (not exhaustive list)

Antibiotic: Ceftiofur (Excede) 200mg/ml

- 3rd generation cephalosporin (broad-spectrum, gram-positive and gram-negative bactericidal)
- Liquid is thick – we recommend using a 16G needle for doses of this medication > ~2ml.
- Route: Intramuscular (IM)

- Adverse effects are uncommon but potentially could include: pain at injection site, discoloration of the skin, hypersensitivity reactions.
- Long-acting (5 days)
- Dosage (6.6mg/kg) will be calculated by veterinarian and instructions will be given to leader.

Vaccine: Purevax ferret distemper vaccine

- 2 sterile vials (one powder, one liquid) are mixed just prior to administration of vaccine to seal for a total of 1 ml of vaccine per seal.
- Route: Intramuscular (IM)
- Adverse effects uncommon but potentially could include: pain and local swelling at injection site, hypersensitivity reactions.
- Refer to vaccination protocol for specifics.

METHODS OF ADMINISTRATION

There are two main methods of medication (drug, vaccine) administration: (1) hand injection and (2) pole syringe injection. Hand injecting a medication requires capture and restraint. Pole syringes can be used for situations in which capture is not necessary or feasible. Our program has two different types of pole syringes that maybe used. The preferred pole syringe is the Dan Inject Jab Stick (spring-loaded), but SafeTFlex pole syringes are also provided, especially in locations with infrequent use or as backup equipment.

Hand injection:

1. Pull up medication (or vaccine) in disposable syringe. Replace with a NEW needle before injecting into the seal.
2. Responders should be trained to use appropriate restraint techniques (*See Seal Handling protocol)*.
3. Review body location for drug administration. For consistency, prepare injection site with a diluted betadine spray or scrub.
4. Administer injection:
5. IM: Keep the needle at a 90 degree angle to the seal. Insert needle at full length. Pull back on the syringe to confirm no blood comes up. If no blood, administer medication. If blood appears, pull needle out and restick with a brand new needle.
6. SQ: Pinch skin away from body of seal and insert needle in the area away from body. **Be careful not to pierce the needle all the way through this skin to the other side**. Pull back on the syringe to confirm no blood comes up. If no blood administer medication. If blood appears, pull needle out and re-stick with a brand new needle)
7. Complete Post-Intervention Monitoring Report.

Safe-T-Flex pole syringe:

This device is not spring loaded. Instead, the drugs are administered through the pole syringe by manual pressure applied by the person giving the injection. The pressure you apply to the handle will push the syringe contents into the seal.

1. Draw up specified volume of medication in a separate 6-20 ml syringe as accurately as possible using a sterile needle (18-20G needle of any length).
2. Pull the *pole syringe* plunger back to make room for the drug volume you just drew up.
3. Inject the drug into the pole syringe by feeding the first syringe’s needle into the pole syringe tip and expelling the drug from the first syringe into the pole syringe.
4. Attach a new, sterile needle of appropriate size (see above) to the pole syringe.
5. **If possible**, wait until the seal is sleeping and sneak up behind the seal to give the injection. Follow through with a forward motion until you are certain the full dose of antibiotics is given. Let the

motion of the seal (as it moves away from you) withdraw the needle.
6. Complete Post-Intervention Monitoring Report.

Dan Inject Jab-Stick (spring loaded pole syringe)
REMINDER NEVER discharge the pole syringe without having the syringe attached and filled with a fluid. Doing so will damage the mechanisms internally and could render the unit useless.

1. Loading syringe
   a. Draw up specified volume of medication in a separate, disposable 6-20 ml syringe as accurately as possible using a sterile needle (18-20G needle of any length).
   a. Retract the plunger on the Dan Inject *reusable* syringe to a volume that is slightly more than the amount to be filled. Use the disposable syringe (with needle attached) to fill the reusable syringe through the top opening.

   b. Attach a NEW needle onto the reusable syringe, which now contains the medication.
   c. Push the button on the pole to release the loading arm. Pull loading arm back on the pole syringe until you hear a click .

   d. Load syringe through the aluminum top casing (note needle CANNOT be recapped at this point) and screw onto top of pole syringe.

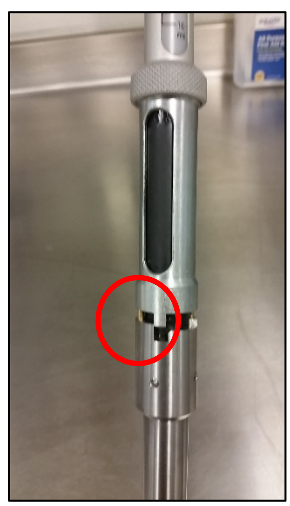
*Note the syringe base is square
which fits perfectly at the base of the aluminum casing.

e. Point the needle away from you and anyone in the vicinity when closing the arm. There are NO buttons or other mechanisms for closing. Keep fingers open to avoid pinch points and use pressure for closure. EXPOSED SHARP!

f. AVOID TOUCHING NEEDLE TO ANY OTHER SURFACES! If you contaminate the needle once it is attached to the pole syringe, you MUST remove and replace it. **Do not use a contaminated needle on a seal, no matter how minor the contamination may seem**.

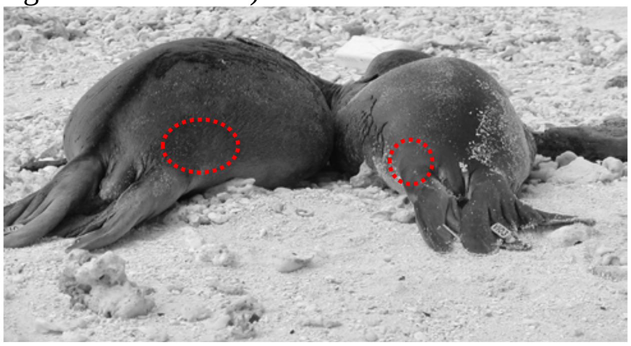
g. Ensure that safety is in the ON position

*Safety ON



*Safety OFF

2. Approach and application
   a. The majority of the time the drug will be administered IM in the right gluteal side of the seal. Do not administer in other body regions without specific instructions from the veterinarian (exception: left gluteal – while not preferred, you may use this site when the right is not feasible).



   b. Move safety to OFF position. (See above)
   c. Approach seal quietly from behind to avoid detection
   d. The pole syringe is triggered when pressure is applied to the aluminum tip. It's essential to use enough force to trigger the syringe (practicing on inanimate objects with water before using the pole syringe on a live animal is required).

   e. The seal will immediately pull away from the syringe once the needle goes into the skin. To anticipate that movement, imagine pressing the pole syringe several feet PAST the seal. That way you move with the seal. (Be aware that the natural instinct is to immediately pull pole syringe away from the seal. Fight the urge and press forward!) You will hear/feel a click when the pole syringe is triggered. **Do not be alarmed if your needle is bent afterwards - needles often bend due to the seal's movement.** If Pole syringe does NOT deploy, walk away and try again at another time. Never re-stick the seal with the same needle.
   f. Quietly and slowly walk away as to not disturb seal further. Most of them are confused from what happened and don't always immediately leave the beach. Give them space!
   g. During the post observations, unscrew the aluminum casing to take out syringe and needle. Be VERY careful with exposed sharps.
   h. Dispose of all used needles in sharps container.
   i. Do NOT throw out the reusable Dan Inject syringe (refer to disinfection instructions below).
3. Complete Post-Intervention Monitoring Report.

4. Cleaning and disinfecting in field:
   a. Brush off excess sand
   b. Rinse equipment using **fresh** water
   c. Spray with dilute Accel and sit for **5 min** then rinse
   d. Dry **thoroughly** with a clean cloth/rag
5. Once back in the lab/home base, follow maintenance protocols below.

Routine Corrosion Prevention and Maintenance for Dan Inject Jab-Stick:

The goal of this cleaning is to rid any surface of debris (i.e. sand, salt crystals, etc.) and stop corrosion causing elements before they start. This process should be done at the **end of each day** in which the pole syringe is used, **or every 2 weeks since the last use** if being stored in the field:

1. Clean the pole syringe after use or exposure to the elements with a mild soap and fresh water solution on a rag or sponge. Wipe with fresh water on a rag/sponge.
2. With a different rag from your tool kit, spray WD40 onto rag and wipe all surfaces of pole and metal syringe holder.
3. Open the handle for the unit and wipe down the underside of the handle and the support arm and hinge.
4. With the handle pulled open, you can rotate the safety mechanism into the safety position. Wipe down all exposed areas that can be reached by moving the safety mechanism back and forth.
5. Wipe down the threads where the syringe holder attaches as well as the threads on the syringe holder.
6. Squirt some WD40 onto the metal plunger at the base of the unit where the syringe attaches and into the mechanism underneath the handle.
7. Attach syringe holder with syringe filled with water, turn to safety and close handle. Make sure all moving parts in this processed have been wiped down with WD40 rag before closing handle.
8. Turn safety off and discharge syringe contents into sand or sink by holding the base of the syringe holder with one hand and the pole with the other and bringing hands together. DO NOT plunge jab stick back into the sand.
   Note: watch pinch points of the safety mechanism with the pole.
9. Repeat this process if mechanism is still requiring more effort than usual to discharge syringe.
10. Repeat process using Corrosion Block on same rag until all debris and signs of corrosion have been wiped clean.
11. Wipe unit clean of any excessive residue and store in container out of elements and heat.

Heavy Duty Care and Repair Procedures:

The goal of this cleaning is to restore use of a pole syringe that has been neglected from its original maintenance cleaning or moving parts are showing signs of corrosion. If routine maintenance is done as scheduled, then this should only be necessary for extreme maintenance of joints.

1. Using PB Blaster spray, spray all joints that are showing resistance. Let unit sit for an hour or two in the shade (to prevent the sun from evaporating the liquid).

2. Repeat the above steps in routine maintenance using the following sprays for each round: PB Blaster, WD40 and Corrosion Block. Exercise any joints that are stiff until they begin to loosen up during the PB Blaster stage.
3. Wipe unit Clean of any excessive residue and store in container out of elements and heat.

16.9 Appendix I: Appendix I of NMFS (2019)

Appendix I: Hawaiian Monk Seal Health Screening Protocol

All persons coming into direct contact with the seal or collecting specimens must be in good health and **wear gloves**. Eye protection (sunglasses or other) is recommended (see “Tagging and Handling” section of HMS manual). Before handling a seal, a vet assistant should be identified and given instructions.

TOOLBOX SUPPLY LIST:

Bleeding supplies:
6ml and 12 ml syringes
18g x 1.5” needles
18g x 3.5” spinal needles
18g x 2” needles
Pre-assembled Vacutainer hub/adapters in clean ziplocs
Extra vacutainer adapters
7.5 ml LTTs
3ml LTTs
10ml GNTTs
10ml RTTs
PAX gene RNA tubes

Biopsy supplies:

Sterile surgical gloves (sizes 6.5, 8.5)

Gauze

6mm Acuderm biopsy punches

2ml cryovials

2.5 ml precleaned teflon vials (NIST)

Precleaned instruments (NIST) wrapped in foil (forceps)

Fecal supplies:

Culturette (MHI)

Viral swab supplies:
Dacron fiber tipped swabs w/ plastic applicator

1.8ml cryovials pre-labeled: eye, nasal, oral, rectal, genital
1.8 ml cryovials filled with viral transport media (VTM): two for nasal swabs

Additional supplies:

Crash kit with fluids and emergency drugs (See Appendix A)

Pole syringe

Sedative(s) – at veterinary discretion (midazolam, concentrated midazolam, diazepam)

Cooler and blue ice

Towel

Ceftiofur (Excede)

25 or 30 mL syringes

16g x 3 ½” needles

Powder free gloves

Data sheets: Epidemiology Sampling Form, Tag Handling Card

Clipboard, pens for labeling, pencils for data recording

Betadine-soaked gauze

Alcohol-soaked gauze

Teflon squirt bottle of high purity alcohol (isopropanol)**

Tape measure

Sharps container

Trash bag/container

Rectal thermometer w/ extra batteries

Sterile lubricant (KY gel or other)

****Always replace teflon bag over squirt bottle! Please be mindful that this is an expensive bottle to replace and should be used specifically for this purpose.**

<u>ORDER OF FIELD SAMPLING PROCEDURES:</u>

1. Restraint and sedation
2. Blood collection order:
    1. Fill big (7.5mL) LTT ***ALWAYS FIRST**
    2. Fill one of each RTT and GNTT
    3. Fill PAX gene tube
    4. Fill remaining RTTs and GNTTs in any order
    5. Fill small (3ml) LTT
3. Swab collection (eye, nose, mouth, genital, rectal, fecal culture)
4. Blubber biopsy
5. Tagging and measuring

<u>SAMPLE COLLECTION:</u>

I. PATIENT MONITORING

A veterinarian must be present for all procedures requiring chemical immobilization. During restraint, vital signs, particularly respirations, should be monitored continuously. In the event of an emergency, the attending veterinarian will abort all sampling efforts and direct emergency procedures. One individual should be designated as the veterinary assistant and tasked with vital sign monitoring/communication with the veterinarian and assistance in the event of an emergency (drawing up emergency drugs, etc., see Appendix A). Emergency duties will be assigned to individuals before capturing the seal.

II. SEDATION

Positioning: ventral recumbency with foreflippers tucked to the sides.

1. Diazepam (Valium) (5mg/ml): 0.1-0.25 mg/kg IV

- *Route:*
    - Diazepam is most effective when administered IV.
    - Use the extradural or hind flipper veins (see Fig. 1).
    - Draw up appropriate amount of drug in a sterile syringe (a 6mL syringe is usually best).
- *Preparation:*
    - Clean the area with betadine solution and alcohol-soaked gauze.
    - Last, do a final rinse with the high purity alcohol in the teflon squirt bottle. This step is important for ensuring that NIST blood samples are not contaminated and are collected consistently.
- *Venipuncture:*
    - Palpate the vertebral column and pelvis and move your fingers cranially 2 or more vertebral spaces, feeling for a “divot” lateral to the spinous processes of the vertebrae.

- o Needle choice:
  - Pups and thin/average weaners: use an 18 or 20g x 1 ½ to 2" needle.
  - Adults and fat weaners: use a 3.5" spinal needle.
- o Before insertion, remove the stylet, holding needle from hub only.
- o Inform restrainers that you are ready to insert the needle.
- o The angle of the needle may vary from a 45 - 90 degree angle to the dorsal surface of the animal.
- o As the needle is inserted, feel it moving through skin, blubber, and muscle until you feel it pop through the membrane of the extradural sinus. You should now see blood rising to the hub of the needle. Attach the syringe containing the diazepam and inject.

- o Draw back using the same syringe to collect 2-3ml of "waste blood" and dispose of syringe/blood in the sharps container. It is collected to avoid contaminating blood samples with residual diazepam from the needle.
- o Remove syringe and attach the vacutainer hub/adapter setup to the needle.
- o Fill tubes in order specified above.

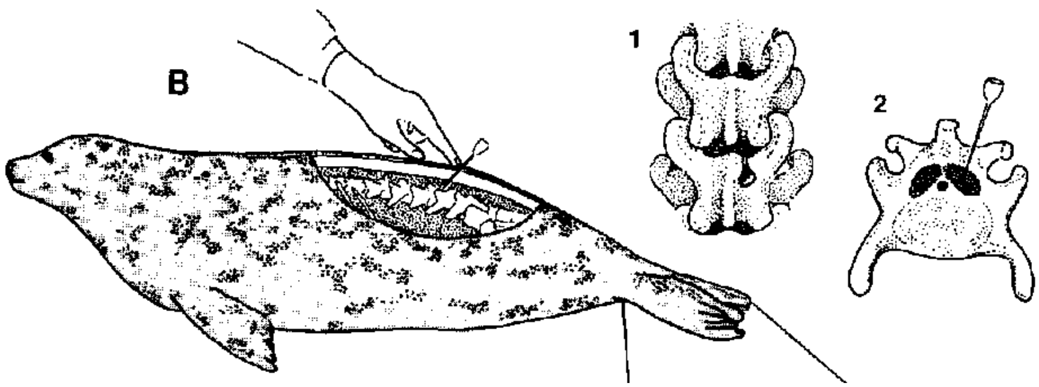


Figure 1.

2. Midazolam (5 mg/ml or 50mg/ml): 0.1 – 0.15mg/kg IM

- Some situations may require capture and manual restraint before drug administration. Other times, it may be sufficient to sneak up to an animal, administer the injection be prepared with boards/nets in case the animal approaches the water. The decision to restrain or corral an animal is to be made between with the handling team and veterinarian on a case-by-case basis.
- *Route:*
  - o Midazolam should be administered IM. Draw up the appropriate amount of drug in a small syringe for accuracy.
  - o Pole syringes are ideal for IM drug administration, as you can sneak up on a sleeping animal and inject in the hindquarters rapidly, causing minimal stress.
    - Instructions for loading the Dan-Inject Jab Stick pole syringe are included in the syringe carrying case.
    - Special needle sizes (16g x 3 ½" needles) are available for use with large adults.
  - o For hand injections, transfer appropriate dose to a large (20mL or larger) syringe to speed drug administration. Use an 16 to 18g x 2" needle.
- *Administration without immediate restraint:*
  - o As the vet approaches the seal to administer sedation, 2-3 people with boards should be standing by (quietly, low to the ground and as out of sight as possible). Ideally, the animal's reaction to the injection will be brief and if everyone else remains beyond the flight distance of the seal, the best scenario is that it will not move far and go back to sleep.
  - o If the seal moves toward the water (or other danger such as boulders, ledges), boarders should approach the head of the animal to prevent the animal from it from reaching the danger or water.
  - o A person with a net should be ready in case the boarders cannot contain the animal adequately.
- It will take 10-15 min. for the sedation to take effect.
- Record respiration rate and activity (movement, head position, etc.) at least every 5 min. on the Epi Sampling Form. Use these trends to gauge the alertness of the seal. Do not approach the animal too

soon after administering the sedative.

- Once you approach the animal, do so quietly. Consider wetting down a towel and place it gently over the seal's eyes (only), as this will help keep it calm. Proceed to blood sampling.

3. Reversal of sedative: Flumazenil (0.1mg/ml): 0.1 - 0.2mg/kg IM or IV

- Midazolam and diazepam can be reversed if an accidental overdose is given, if the animal is not responding well to the sedation and emergency procedures are instituted, or if the animal is too slow to wake up following a procedure. IV administration will work rapidly, but IM administration is also fast (minutes) and can be used if IV access is not immediately available.

III. BLOOD SAMPLING

- *Assistant duties:*
  - Before capture, set the vacuums in the LTT vacutainer/syringe tube by gently pulling back on the plunger until it locks into place and snapping it off. This step should **not** be done at the lab ahead of time, as syringes can lose their vacuum.
  - The assistant should ensure that the veterinarian receives the blood tubes in the correct order (see below).
- Attach vacutainer tubes (they will automatically fill if you are in the vessel).
- Fill tubes at least halfway to allow for proper ratio of blood to anti-coagulant.
- Gently rock the tubes 10-15 times to thoroughly mix additive and blood.
- Fill tubes as follows:

1. Big (7.5mL) LTT
2. Small (3ml) LTT
3. One of each RTT and GNTT
4. PAX gene tube
5. Remaining RTTs and GNTTs in any order

- Immediately place all tubes **upright** (in particular, the RTTs) in the styrofoam tube holder in the cooler. Tubes should not come into direct contact with the ice, which will cause blood cell lysis.
- The PAX gene tubes must be cooled gradually. They should be stored upright at room temperature for 2 hours before freezing (in the cooler with blue ice is fine, provided that they do not come in direct contact with ice). When freezing, the PAX gene tube should be frozen for 24 hours at -20C before being transferred to the -80C freezer. Long-term storage in a -20C freezer is acceptable as well..
- If the large LTT is not filled first, please note this on the datasheet.

III. SWAB COLLECTION

Use sterile dacron polyester fiber tipped swabs with plastic applicators. Swabs should be collected from the following locations: rectum, genital orifice, nares, medial canthus (corner) of eye, lateral commisure (corner) of the mouth. Collect 2 swabs from each location*, place in pre-labeled cryovials, break off tips of swabs in sterile manner, and preserve in liquid nitrogen.
*Collect 4 nasal swabs. Two nasal swabs should be collected in a dry cryovial and two nasal swabs should be collected in viral transport media (VTM). Collect 2 fecal swabs and place both in one vial of C&S media.

IV. BLUBBER BIOPSY

Preparation of biopsy site
Wear sterile surgical gloves. The blubber biopsies should be collected from the lateral aspect of the seal's pelvic girdle, 5-15cm cranial to the wing of the ileum. Before inserting the punch, clean the area with betadine and 70% isopropyl alchohol (take precautions in windy situations to avoid getting in eyes of personnel). **After scrubbing, do a final rinse of the area with the high purity isopropanol in the teflon squirt bottle (**This is important for NIST sampling).

Blubber biopsy collection and disposition
Collect two full-thickness biopsies (2-5 cm). Use the pre-cleaned, foil wrapped (provided by NIST) thumb forceps or scissors as necessary. **Do not allow gloves to contact tissue.** After samples have been collected, clean the biopsy sites with betadine solution. The wound can be left to heal through second intention.

The first blubber sample should be stored in a 7mL teflon vial for toxicology analysis. The second sample should have the skin removed (as aseptically as possible). The skin should be placed in a 2mL cryovial containing DMSO. The blubber should be placed in a cryovial for fatty acid radioactive isotope analysis. Freeze both samples (preferably -80) as soon as possible.

SAMPLE COLLECTION GUIDE

See Sample Processing Protocol for details on what to do back at the lab.

Item (#/seal)	Tube Vol.	Anti-coagulant	Blood Fraction	Short-term	Processing instructions	Long-term	Purpose (Investigator)
LTT (1)	7.5 mL	EDTA	Whole	Blue ice	Divide into 1mL aliquots and place in cryovials	LN/ UF	Archive (NIST/Trace Elements)
LTT (1)	3 mL	EDTA	Whole	Blue ice	Antech	Do not store	Blood chemistry (HMSRP)
PAX gene tube (2)	2.5mL	RNA preserv-ative	Whole	Store upright at room temp for 2 hours	Transfer to -20C freezer after 2 hours room tem. Then transfer to LN/UF if desired.	-20/ LN/ UF	Biotoxins (NOS)
GNTT (3)	10 mL	NaHep	Plasma	Blue ice	a) Spin, transfer 2.5 mL from tube into 7 mL Teflon jar b) Spin, divide remainder into 1 mL aliquots and place in cryovials	LN/ UF	a) Contaminants (NIST) b) Archive (split half and half)
GNTT (1)	4 mL	NaHep	Plasma	Blue ice	Spin down and aliquot into cryovial(s)	LN/ UF	a) Biotoxins (NOS)
RTT (4)	10 mL	None	Serum	Upright Blue ice	Divide into 1mL aliquots and place in cryovials	LN/ UF	a) Tier 1 (HMSRP) b) HMSRP/ NIST Tissue Bk (split half and half)
Viral swabs				Blue ice	2 nasal swabs – VTM; Nasal, ocular genital, anal (2 each) – Dry cryovials	LN/ UF	Tier 1 (HMSRP)
Rectal swabs				Blue ice		LN/UF	Culture (*Vibrio*) (UC Davis)
Cultur-ette (fecal)				Blue ice	IDEXX/Antech	N/A	Fecal culture (aerobic, anaerobic w/ sensitivity) – MHI as needed
Blubber biopsy #1				7 mL vial (Teflon) Blue ice		LN/ UF	Contaminants (NIST)
Blubber biopsy #2				2 mL cryovial		LN/ UF	a) Skin: archive/ stable isotopes (HMSRP) b) Fatty acids archive (archive; S. Iverson/ Dalhousie)

16.10 Appendix J: Appendix J of NMFS (2019)

Appendix J: Beach Pen Construction and Monitoring Protocol

The beach pen construction protocol can be used as a guideline for all islands. This protocol focuses on general beach pen requirements and may not meet all location-specific needs. Each island should modify their beach pens according to the individual needs of the seals and location-specific considerations while ensuring key pen requirements (outlined below) are met. Please contact Michelle Barbieri for questions or concerns: michelle.barbieri@noaa.gov.

Materials: Metal fencing panels
T-posts or tent poles
Post pounder
Bungee cords or zipties
Shade cloth and/or Easy Up canopy
Grommets, hammer, hard surface
Pallet tub lid or other similarly shallow container for water
Line to secure shade cloth/Easy Up canopy

Pen Requirements: Pens should be located in an area with cross ventilation, away from waves or high tide, relatively close to camp for daily checks but not too close for disturbance. The ideal location is high on the berm but not in the vegetation. Not all islands have these locations available so please use your best judgment.

Pen Construction: Ratio of fencing panels to posts to bungee cords: 1:1:2 (example: 15 panels, 15 posts, and 30 bungees)

Metal Fencing panels (orientation & positioning)

- Lay out fencing in the sand outlining the shape of the pen before pounding in the posts. In general the shape of the pen is not important so create what makes most sense in each situation.
- Panels can be oriented along their long or short side depending on your needs. Examples of situations to consider:
    - Will there be large animals to keep out and thus need a taller/stronger fence?
    - Will there be several animals inside the enclosure needing a larger area for short term?
- Place fence posts at juncture of 2 fence panels & on the outside of the pen
- Panels have c-clips to secure fencing to frame – be sure the 2 open ends of the c-clip are facing on the outside of the pen to prevent injury to seals

Bungee cords are preferred over zipties when available. Bungees are reusable and create less plastic waste. Bungees also allow quick access into the pen at any location along the fence perimeter.

Attachment of bungees –

- Secure fence panels to each post with 2 bungees – one near the top of the fence panel and one near ground level

- Wrap the bungees so the least amount of cord is on the inside of the pen. This limits access of the bungee to the seals

Shade:

Shade Cloth is provided to all islands but may need to be cut and sized for your pen. Cut and size the cloth to provide the maximum amount of shade possible. Strategically place shade based on sun position so that the maximum amount of shade is created.

- While planning the positioning of the shade cloth, choose locations to attach grommets that will stretch the shade cloth tightly over the pen without drooping into it. Follow instructions on grommet package for attachment.
- Tie off shade cloth with line to the outside of the pen to minimize hazards to seals. Avoid draping shade cloth over posts as wind will accelerate wear and tear of cloth.

If available, Easy Up canopies may be used as an alternative or in addition to shade cloth. Make sure Easy Ups are heavily secured to withstand the wind. Try to keep the majority of the Easy Up is out of the pen when possible.

Place pallet tub lid (or equivalent) in the pen preferably under the shade and fill with sea water. Replace water as needed.

Instructions for monitoring seals in beach pens

Seals should be checked at least hourly during daylight hours and at least three times each night. Please record all observations on the paper log provided. Please email the HMSRP veterinarian (Michelle Barbieri - michelle.barbieri@noaa.gov) once daily with an A-OK or brief synopsis of how things are going and elaborate *objectively* on any concerns.

Things to observe and report:

- Refer to seal assessment guidelines/checklist
- General behavior (resting, alert, active, pacing, vocalizing)
- Changes in alertness or respiratory rate/character (rapid, shallow, labored)
- Check integrity of enclosure, inspect area for hazards to seal
- For feedings, report number of fish offered and number of fish consumed. If no fish were consumed, note whether or not the seal showed interest in the fish or not (e.g., mouthing, shredding, tossing fish). If >1 seal per pen, observe from a distance to the best of your ability to evaluate which seals are eating vs. uninterested.
- On the day of release from the shore pen, please record release time and behavior. Please use same objectives for observations post-release.

Feedings:

The HMSRP veterinarian (Michelle Barbieri) will provide instructions on the amount of fish to give and timings of feedings (2x or 3x daily). Deviation from these instructions should be done only after consultation with the veterinarian.

If seal is not interested in fish or only consumes part of the fish offered:

1. Communicate this to veterinarian in daily email correspondence
2. Automatically skip the next feed
3. Feed half of the normal amount for the subsequent two feeds (after the skipped feed) unless instructed by the veterinarian to do otherwise.

In general, seals are offered fish 2-3 times daily and specifics will be provided by the veterinarian based on each individual's assessment. Twice daily feeds should occur at approximately 0800 & 1800 (within an hour is OK). Three times daily feeds should occur at approximately 0800, 1300, 1800 (within an hour is OK) and with a minimum of 5 hours between feeds**.** Food will be withheld from seals 8 hours prior to any transport as directed by the veterinarian.

1. Wear clean rubber/latex/nitrile gloves when handling fish
2. Count out frozen fish and discard any damaged fish:

   1kg is approximately 10 fish
3. Thaw fish in cool water (potable fresh water or sea water) immediately before feeding (it will take ~15 min. to thaw about 1-2 kg of fish in a 5 gallon bucket). Put smaller amounts of fish in multiple buckets to speed thawing.
4. Throw all fish into water/small pool within the enclosure at once and move to where you can observe feeding from a distance.
5. Allow 20-30 minutes to observe (if not eaten immediately). Record findings on log.
6. Make every effort to safely remove uneaten fish from enclosure within 20-30 minutes and discard. Fish can be discarded in its own bucket (use an old one) that is kept away from camp.

Please clearly label/flag the bucket so the whole bucket can be thrown away back in Honolulu and no one has to open it!

7. WASH/SANITIZE hands after every handling of fish.
8. Wash with soap and water and disinfect (Accel) buckets/feeding supplies between each feed. Remember that Accel needs a contact time of 5 minutes. Rinse items after 5 minutes.

16.11 Appendix K: Appendix K of NMFS (2019)

Appendix K: Health Screening and Quarantine Protocols for Translocations

HEALTH SCREENING AND QUARANTINE PROTOCOLS FOR HAWAIIAN MONK SEAL TRANSLOCATION BETWEEN SUBPOPULATIONS

These protocols support NMFS' translocation actions. These protocols are intended for any seal translocations between subpopulations (e.g., two-stage translocations or experimental juvenile translocations), as opposed to rapid and short distance translocations (within atolls or within the main Hawaiian Islands, MHI). Separate protocols are included for translocating different age classes of seals and are applicable to any locations in the Hawaiian Archipelago.

These protocols are subject to refinement and change based on experience that will accrue during the next decade, veterinary consultation, emergence of new testing procedures, disease risks, etc. Protocols will be reviewed annually and updated as required to refine protocols and improve implementation.

Weaned Pup Translocations

Steps involved in weaned pup translocations include:

1) Selection and capture of seals, health screening, and attachment of tracking instruments.
2) Recapture and transport to vessel/aircraft.
3) Transport to destination site.
4) Release of seals at new location.
5) Post-release monitoring.

Transport Vessels

A variety of transportation modes will be used including large vessels (NOAA ships, other chartered vessels), airplanes, helicopters, automobiles, and other as appropriate depending on location and available resources.

Specific Protocols

1) *Selection and capture of seals, health screening and attachment of tracking instruments.*

Any weaned pup at the designated source site will be considered a candidate for selection, as long as it exhibits no apparent signs of disease, injury or any other factors that may compromise survival. Relatively recently (i.e., less than a month previous) weaned pups may be favored for selection as they are more likely to remain at the release location longer than those that have weaned earlier (Baker et al. in review). Seals will undergo health screening and a subset will be instrumented with a tracking device approximately 1-4 days prior to transport. Seals will be captured using standard practices (by hand or using a hoop net). Blood may be collected without sedation or seals will be sedated.

Seals will be evaluated using the current standard health screen. This may be modified as deemed necessary due to specific disease concerns in source and recipient subpopulations, up to date testing procedures and veterinary consultation. Current practice includes:

<u>Blood Analysis</u>

1) Field analysis:

   a. WBC count – Unoppette system
   b. RBC count – Unoppette system
   c. WBC differentials, platelets – Microscope and archive extra unstained smear
   d. Hematocrit/ PCV – Microhematocrit centrifuge
   e. Hemoglobin
   f. Serum chemistry (Na, K, Cl, BUN, Creat, Ca) – I-Stat kit
   g. Glucose – Glucometer and test strips
   h. BUN - Azostix

2) Lab analysis (frozen 0.5-1.0 mL aliquots of serum, stored in liquid nitrogen dewar in the field)

   a. Serum chemistry – send to IDEXX
   b. Tier 1 testing, which currently includes: morbillivirus, seal herpes 1, Toxoplasma, and fecal culture.

3) Banked blood samples stored in liquid nitrogen dewar in the field

   a. Remaining serum (or at least 4 aliquots)
   b. Whole blood (Na heparin and EDTA)
   c. EDTA plasma, buffy coat, and RBC
   d. Na heparin plasma, buffy coat, and RBC
   e. PAX gene blood RNA tube (for biotoxins)

<u>Swab processing</u>

1) In the field place all swabs in the liquid nitrogen dewar after collection

2) Lab analysis

   a. 1 nasal and 1 rectal swab in Avian Influenza transport media (frozen) – send to National Wildlife Health Center in Madison

b. 2 dry swabs from the eyes, nares, mouth, genital orifice, rectum and any external wounds
c. 1 swab of any abnormal tissue in viral transport media (if deemed appropriate)

<u>Blubber Biopsies</u>
Put in liquid nitrogen dewar in the field
1) 1 for toxicology (Teflon container)
2) 1 for fatty acid analysis (cyrovial)

<u>Other Sampling</u>
1) Any other sampling deemed necessary by the PI or attending veterinarian.

<u>External Exam</u>
1) Physical Exam
    a) Assessment for external wounds
    b) Auscultation of lungs, heart
    c) Examine eyes, nose, ears etc. (damage, disease, moisture)
2) Morphometrics
    a. Girth
    b. Length
    c. Weight

Samples not analyzed in the field will be stored, shipped, and analyzed as described in the current monk seal permit.

If, based on veterinarian's physical exam and immediately available test results, seals do not show any signs of injury or illness, some may be instrumented with appropriate telemetry equipment to monitor them after release. This device will assist post-release monitoring until the opportunity to visually survey the seals arises.

If seals do show physical signs of injury or illness, the attending veterinarian will determine whether to sedate for full biomedical sampling or to treat the injury or illness. These animals will be covered under the health assessment portion of the PIFSC research and enhancement permit, or under the MMHSRP permit depending on the treatments required.

After this handling, seals will either be released and allowed to freely range until capture for transport, or will be held in a shore pen (approximately 1-4 days). Allowing seals to freely move will minimize any stress seals may experience being held in a captive shore pen. Holding in shore pens allows for better assessment of animals health and reduces effort of relocating seals within the atoll. The decision to use pens or allow seals to free-range prior to transport will depend on conditions at the field site, results of physical examination and transport logistics. If seals are allowed to range freely, prior to the second capture the seals will be visually assessed for any outward signs of injury or illness. If the attending veterinarian determines the animal to be unhealthy, either after physical examination and/or evaluation of blood sample, then the animal will not be translocated.

2) Recapture and transport to vessel/aircraft.

Weaned pups will be captured using standard techniques for the transport of weaners. If transport involves a small boat shuttle to a larger ship, animals will be restrained in a stretcher net by two trained seal biologists and placed on the deck inside the small boat. Seals will then be transported directly to the vessel. Water will be available onboard to cool the seal when needed. The number of seals that may be transported at one time in the small boat will be dependent the specific boat's capacity.

There should be adequate area that no seals are piled on top of each other and that there is a reasonable amount of space for researchers to operate to cool and move seals as necessary.

Seals will be taken onto the vessel by lifting the entire small boat by crane up to the mid-ship low railing access on the port side of the vessel (or the safest method depending on the vessel being used). One biologist will remain with the seal during lifting. Seals will be hand lifted from the small boat onto the vessel and brought to their cages.

The distances between cages will be wide enough to allow biologists to move between, prevent spread of urine and feces between cages, and allow the free flow of air. The cages will be strapped to the deck to prevent sliding if rough seas develop. Seals will be placed on a blue tarp, removed from the stretcher net and lifted manually into the cages. Seals will be held separately. A saltwater hose is located near the cage and ice is available for cooling off seals in the heat of the day. Cage openings will be accessible to allow access to animals if medical care or treatment is needed in transit.

If transport is via automobile to aircraft, similar but more logistically simple procedures will apply. Seals will be captured in the same way. Unless it is not feasible, the seals will be transported in cages (again while being observed and with water for cooling available) in automobiles and likewise aboard aircraft.

3) Transportation to destination site

The transportation of seals between subpopulations could be done via boat, plane, car, or other reasonable mode of transportation. Multiple modes of transport can be used at any time. During all transports, the animals will be escorted by a veterinarian and sufficient staff to be able to respond to an emergency.

<u>Transport via ship</u>
During transport the deck(s) holding the seals will be off limits to anyone except seal biologist monitoring the animals, the veterinarian and ships safety officers. No physical contact with seals will be made unless a problem arises in which a seal needs to be restrained for examination or treatment (see contingency plan below). If physical contact is made, protocols for handing seals in the wild will be followed as described in the permit application and as written in the Hawaiian monk seal Field Research Manual for safe handling of seals and minimizing risk of disease transmission (e.g., clean coveralls that have been soaked in bleach solution, wash hands, etc). Observers will look for a variety of threats, indications of stress or disease, and ways to mitigate both while observing the animal:

a) Entrapment/entanglement in cage
b) Abnormal discharge from body orifices
c) Abnormal respiration
d) Abnormal behavior
e) Modifying ambient temperatures to prevent overheating
f) Enforce security-preventing disturbance by people on ship
g) Monitor for ship equipment/supplies posing risk to seals.

Seals will be monitored 24 hrs a day while on the ship. Observers will watch for changes in external behavioral/health parameters. Initially upon be loaded onto the boat the seals will be closely observed for signs of acute stress (e.g. continued high respiration and heart rate, agitated behavior, shaking). Descriptive and medical observations will be collected for each individual seal. The following types of data will be recorded:

a) Observation form to be annotated at the end of each shift with significant findings; summary form to be completed by veterinarian daily.
b) Summary form to be completed at the end of each 2-hour shift
c) Eye exam form - only if eye issue is observed

Veterinary exam sheet will also be filled out by the attending vet prior to release.

4) Release of seals.
The protocols for releasing seals will be dependent on conditions at the selected release site(s).

General Considerations:

- Most releases will be on shore at a beach selected based on suite of criteria including, but not limited to:
    - site where pups have weaned and survived in past
    - ideally where conspecifics of similar age are present or frequent
    - if in MHI, then isolated from human contact
- Immediately after release seals will be monitored on shore for as long as logistically practicable.

If the site is a remote island or beach and landing by small boat is treacherous then this strategy will be considered (this will only be done in rare circumstances):

The vessel will approach the release site and attempt to get as close as possible to minimize distance traveled by small boats. Seals will be removed from their cages and placed on a blue tarp. They will be captured using a stretcher net and brought to the small boat, which will be held by the crane at the portside mid-ship low railing access (or other technique deemed safest and depending on vessel). Seals will be transported on the floor of the small boat and the boat will be lowered into the water for a near-shore release of seals.

The small boat will attempt to get within at least 100 m of shore but closer if conditions allow. This will mean the boat will be in shallow water with emergent land clearly visible for seals to navigate by. Two biologists will lift the seal over the rail of the safe boat, lowered to the surface of the water and one side of the stretcher net dropped allowing the seal to swim away. Safety lines will be tied to the boat side bar of the stretcher net and connected to the SAFE boat. This will keep the stretcher net from sinking and will cause the net to open releasing the seals if it should be dropped. An additional crewmember will be prepared with snorkel gear to help in the water if something needs to be done in the water.

If the site can be accessed by truck or other vehicle the following should be considered:

- Time of transport should be minimized so animals should be moved be transported during peak traffic times
- Animals will be escorted in the back of the truck by monk seal specialists to monitor the animals' health and welfare during transport
- Water will be available to cool the seal during transport
- A veterinarian and emergency gear will be available should an animal need assistance
- A back up/escort vehicle will be accompany the transport in case a vehicle should breakdown, so the animal(s) can continue to be moved

5) Post Release Monitoring

a. Remote Monitoring

Movement and diving behavior of seals instrumented with tracking devices data will be compared to data concurrently collected from native seals or to pre-existing data on seals of similar age to determine whether translocated seal behavior is within the normal observed range.

b. Resighting

Attempts to resight translocated seals will be made during regular population monitoring effort or intensified observation at the release subpopulation. The level of observation effort will vary largely depending upon the accessibility, logistics and cost of mounting surveys. Subsequently, haulout behavior and survival of translocated versus native seals of the same age will be compared.

Translocation of Older Seals

The following protocols pertain to the translocation of juvenile or sub-adult Hawaiian monk seals (e.g., involved in the second stage of two-stage translocation). Similar protocols will be applied to translocation of aggressive adult male monk seals. Any seal older than 1 yr, which has been identified for translocation for any of the purposes proposed under the PEIS, may be subject to these protocols. Once identified for translocation, subjects will be considered further if they exhibit no apparent signs of disease, injury or any other factors that may compromise survival[16].

Steps involved in translocation of older seals may include some, but not necessarily all, of the following:

1) Selection and capture of seals for health screening and attachment of tracking instruments.
2) Quarantine
3) Transport
4) Release of seals at new location.
5) Post-release monitoring

Transport Vessels *(*Same as for weaned pups)

Specific Protocols for Older Seals

1) Selection and capture of seals for instrumentation and health and disease screening.

[16] Aggressive adult male selected for translocation to mitigate harm to other seals may nevertheless be selected even if compromised in some way.

Procedures will be as described above for weaned pups with the following exceptions. Older seals will typically be captured with a stretcher or hoop net and transported in cages appropriate to their body size. Because older seals are far more mobile than weaned pups, they will usually be held in shore pens after initial capture until transport to the destination. As with weaned pups, seals which do not pass their health screen will not be translocated. If appropriate, they may be brought in for treatment under the MMHSRP or released on site if deemed appropriate by the attending veterinarian. Further, aggressive adult males deemed inappropriate for translocation may be brought into permanent captivity or euthanized according to the currently existing research and enhancement permit.

2) *Quarantine Period*
When transporting seals from the MHI to the NWHI, a period of quarantine may be necessary to reduce the likelihood of transferring a disease between the two regions. Quarantine holding will be done at a facility, on board a ship or in shore pens depending on the situation and facilities availability. The quarantine period should be long enough for the analysis of biomedical samples or longer than the prepatent period for the demonstration of clinical signs for the diseases of greatest concern. Two weeks is the generally accepted period and this period could include the transport period.
Specific quarantine protocols are described in greater detail in a subsequent section.
3) Transportation to release site
Transportation of seals will follow the protocols established for weaned pups.

4) *Release of seals at new location.*
Release of seals will follow the protocols established for weaned pups.

5) Post Release Monitoring
Monitoring will be conducted as described for weaned pups.

Injury/Illness during transport

If during transport any seal becomes sick or injured, it will be cared for in transit by veterinary and husbandry staff equipped with emergency drugs, antibiotics, intubation equipment, fluids for hydration, and IQF herring if tube feeding is necessary. The compromised seal(s) will be monitored 24 hours/day until it can be delivered to a captive care facility. Captive care will be conducted using established protocols refined and developed with recent captive care activities for Hawaiian monk seals and other pinnipeds under the authority of the MMHSRP permit. Eventual release of the seal will be determined according to standards of the MMHSRP.

Detailed Hawaiian Monk Seal Quarantine Protocol

The following are quarantine protocols that will be followed during the captive holding of Hawaiian monk seals, for example during translocation quarantine periods. Quarantine will typically occur in a captive facility, but these protocols can be adapted for use in a shore pen situation if needed. In such cases, reference to “pools” or “tanks” would apply to separate shore pens.

To date, no infectious disease that can be spread horizontally between seals has been found to cause clinical disease in Hawaiian monk seals. The following protocol takes this into consideration and is designed to reduce the risk of transmission of disease from outside sources to seals under human care. These sources include domestic animals and terrestrial wildlife (both directly and indirectly via fomites). Because humans act as fomites and because habituation of temporarily held monk seals is of paramount concern, every effort should be made to minimize human contact with releasable seals.

I. QUARANTINE

A. QUARANTINE DEFINITION AND OBJECTIVES

1. Quarantine refers to “any isolation or restriction on travel or passage imposed to keep contagious diseases, insect pests, etc. from spreading.”
2. Hawaiian monk seals held in captive care must be maintained under strict quarantine at all times. Quarantine measures between individual seals are at veterinary discretion based on health assessment findings.
3. All personnel involved in the feeding, handling, and care of these seals must be properly trained in quarantine procedures by an experienced staff. Quarantine procedures should always be clearly posted.

B. APPROVED DISINFECTING AGENTS

1. Dilute (10%) bleach, accelerated hydrogen peroxide or Nolvasan solution may be used. Practices differ slightly for each type of disinfecting agent and adherence to these practices is crucial to adequate quarantine.
2. The preferred agent is accelerated hydrogen peroxide (brand name: Accel) because it is less toxic than bleach and has a shorter contact time than bleach and Nolvasan.
3. CONTACT TIME is the most important aspect of disinfection. Each agent should be allowed to contact the surface that is being disinfected for the following minimum amounts of time:
    a. Bleach: 10 minutes
    b. Nolvasan: 10 minutes
    c. Accel: 5 minutes
4. When using bleach, either in footbaths or otherwise, it is imperative that organic matter (feces, dirt, etc.) be removed from the surface FIRST. Bleach will not adequately disinfect in the presence of such debris.

C. NMFS QUARANTINE POLICY

Quarantine from Outside Sources

1. All equipment used in the quarantine facility, including feeding, handling, clothing and medical supplies MUST be:
    a. Used exclusively for monk seals
    b. Properly sanitized after each use
2. **NO VISITORS** are allowed in monk seal quarantine area unless previous approval is granted by the permit holder (Charles Littnan) and the on-site supervisor. This approval is granted on a case-by-case basis.
3. Any person working with wild or domestic animals or visiting another animal care facility on the same day must shower and change clothes before and/or after entering the seal enclosures.
4. Gloves should be worn anytime a seal (or biological samples) will be handled. Thoroughly wash hands with soap after handling seals or biological samples.
5. **FOOTWEAR**:
    a. No street shoes are to be worn inside enclosures.
    b. Closed-toe footwear designated for "monk seal quarantine" should be kept at the lower entrance to each enclosure. This footwear should be used in the enclosures at all times and nowhere else. Breathable footwear (such as crocs) is permitted unless the wearer will be in standing water contaminated with biological matter (*i.e.*, feces). Rubber boots should be worn to completely protect the feet from biological matter in these instances, such as during tank cleaning.
    c. Footwear described above should be dipped in a footbath and scrubbed upon entry into and exit from the pool area. A footbath and long handled scrub brush should be kept at the bottom of the steps, inside the gate of each enclosure.

6. **PROTECTIVE CLOTHING:**
    a. Any person that will potentially come in direct contact with seals must wear clothing that is designated for monk seal quarantine use only. This clothing can include coveralls, tee shirts and shorts/pants.
    b. All quarantine clothing should be kept clean and remain at Ford Island in a designated area away from potential sources of contamination. It should never be worn when handling other species or animals outside of Ford Island.
    c. Clothing should also be changed before and after handling any sick individual seals.
    d. Protective clothing worn during procedures should be washed and disinfected at the end of each day.
7. Any new equipment or tools brought into the quarantine area must first be disinfected.

Seal Isolation

These measures should be followed if sick and healthy seals are housed at the same facility concurrently:

1. Use separate cleaning and feeding supplies, footwear and clothing exclusively for the sick seal unless instructed otherwise by the attending veterinarian.
2. Veterinary approval is required for any movements of seals between enclosures or when combining more than one seal in a tank.
3. If a seal requires isolation, follow the Potential Disease Outbreak Protocol.

II. OBSERVATIONS AND CONDUCT AROUND SEALS

A. OBSERVATIONS

1. In the morning and prior to each feed, conduct a thorough inspection of the seals and pens before proceeding with further activity. Following each feed or handling event, monitor the seals' behavior closely. Perform a final inspection before leaving for the day.
2. Throughout the day, use the cameras to observe each seal at least every 60 minutes. Observe and record the condition and activity level of the seal. Record the presence, color, consistency and amount of feces, urine, and spew (and the ID of the seal that produced it, if known). Look for any harmful debris in or around pens.
3. Note anything unusual in a seal's appearance (eye discharge or cloudiness, nasal discharge, bite wounds, etc.) and behavior (lethargic, unresponsive, stereotypic behaviors, etc.). Notify attending veterinarian and animal care manager immediately of any abnormal changes in a seal's health.
4. Succinctly record any observations on the Daily Observation Sheet, including the time and observer's initials. Frequently used acronyms: BAR = bright, alert, and responsive; QAR = quiet, alert, and responsive.

B. CONDUCT AROUND THE SEALS AT ALL TIMES

Every possible effort should be made to minimize the habituation of the seals by reducing human-seal interactions.

1. Do not enter enclosures unless absolutely necessary.
2. When in enclosures, **DO NOT MAKE PHYSICAL CONTACT WITH SEALS** unless necessary for procedures requiring handling. Minimize going into the enclosure and the amount of time you spend in the enclosure as much as possible.
3. Minimize talking and noise when working with or near the seals and the enclosure. Move slowly and avoid startling gestures.
4. Whenever possible, observers should remain as inconspicuous and unobtrusive as possible to observe seals' normal behaviors in captivity and minimize their stress in captivity.
5. Each person entering an enclosure with the seal should be carrying a herding board, which should within arms-reach at all times.
6. Outside of feeding sessions seals may display undesirable behaviors. Record these observations and follow these instructions:
   a. Approaching too closely or too rapidly

→ Use a herding board to keep the seal away

b. Mouthing hoses, brooms, or boots

→ Discourage this by preventing opportunities for seals to bite at these objects

c. Stereotypic behaviors (repetitive splashing, slapping at the walls of the enclosure, pattern swimming)

→ These are a sign of boredom and may be reduced by providing seals with approved environmental enrichment devices (EEDs). Objects such as marine debris that the seals may encounter once returned to their natural habitat should not be used as EEDs so that they do not associate these objects with food or play. A good example of an EED is sinking a milk crate that has fish stuck in the holes or providing some of their daily caloric needs through “fishsicles.”

III. CLEANING THE QUARANTINE AREA

A. DISHES

1. Wash all dishes used for feeding and handling with dish soap and water. Scrub the inside of all feeding tubes using a tube brush. Rinse thoroughly.
2. Place all dishes in a dish sanitizer. If a dish sanitizer is not available, the following steps should be followed after step 1, above:
    a. Soak or spray all equipment (bolus syringes, knives, tongs, cutting boards, etc.) with disinfectant according to section I.B. (“Approved Disinfecting Agents”) above.
    b. Rinse all dishes thoroughly to remove the disinfectant.
    c. Allow all dishes to air-dry.
    d. Stomach tubes should be washed with soap and water, rinsed thoroughly, and then boiled for 10 minutes.
3. Bolus Syringe Care: after the syringes have been washed and dried as described above, lubricate the O-ring with mineral oil and put the syringes back together for safe storage. Be careful when handling the syringes as they are fragile and can crack easily.

B. DAILY CLEANING AND MAINTENANCE

Seal Enclosure Cleaning

1. Do not allow seals to mouth or bite brooms or hoses.
2. Never allow equipment to remain unattended in an occupied seal enclosure. Return all equipment to its storage area after use.
3. Always keep enclosure gates bolted.
4. When cleaning, take the opportunity to look for vomit, diarrhea and observe the feces for consistency and parasites. Always record observations form in the seal’s chart and make special note of any unusual findings.
5. Every morning, inspect the entire pen enclosure for any scat, urine, fish parts, and wind-blown debris. If necessary, use a broom and fresh water hose to clean the seal enclosure. Thoroughly rinse all fish scales, blood, and debris from the decks, walls, and ledge of the

enclosure and walkway with the fresh water hose after each feed. Special care should be taken to clean scales from doors, door handles, and bolts.

6. Before leaving in the evening, the deck and pool walls and floor should be hosed down and any spattered blood, scales, scat, or other debris should be scrubbed away.

Footbaths and Walkways

1. Rinse off the walkway and stairs leading to the seal enclosure at least once a day. Scrub the walkway with broom, disinfectant and water as needed.
2. Refill footbaths as needed depending on choice of disinfectant (usually once per 1-2 days for Accel). When using bleach, footbaths should be refilled anytime organic material is present.
3. If using bleach, add 1 cup bleach to 1 gallon of water and be sure to have a final water rinse before the pen entrance.

Fish House Cleaning

1. Freezers and refrigerators must remain clean and neat at all times. All feeders are responsible for maintaining freezer cleanliness on a daily basis. Keep freezers free of ice buildup as much as possible.
2. Wipe down all counter and table surfaces after each feeding. Be especially mindful of cleaning any fish scales and spattered blood from the all surfaces after each feeding.
3. Mop the food prep room floor after the morning feeding.
4. Empty the garbage daily.

C. WEEKLY CLEANING

Seals should be crated/kenneled and weighed once weekly using the forklift. Weekly cleaning can be done during this time. Use a net to scoop the seals out of the water and herding boards to direct them into the holding area. Be sure to keep the seals wet, shaded and monitor their behavior regularly.

Seal Enclosure

The monk seal pools should be drained and the pools, walls, ledges, doors, and stairways cleaned once a week using accelerated hydrogen peroxide disinfectant (preferred) and a large, soft-bristled brush.

1. Drain pool, empty all footbaths.
2. Spray and use disinfectant to scrub all surfaces (pools, walls, ledges, doors, stairways).
    a. If using bleach solution instead of hydrogen peroxide, all organic matter must be rinsed away first and be careful to direct the rinse water toward the drain holes at the corners of the enclosure, away from seals because (bleach is a skin and eye irritant).

3. Allow appropriate amount of contact time for the disinfectant used (see above).
4. Hose off all surfaces, then close drain and turn on the water inflow.
5. Refill footbaths and when pool is full, return seals to enclosure.
6. Thoroughly rinse and put away all cleaning equipment.

7. Record the seals' behavior, the duration spent in the holding area, and any other relevant information from the cleaning event (scat, spew, urine, etc.) on the observations form in each seal's chart.

D. QUARTERLY CLEANING

Every 3 months, and particularly before the rainy season or forecasted heavy rainfall, the shade structure should be rinsed (if removable, it should be removed and scrubbed) to remove dust and debris. Rinse water should not go into an enclosure if it is occupied by a seal – remove the seal as with weekly cleaning procedures. Clean enclosure per weekly cleaning instructions after cleaning the shade structure.

IV. WATER SAMPLING SEAL TANK

Sampling should occur on the same day and time each week at least a couple of days after the weekly enclosure cleaning. Collect one sample from each occupied pool and one from the inflow in addition to a temperature control sample collected from the pool. These samples are submitted to Hawaii Food & Water Testing Lab (HF&WTL) for total coliform testing.

1. Be as sterile as possible: wear gloves, do not open lid to bottle until immediately before collection, do not contaminate inside of lid or bottle, don't set the lid down, etc.
2. Collect the inflow sample by removing the lid and holding the bottle under the water inflow to fill it. Decant any excess water being careful not to touch the lip of the bottle or the lid.
3. Sample the pool (pool and temp control sample) 180^0 from the water inlet. With the lid still in place, submerge the bottle about 1 foot deep. Unscrew the lid underwater with the bottle positioned counter-current to fill the bottle. Replace the lid underwater. Remove the bottle from the water and decant the excess water being careful not to contaminate the bottle or lid.
4. Immediately place the samples in the small red cooler with blue ice (provided by HF&WTL) for transport to the lab. If transport is not immediate, place the samples in the refrigerator (sampling fridge, not fish storage fridge). Store sample bottles in the cooler and ice pack in freezer until next sampling.
5. Complete all the necessary paperwork and be sure to label each bottle (pool, inflow, temp control).
6. Results submitted on Tuesday are usually faxed to us, c/o Angie Kaufman, on Thursday or Friday. These counts should not exceed 1000 MF/100ml. If fecal coliform counts exceed 1000 MF/100ml, results are reported to Robert Dollar by phone; sampling must be repeated within 24 hours. Promptly notify the veterinary staff if counts are above 1000 MF/100ml.
7. Enter the date, time, coliform count, and any pertinent comments in the HMS Water Testing spreadsheet.

DIRECTIONS TO HF&WTL

2688 B Kilihau St.
Honolulu, HI 96819
Ph: 836-5558

Fax: 836-5509
contact: Wendy

Open Mon.-Friday, 8am-5pm
Located in Mapunapuna near the airport. Go east (towards the airport) on Nimitz Hwy & turn left on Kakoi St then right on Kilihau St (2688B Kilihau St.). It's the 3rd grey building on the left.

V. SEAL ILLNESS/EMERGENCY CARE

1. In case of an emergency or suspected illness, refer to the phone list and call the attending veterinarian or veterinary technician immediately to relate symptoms or circumstances of emergency or illness. Follow the emergency chain-of-command protocol.
2. A veterinarian or trained veterinary staff will perform any needed blood sampling.
3. A crash kit and emergency drugs will be kept at all facilities when seals are present. All other medical supplies for blood sampling, fluid and antibiotic administration, monk seal medications, and additional medical supplies are kept at the Vet Lab Ford Island.

EXAMPLE **Physical Examination Form**
Circle as appropriate

Body outline: Swelling, Wound, Change from previous day
If yes, describe: ____

Flippers: Normal use of all 4 flippers with full-range of motion, Favoring one flipper (describe), Lacerations, Swelling, Ulcers/sores, Signs of pain or discomfort

Discharges: Ears, Nares, Eyes, Umbilicus, Rectum, Vagina, Other
If yes, describe amount:______ mL, Color:___________,
Consistency:_______________

Feces: Describe amount:_______ mL, Color:___________,
Consistency:________________

Urine: Color:_____________

Eyes:

Right: Discharge: Clear tears, Crustiness around eyes, Purulent discharge
Redness or congestion of conjunctiva, Swelling of conjunctiva, Prominence of third eyelid, Corneal opacity/ cloudiness, Corneal ulcer, Lacerations, Swelling of eyelids, Squinting or photosensitivity, Any obvious loss of vision

Left: Discharge: Clear tears, Crustiness around eyes, Purulent discharge
Redness or congestion of conjunctiva, Swelling of conjunctiva, Prominence of third eyelid, Corneal opacity/ cloudiness, Corneal ulcer, Lacerations,

Swelling of eyelids, Squinting or photosensitivity, Any obvious loss of vision

Mouth: Color of mucous membranes: Pink, Red, Pale pink/White
Teeth: Broken, Erupting. List
site:_______________________________________

Behavior: Alert, Bright, Lethargic, Depressed, Active, Inactive, Stereotypic behavior, Disorientation, Vocalizations, Other abnormal behavior for each individual seal, Any marked change from previous days
Describe:____

Other comments (environmental conditions, respiration rate, heart rate, etc.):

____
____
____
____
____
____

Animal ID: __________ Date:_____________ Name of Observer:___________________
Time:_____________

16.12 Appendix L: Appendix L of NMFS (2019)

Appendix L: Protocol for Displacement with Aversive Audio

Site selection - Sites that present dangers to seals or people around seals

- *Heavily used children's swim areas* (*ex.* Keiki Pool, Poipu Beach, Kauai): These are areas with a high likelihood of human-seal interactions, which could be particularly negative given the presence of children. This situation is primarily a human safety concern.
- *Canals with physical dangers/water quality concern*s (*ex.* Lihi Canal, Kauai): Canals may be areas of concentrated pathogens (leptospira, toxoplasma, etc.) or pollutants, trash and debris, and fishing nets threatening the health or safety of seals. This situation is primarily a seal safety and health concern.
- *Boat harbors or launch areas* (*ex. Lahaina Harbor*): A small number of seals have been observed swimming, resting, and feeding (both on live fish as well as being provisioned) in boat harbors or boat launch areas. This significantly increases the potential of a boat strike or other serious injury. This situation is primarily a seal safety and health concern.

Safety Considerations

- Safety thresholds were determined primarily based on NOAA[1] guidelines for PTS and TTS. Additional NOAA[1,2] and Navy[3] guidelines were consulted regarding sounds sufficient to elicit behavioral responses and safety thresholds for in-air sounds.
- Where recommendations differed between resources, we took the most conservative estimate. (Details in Table 1.)
- Safety considerations will be based on animal distance from the sound source. We use the source level for a distance of 1m, then calculate sound attenuation (15*Log(distance in meters)) to estimate levels received by seals 5 or 10m from the device.
- Aversive audio tools may include several options of devices and sound types:
    - Playback devices playing "natural" noises (non-impulsive sounds) such as predator (killer whale) calls,
    - Playback devices playing "startling" noises (non-impulsive sounds) such as, boat noises, horns or sirens, simulated explosion sounds.
    - Metal pipe struck to produce a clanging noise (impulsive sound).
    - Airhorn triggered to produce loud horn noise (impulsive sound).
- To maximize effect, we have selected a range of audio tools producing sounds at or above the Behavioral Response thresholds while remaining safely below the TTS or PTS thresholds.

- Effectiveness of similar source levels is supported by experiments with other seal species (avoidance behavior observed in grey seals and harbor seals for sounds received at 135–144dB re 1 μPa (RMS)[4], and predator calls played at 148dB re 1μPa have effectively elicited response from harbor seals[5]).

- We conducted preliminary tests of currently available equipment to ensure safe and effective deployment. In addition to max source level (dBrms), we considered the duration of play that would be safe for cumulative sound exposure (SEL_{cum}) (Table 2).
    - Underwater sound levels based on hydrophone measurements.
    - In-air sound levels based on measurements with a sound level meter.
- Any new equipment or new sounds we develop will be similarly tested before deployment to be sure that we are able to control the source level, play at safe levels, and adjust total time of play to stay within a safe range of cumulative sound exposure.

Procedure

- If the seal is in the water (as in dangerous waterway situations), the aversive audio tools will be used alone, without physical displacement.
- If the seal is on land (as in dangerous haul-out situations), aversive audio will be used to augment standard physical displacement protocols using crowding boards.
    - If appropriate, seals will be displaced from undesirable haul out locations in the usual fashion using crowding boards, with the addition of a team member stationed with the aversive audio device.
    - Aversive audio will be paired with crowding board contact to heighten the aversive startle response during the normal displacement procedure.
- The audio device will be placed no closer than 1-5m from the seal (whether on land or in water). The device will be submerged in 1-5m of water for in-water deployment. Sound will be immediately stopped in the event that the seal approaches within 1m of the device. Source level and/or playback time may be increased if the seal swims beyond 5m (Table 3).
- Audio will be played in short intervals (10 seconds of sound, 10 seconds of silence) repeated for one minute after the seal enters the water. If the seal does not completely leave the area after one minute, playback may be repeated up to five times (maximum play duration will be determined according to safe cumulative exposure for each sound type, see Table 2).

Other protected species concerns

- Other protected species (fish, sea turtles, cetaceans) do not regularly occur in the shallow nearshore areas these aversives are currently being considered.

However, NOAA interim standards and Navy guidelines indicate that similar safety thresholds apply to mid-frequency sensitive cetaceans that could occur in study areas.

- A visual survey will be conducted for the presence of any other protected species prior to application of audio aversives.
- If protected species are detected at close range to present a danger of crossing PTS or TTS thresholds, then playbacks will not occur. If they appear at close range during playback then playback will be halted and behavior will be observed and recorded.
- Because the sounds we intend to use for aversive audio application can travel far (up to 630m based on source-15*Log(distance in meters)) before attenuating below the behavioral response threshold for conspecifics or cetaceans, it is possible that cetaceans up to 630m could go unsighted yet be exposed to sounds levels above the threshold for eliciting a behavioral response (120dB, Table 1), thus constituting Level B harassment. Thus, our take table includes additional spinner dolphins and bottlenose dolphins associated with this activity beyond the number of incidental takes associated with other monk seal research and enhancement activities.

References:

[1] National Marine Fisheries Service (2018) 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater

Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

[2] NOAA / NMFS West Coast Region (Accessed July 2015) Interim Sound Threshold Guidance. Available at http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

[3] Navy (2017) Criteria and Thresholds for US Navy Acoustic and Explosive Effects Analysis (Phase III), SSC Pacific, Technical report.

[4] Götz, T., & Janik, V. M. 2010. Aversiveness of sounds in phocid seals: psycho-physiological factors, learning processes and motivation. The Journal of experimental biology, 213:9, 1536-1548

[5] Deecke, V. B., Slater, P. J., & Ford, J. K. 2002. Selective habituation shapes acoustic predator recognition in harbour seals. Nature, 420:6912, 171-173.

Table 1: Established Sound Thresholds for Phocids

	Under Water[1]				
	A dBpeak	**A dBcum**	**B dBrms**	**C dBpeak**	**C dBrms**
PTS Onset (non-impulse)	ns	201	--	--	--
PTS Onset (impulsive)	218	185	--	--	--
TTS Onset (non-impulse)	ns	181	--	--	--
TTS Onset (impulsive)	212	170	--	--	--
Behavioral Response (non-impulse)	ns	ns	120	ns	166*
Behavioral Response (impulsive)	ns	ns	160	ns	165**
	In Air[2]				
	A dBpeak	**A dBcum**	**B dBrms**	**C dBpeak**	**C dBcum or rms**
PTS Onset (non-impulse)	ns	ns	ns	ns	154
PTS Onset (impulsive)	ns	ns	ns	161	138
TTS Onset (non-impulse)	ns	ns	ns	ns	134
TTS Onset (impulsive)	ns	ns	ns	155	123
Behavioral Response	ns	ns	100	ns	100
Behavioral Response	ns	ns	100	ns	100

Table Notes and Abreviations

1 all decibels referenced to 1μPa (standard underwater pressure)

2 all decibels referenced to 20μPa (standard air pressure)

ns = not specified in the thresholds presented by the specified source

dBpeak = sound level threshold based on peak SPL measurement

dBrms = sound level threshold based on RMS measurement

dBcum = cumulative sound exposure thresholds based on weighting functions, to be conservative our measurements did not account for weighting. Based on the metric SEL_{cum} which was calculated based on measured sound levels and the equation:

SEL_{cum} = SPL (dB) + 10 $\log_{10}$ (duration of exposure in seconds).

PTS = permanent threshold shift

TTS = temporary threshold shift

* Based on a probabilistic model, 50% probability of behavioral reaction at 166 dB. The 166 dB thresholds is associated only with sonars and other transducers.

** The 165 dB threshold is only associated with underwater explosives.

Sources for Table Data

A) National Marine Fisheries Service (2018) 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

- Most recent NOAA guidelines, specifies damaging levels only, considers underwater sound only

B) NOAA / NMFS West Coast Region (Accessed July 2015) Interim Sound Threshold Guidance. Available at http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

- Interim guidelines for west coast, specifies damaging levels as well as behavioral thresholds, considers both underwater and in-air sound

C) Navy (2017) Criteria and Thresholds for US Navy Acoustic and Explosive Effects Analysis (Phase III), SSC Pacific, Technical report.

- Current Navy guidelines, specifies damaging levels as well as behavioral thresholds, considers both underwater and in-air sound

Table 2: Maximum source levels and permissible cumulative sound exposure levels for aversive audio tools.

For each sound type we indicate the max source level (dBrms, reported rather than peak since we are well below peak thresholds and rms is more appropriate for SELcum calculations) as well as cumulative sound exposure levels for a 10 second play interval. The #10s Play Intervals indicates the number of intervals for which the given sound could be played without reaching NOAA's SELcum thresholds for TTS (note: most of these sounds are safe for much longer durations than would be played under this protocol). Source levels are referenced 1m from speaker, sounds won't be played if animals are <1m from source.

	Under Water[1] (measured 1m from source)			In Air[2] (measured 1m from source)		
	max source level (dBrms)	# 10s Play Intervals	SELcum[3]	max source level (dBrms)	# 10s Play Intervals	SELcum[3]
Predator Sounds (natural, non-impulsive)	146	15	168	105	15	127
Startle Sounds (man-made, non-impulsive)						
Boat motor	146	15	168	100	15	122
Simulated Explosion*	150	15	172	94	15	116
Recorded Horn	162	6	180	102	15	124
Air Horn (man-made, impulsive)				129[4]	0	na
Metal Pipe	165**	2.5sec	169	104	5	121

(man-made, impulsive)	

1 All recorded sounds played on an **iPhone5 at MID volume, through our TOA amp at volume 10.**

All decibels referenced to 1µPa (standard underwater pressure)

2 All recorded sounds played on an **iPhone5 at MID volume, through our TOA amp at volume 10.**

All decibels referenced to 20µPa (standard air pressure)

3 SEL_{cum} was calculated based on measured source levels and the equation:

SEL_{cum} = SPL (dB) + 10 $\log_{10}$ (duration of exposure in seconds).

4 Note, commercially available airhorns, at the sound source, exceed the TTS threshold for in-air sounds, thus the airhorn would only be played at a greater distance from the animal. See Table 3.

* This is a computer-generated sound effects clip, without the impulsive qualities of a real explosion.

**Peak-to-peak (rather than dBrms) source level was used to determine SELcum. This results in a conservative estimate of SELcum (i.e., higher SELcum is calculated using peak-to-peak compared to dBrms source level). This impulsive sound would quickly exceed SELcum thresholds if played continuously, thus it is only eligible to played with up to 3 brief strikes of the pipe during 2.5 seconds if animal is at close range.

Table 3: Maximum source levels and permissible cumulative sound exposure levels for aversive audio tools at variable distances.

For each sound type we indicate the source level referenced to 5 or 10m from sources mentioned in Table 2 (dBrms, reported rather than peak since we are well below peak thresholds and rms is more appropriate for SELcum calculations), as well as cumulative sound exposure levels for a 10 second play interval. The #10s Play Intervals indicates the number of intervals for which the given sound could be played without reaching NOAA's SELcum thresholds for TTS (note: most of these sounds are safe for much longer durations than would be played under this protocol).

	Under water[2] (5m[1] from source)			Under water[2] (10m[1] from source)		
	max source level (dBrms)	# 10s Play Intervals	SELcum[3]	max source level (dBrms)	# 10s Play Intervals	SELcum[3]
Predator Sounds (natural, non-impulsive)	136	15	158	131	15	153
Startle Sounds (man-made, non-impulsive)						
Boat motor	136	15	158	131	15	153
Simulated Explosion*	140	15	162	135	15	157
Air horn	152	15	174	147	15	169
Air Horn (man-made, impulsive)	129[4]	0.3	123	129[4]	0.8	123

Metal Pipe (man-made, impulsive)	155**	3	170	150	8	169

1 Sound attenuation based on 15*Log(distance in meters).

2 All recorded sounds played on an **iPhone5 at MID volume, through our TOA amp at volume 10**.

All decibels referenced to 1μPa (standard underwater pressure).

3 SEL_{cum} was calculated based on measured source levels and the equation:

SEL_{cum} = SPL (dB) + 10 $\log_{10}$ (duration of exposure in seconds).

4 Note, commercially available airhorns, at the sound source, exceed the TTS threshold for in-air sounds, thus the airhorn would only be played at a greater distance from the animal. Given the high levels, and short time allowable, the airhorn should be played in several short one-second blasts, rather than continuous 10-second segments.

* This is a computer-generated sound effects clip, without the impulsive qualities of a real explosion.

**Peak-to-peak (rather than dBrms) source level was used to determine SELcum. This results in a conservative estimate of SELcum (i.e., higher SELcum is calculated using peak-to-peak compared to dBrms source level; also as strikes to the pipe will have some pause in between, the cumulative time of exposure will not be 100% of the duration).

Note, only in-water calculations are provided, in-air play is intended to provide an initial startle when trying to motivate the animal to move with crowding boards. We do not intend to continue in-air audio play as an animal moves 5-10m away.

Equipment

Audio source: iPhone5s

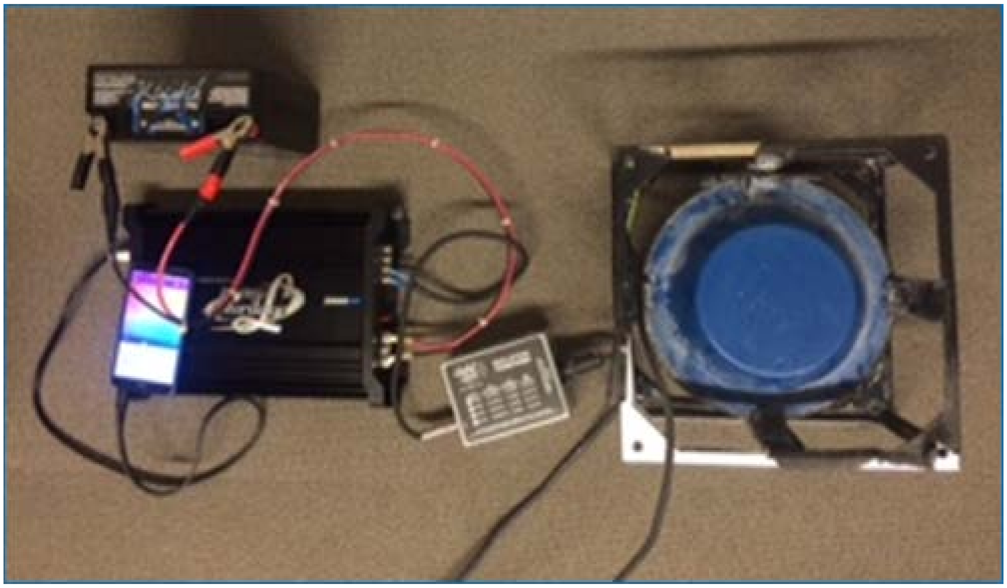
Power source: Kinetik 12v/600watt scooter battery

Amp: TOA CA-160 car amplifier, 60watt output

Transformer: Lubell AC205 isolation transformer

Speaker: Lubell LL916C underwater speaker

Containment: Power and audio source in hand-held water proof case, speaker and cord to be deployed from Rubermaid carry tote



Candidate sounds

Impulsive Sounds

- Metal pipe (note tests conducted in sea water with different hydrophone at HIMB)

Recorded Sounds (Non-Impulsive)

- Killer whale calls recording
- Simulated explosion recording (this is a computer-generated sound effects clip)
- Air horn recording
- Boat motor recording

16.13 Appendix M: Appendix M of NMFS (2019)

Appendix M: HAWAIIAN MONK SEAL NECROPSY PROTOCOL

SAFETY CONSIDERATIONS

Before performing a necropsy, be sure you have read the following documents located in the **Zoonotic Disease** section of your **Master Field Log** and your camp's **Necropsy Manual**:

Occupational Safety: Working with Marine Mammals and Your Health
http://www.vetmed.ucdavis.edu/whc/mmz/Occupational%20Safety.htm

Marine Mammal Zoonotic Bacteria
http://www.vetmed.ucdavis.edu/whc/mmz/bacteria.htm

Marine Mammal Zoonotic Viruses
http://www.vetmed.ucdavis.edu/whc/mmz/viruses.htm

Zoonosis and Quarantine (MARP Manual)

Appendix II: Infectious Agents (Aguirre *et al*., 1999)

Public Health (Cowan *et al*., 2001)

Assessment of the Risk of Zoonotic Disease Transmission to Marine Mammal Workers and the Public: Survey of Occupational Risks*
http://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/Programs/Photogrammetry/Marine_Mammal_Zoonoses_Final_Report-2.pdf

*Only available online and on your field computer:

Preventing Disease Transmission

Avoid direct contact with dead seals to prevent transmission of infectious diseases that may be pathogenic to humans. Persons performing the necropsy must:

1. Cover all surface wounds with a protective dressing before gearing up.
2. Wear protective gear, including latex or vinyl gloves, mask, disposable gowns, and foot covers. Change torn gloves **immediately**.
3. Seek medical attention **immediately** if you get any cuts, punctures or other injuries during the necropsy. Notify the attending physician of the source of the injury.
4. Disposable items such as scalpel blades, needles and biopsy punches MUST be disposed of in sharps containers.
5. If possible, pull carcass up the beach to higher ground and bury it after necropsy to avoid attracting scavengers and to minimize the potential for disease transmission.
6. Disinfect all instruments and contaminated equipment after the necropsy has been performed (see Post Necropsy section below).
7. Once the necropsy has been performed and all gear has been cleaned and disinfected, wash thoroughly with soap. Disinfect reusable clothing with Accel solution (see tagging handling protocol) and dispose of all contaminated clothing, gloves, gowns, etc. in a biohazardous waste bag.
8. DO NOT STORE ANY SPECIMENS IN FREEZERS/REFRIGERATORS USED FOR HUMAN FOOD.

GENERAL CONSIDERATIONS

A necropsy is a systematic examination of the whole body, organs, and tissues and is a basic tool for investigating disease and for monitoring the health of the Hawaiian monk seal population. **Whenever possible, necropsies should be performed by a trained veterinary pathologist** experienced in recognizing and interpreting lesions and abnormalities.

Necropsy How-To Guides:
For general guidance on the steps in performing a necropsy, please refer to the following resources, but follow the sample

collection protocols provided in this document and the most recent version of the Necropsy Report Form.

1. **Field Manual for Phocid Necropsies (specifically *Monachus schauinslandi*)** (FMPN) located in your camp's **Necropsy Manual**
2. **Marine Mammal Necropsy: An Introductory Guide for Stranding Responders and Field Biologists** located on your field computer and also available at: http://www.bahamaswhales.org/strandings/necropsy.pdf
3. **Monk Seal Necropsy photos and helpful hints** Power Point Presentation on your camps necropsy computer.

Necropsies will have the most scientific value when they are carefully documented. Adherence to this protocol and the **Necropsy Report Form** will assist in the documentation and standardization of information, which may be valuable in determining morbidity and mortality factors within the population and as well as for individual seals.

Things to keep in mind:
1. Record all observations – when in doubt, just describe what you see.
2. The order of the **Necropsy Report Form** follows the sequence of general dissection and examination. If you are skilled and familiar with Hawaiian monk seal necropsies, you may find it easier to use the Necropsy Specimen Checklist, but **be sure to have someone record all observations, photos, measurements, and descriptions of organs on the Necropsy Report Form.**
3. Tissues and organs must be examined in a systematic manner. The precise method used for a necropsy is less important than establishing a routine in which each body system is examined fully.
4. **Once the carcass has been opened, take tissue specimens for virology, bacteriology and toxicology first, then sample for histopathology.**
5. Samples of **normal and abnormal** tissue should be collected for laboratory analyses.

The ability to obtain reliable data from necropsies depends on the following:
1. Condition and location of the carcass
2. Adherence to detailed protocols
3. Number of seals necropsied throughout the year
4. Amount of time available to perform a thorough necropsy
5. Care in sample preservation and labeling of specimens
6. Care in shipping and storing specimens

Decomposed carcasses may be unsuitable for histopathology but can be useful for observing gross lesions. Collect brain samples regardless of the state of decomposition. Collect samples from all organs listed, even those that appear normal. In general, tissue specimens must be sufficiently thin (**less than 1 cm thick**) to allow proper fixing of 10 parts 10% buffered formalin: 1 part tissue. For some tissues (e.g. brain and lung), you may need to make parallel cuts (0.5 cm in thickness) in the tissues to allow preservation. After the tissues have been fixed in formalin 24-48 hours, pour off the formalin, rinse the tissues in fresh water, and add fresh formalin solution.

NECROPSY INSTRUCTIONS

Complete a **Hawaiian Monk Seal Necropsy Report Form** for **all** carcasses recovered. Use the **full form** if you perform an internal examination of the carcass, regardless of the condition code. The **partial form** can be used for necropsies where very minimal data is collected. Record "N/A" for any sections that are not applicable, and state what organs/tissues were not examined. At a minimum, describe each organ examined and sample as many organs as possible, prioritizing the following tissues: **brain, lung, liver, kidney, blubber.**

Photograph the exterior for ID (even if tagged), to document injuries or other unusual conditions, and to document body condition. Photograph the seal from all 4 sides (dorsal/ventral/left lateral/right lateral) and a close up of the hind flippers with tags. In addition, take close-ups and a wider view (to show perspective) of injuries and unusual conditions. If possible, include an index card in each frame that notes the following: Seal ID, Date, Size, Sex, and island and a ruler. Record photographs on the Necropsy Report Form.

Complete **survival factor form** and **tag handling card** for each carcass.

External examination

Document any specific external lesions, abnormalities, or scar patterns. Examine, describe, and photograph any external lesions or injuries, the anogenital area, scars and other distinguishing characteristics.

Experience has shown that in cases where pinnipeds have drowned, there is often a complete absence of expected gross and histological findings. For this reason, it is imperative to look closely for external indications of entanglement. Findings may include: bent or missing vibrissae, torn or missing nails, and cuts in and around the nares, mouth, and gums. Closely examine the tips of all extremities to look for line or net cuts. Linear marks on the pelage are also of interest. Photograph any suspected abnormalities with close up/macro images, followed by images that demonstrate the location(s) on the body of each close up image.

Carcass condition codes

Evaluate carcass condition (state of decomposition). Carcass condition is influenced by many factors including disease, body temperature, and environmental temperature. ***Rigor mortis*** (stiffening of the body following death) may serve as an indicator of carcass evaluation. It can occur within hours in warm weather, but is extremely variable. *Rigor mortis* indicates that a carcass may be in good condition (Code 2).

Code 1: just died (*e.g*., euthanasia)

Code 2: fresh/carcass in good condition (rigor mortis, fresh smell, normal appearance, minimal drying of skin and mucous membranes, eyes clear, carcass not bloated, muscles and blubber firm, viscera intact and well-defined, guts with no gas). NOTE: Rigor mortis (stiffening of the body following death) may serve as an indicator of carcass evaluation. It can occur within hours in warm weather, but is extremely variable. Rigor mortis indicates that a carcass may be in good condition

Code 3: fair/decomposed (carcass and organs intact, bloating, skin sloughing, mild odor, eyes sunken, dried mucous membranes, friable viscera, blubber oily, muscles soft but still intact, gut dilated with gas)

Code 4: poor/advanced decomposition (carcass may be intact but collapsed, skin sloughing, strong odor, blubber soft with pockets of gas, liquified organs, blood thin and black, viscera friable difficult to dissect and easily torn, gut filled with gas)

Code 5: mummified/skeletal remains (skin draped around bones, remaining tissues desiccated)

Tags

If flipper tags are present, note their condition on the survey form (data type ‘T’) and tag condition forms. Collect and place them in a whirlpak bag labeled with animal ID, island/atoll, date, and survival factor number. Scan the entire body for PIT tags by holding the PIT tag reader as close to the body as possible. Even if PIT tags are not found, indicate on the survey sheet that a scan was completed and where on the body the scan was performed.

Morphometric measurements

Axillary girth – At the armpit, measure the circumference around the entire body in centimeters.

Standard length – Measure the straight line (not curved) length of the entire seal from the tip of the nose to the tip of the tail in centimeters. If a scale is available, weigh the body and report units. **Record measurements on both the TAGGING/HANDLING CARD and the Necropsy Report Form.**

Swab Collection

Use sterile Dacron swabs. Avoid touching swab tip to anything other than the tissue being swabbed. Immediately place swab in cryovial and break off the end of the plastic applicator against the side of the cryovial container (it should snap easily).

Internal Examination

TAKE INTERNAL PHOTOGRAPHS ONLY WHEN UNUSUAL CONDITIONS ARE NOTED OR IF YOU ARE UNSURE IF IT IS UNUSUAL. If unusual conditions are noted, include a size reference (*e.g.,* ruler) and label with seal ID, survival factor number, date, and island. Take two photographs, one with the organ *in situ* (in its anatomical position/location) in the body and one with the organ removed from the body and placed on a solid white or light blue surface.

Record complete and thorough observations. Assume more is better when describing and recording information. The rule here is if in doubt, write it down. If unsure whether something is abnormal, state this and succinctly describe. Descriptions should be clear, concise, and without personal interpretation. Appropriate tissue preservation along with YOUR precise description of findings may allow the identification of causes of death in the population.

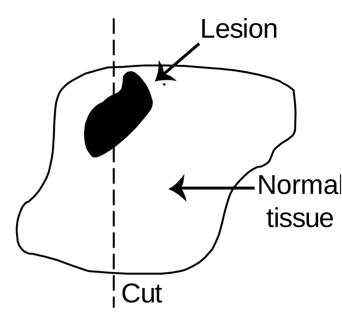
Identify the appropriate descriptors for each organ examined. The descriptions provided herein are NOT an exhaustive list of terms, but rather a list for your reference. **Describe surface, consistency, color, and cut surface of both normal tissues and abnormalities or lesions.**

Descriptors of Organs and Lesions

Surface:	Smooth, rough, shiny, dull, thickened, wrinkled.
Consistency:	Firm, soft, flabby, dry, wet, fluid-filled, sharp-edged, friable (easily pulverized or crumbled).
Color:	Transparent, translucent, opaque; white, cream, green, yellow, brown, pink, red, nutmeg (normal pattern of liver), etc. Use simple colors, do not get complicated. Also comment how color is spread through tissue- homogeneous, speckled, streaked, blotchy, blanched, mottled (i.e., pink with specks of red). Additional descriptors may include bright, pale, dark.
Cut surface:	Slice organ several times appropriately and spread apart to look at internal surface. Be sure to describe color of the cut surface. Descriptors include swollen, bulging, shiny, dull, eroded, glistening, scaly, pitted, oozing
Size:	Record in metric system (mm, cm), measure length, width and depth or diameter of the lesion. Enlarged, (hypertrophied), small (atrophied), normal size.
Shape:	Square, rectangular, triangular, oval, round, cuboidal, spherical, discoid, rhomboid, tear-shaped, wedge-shaped, spindle-shaped, irregular, long, slender, indented, narrow, lace-like, tortuous, branching, speckled (miliary), flat, raised, depressed, shrunken, papillary, cauliflower-like.
Distribution:	Single discrete lesion (focal), multiple lesions in one location (multifocal), or multiple lesions scattered diffusely throughout the organ or body cavity (diffuse); locally extensive, random, even.
Location:	Surface, capsule, wall, dorsal or ventral, caudal or cranial, anterior or posterior, medial or lateral, proximal or distal, internal or external, full or partial thickness of a wall of an organ.
Fluid:	Clear, cloudy, turbid, thick, thin, bloody, muciod, exudate, dark, tarry
Consistency:	Spongy, granular, gel-like, firm, soft, hard, rock-hard, dense, creamy, buttery, brittle, lumpy, velvety, warty, tenacious, gritty.
Cut surface:	Bulging, engorged, granular, nodular, pitted, oozing
Odor:	None, sweet, sour, rancid, ammonia-like, putrid, fruity, petroleum- like

Collecting necropsy tissues

Each complete necropsy should have two jars containing complete tissue sets of all tissues, and both having the same specimen number. One set should be sub# A and the other sub# B. Tissue set A should be the most complete set, (*e.g.,* if you freeze one eye, tissue set A should have the formalin fixed eye). If there are any unusual lesions in any of the tissues sampled, be sure to include the margin between abnormal and normal tissue in both tissue sets A and B.



Collect samples of ALL LESIONS in formalin. Describe and sample areas that appear to stand out in marked contrast to the main body of tissue. Samples should include the margins between the normal and abnormal tissue and a description (*i.e.*, sharp line versus vague and gradual, circumscribed, encapsulated). Make sure to check the boxes next to the appropriate specimens as collected on the necropsy report form.

Tissues for Toxicology (contaminants and biotoxins): Code 1, 2 ideal. Codes 3, 4, 5 useless.

Toxicological analyses may be performed for heavy metals, organochlorides, selenium, and dioxin. When sampling for toxicology, it is important to use standardized sampling procedures so that even when low levels of contaminants are present, differences may be attributed to biological processes and contaminant exposure and not to variation in the collection process.

For MHI necropsies, follow NIST sample collection protocol to collect toxicology specimens (this has been incorporated into the MHI necropsy form).

Tissues for Microbiology: Code 1 ideal; Codes 2, 3 limited; Codes 4, 5 useless

Tissues for Toxoplasmosis diagnostics: All Carcass codes. Collect brain (quarter size) into whirlpack and cover with antibiotic saline solution. The tissue must be REFRIDERATED and sent to UC Davis asap.
Codes 3-4. Collect any bodily fluids and freeze. Send to UC Davis

Collect by special request only. Specimen collection for bacteriology and virology is determined primarily by the nature of gross pathologic lesions. Samples should be taken aseptically, from external surfaces, body cavities and internal organs as soon as they are exposed. Place swabs in respective transport media and refrigerate at 4 C or place on blue ice immediately and freeze upon arrival to laboratory or field camp. If cryovials are available, ultrafreeze the swabs with tissue samples in liquid nitrogen. Samples for microbiology are worth the time and effort only when tissues are in suitable condition. With an "aborted fetus", perinatal death, or newborn in main Hawaiian Islands (MHI), collect specimens according to "Fetus" section of MHI Necropsy Form and refrigerate for microbial analysis.

Post Necropsy

1. Review the completed **Necropsy Report Form**, making sure that all boxes have been checked off on the form for all samples collected.
2. Necropsy Report Forms, photos, “List of Specimens Collected”, and any other pertinent data should be returned to the NMFS PIFSC Honolulu Laboratory.
3. Refer to the section “Preventing Disease Transmission” #4-8 on page one for post-necropsy clean-up tips. Clean necropsy tools (you may also need to spray them with WD-40 or LPS) and restock necropsy kit so that it is ready for the next necropsy.
4. Change the formalin for all formalin fixed tissues as noted above.
5. Make sure that the tagging/handling card, and tag condition drawing forms are complete. **Necropsy Report Forms** tagging/handling cards, survival factor forms, and photos should be returned to the NMFS Honolulu Laboratory.
6. Record specimens collected on the **Specimen Collection Summary** and assign specimen numbers as outlined in the **Specimen Collection Protocol**.
7. Clean necropsy tools. Before disinfecting, remove all organic matter from instruments by washing them thoroughly with warm (if possible) soapy water. If instruments are not cleaned properly before disinfecting, the remaining organic matter may shield organisms from destruction, and may inactivate the disinfectant. Be sure to wear proper protective gear (gloves, masks, etc.) when washing instruments. To minimize aerosolization, keep instruments below the water line when washing. Disinfect instruments with Rescue hydrogen peroxide solution for at least 5 minutes. Be sure to thoroughly rinse instruments with fresh water after disinfecting. Air dry all instruments thoroughly before putting them away. You may also need to spray them with WD-40 (or LPS)
8. Restock necropsy kit so that it is ready for the next necropsy.

References

Arnemo Jon M, Ahlqvist Per, Andersen Roy, Berntsen Finn, Ericsson Göran, Odden John, Brunberg Sven, Segerström Peter, and Swenson Jon E. "Risk of Capture-related Mortality in Large Free-ranging Mammals: Experiences from Scandinavia." Wildlife Biology 12.1 (2006): 109-13. Web.

Baylis, A. M., Page, B., Staniland, I., Arnould, J. P. and McKenzie, J. (2015), Taking the sting out of darting: Risks, restraint drugs and procedures for the chemical restraint of Southern Hemisphere otariids. Marine Mammal Science, 31: 322-344. doi:10.1111/mms.12148

Champagne, Cory D., Houser, Dorian S., Costa, Daniel P., & Crocker, Daniel E. (2012). The Effects of Handling and Anesthetic Agents on the Stress Response and Carbohydrate Metabolism in Northern Elephant Seals. *PLoS ONE, 7*(5), E38442.

Crockford, J., Hayes, F., Jenkins, J., & Feurt, S. (1957). Nicotine Salicylate for Capturing Deer. *The Journal of Wildlife Management, 21*(2), 213-220. doi:10.2307/3797587

Dierauf, L. A., Gulland, F. M., and Whitman, K. L. (2018). CRC *handbook of marine mammal medicine (*3rd ed.). Boca Raton: Taylor and Francis.

Higgins, D. P., Rogers, T. L., Irvine, A. D. and Hall-Aspland, S. A. (2002), USE OF MIDAZOLAM/PETHIDINE AND TILETAMINE/ZOLAZEPAM COMBINATIONS FOR THE CHEMICAL RESTRAINT OF LEOPARD SEALS (*HYDRURGA LEPTONYX*). Marine Mammal Science, 18: 483-499. doi:10.1111/j.1748-7692.2002.tb01050.x

Hooker, Sascha K., Baird, Robin W., Al-Omari, Sa'ad, Gowans, Shannon, & Whitehead, Hal. (2001). Behavioral reactions of northern bottlenose whales (Hyperoodon ampullatus) to biopsy darting and tag attachment procedures.(Statistical Data Included). *Fishery Bulletin*, *99*(2), 303-308.

Kreeger, Terry J. “Analyses of Immobilizing Dart Characteristics.” *Wildlife Society Bulletin (1973-2006)*, vol. 30, no. 3, 2002, pp. 968–970. *JSTOR*, JSTOR, www.jstor.org/stable/3784255.

Kreeger, Terry J., and Arnemo, Jon M. *Handbook of Wildlife Chemical Immobilization*. 4th ed., International Wildlife Veterinary Services, 2012

Lynch, M. , Tahmindjis, M. and Gardner, H. (1999), Immobilisation of pinniped species. Australian Veterinary Journal, 77: 181-185. doi:10.1111/j.1751-0813.1999.tb11231.x

McKenzie, J. , Page, B. , Goldsworthy, S. D. and Hindell, M. A. (2013), Behavioral responses of New Zealand fur seals (*Arctophoca australis forsteri*) to darting and the effectiveness of midazolam and tiletamine-zolazepam for remote chemical immobilization. Marine Mammal Science, 29: 241-260. doi:10.1111/j.1748-7692.2011.00553.x

McGregor, H., Hampton, J., Lisle, D., & Legge, S. (2016). Live-capture of feral cats using tracking dogs and darting, with comparisons to leg-hold trapping. *Wildlife Research*,*43*(4), 313-322.

Pussini, N. and Goebel, M. E. (2015), A safer protocol for field immobilization of leopard seals (*Hydrurga leptonyx*). Marine Mammal Science, 31: 1549-1558. doi:10.1111/mms.12232

Plumb, D. C. (2008). *Plumb's veterinary drug handbook* (6th ed.). Stockholm, WI: PharmaVet.

Table 1. Brief review of drugs commonly used in pinniped sedation

Class	Name	Effect/uses	Dangers	Additional Information	Species used
Benzodiazepine: excellent muscle relaxants commonly used in conjunction with cyclohexanes, commonly have antagonist	Diazepam	muscle relaxant, anticonvulsant, appetite stimulant	Sedation and ataxia, CNS excitement (dogs), hepatic failure or behavior changes (felines), muscle fasciculations (horses), possibly teratogenic	Can be administered orally, rectally, or intravenously (IV), see Flumazenil or sarmazenil for antagonist information	Antarctic fur seal
	Midazolam	Depresses central nervous system (CNS) to produce anxiolytic, sedative, skeletal muscle relaxant, and anticonvulsant effects	Respiratory depression, possibly teratogenic	When used alone has no predictable sedation effect, 3x as potent as diazepam and can be given intramuscularly (IM), IV, intra-carotid injection must be avoided, Flumazenil or sarmazenil given as reversal	South American fur seal, New Zealand fur seal, Antarctic fur seal, Australian fur seal, California sea lion, Stellar sea lion, Grey seal
Alpha-Adrenoreceptor Agonists: strong sedatives that can be completely antagonized, animal can be aroused while under	Xylazine	Produces state of sedation with a shorter period of analgesia, causes CNS depression, skeletal muscle relaxation, in high doses can cause respiratory depression	Can have an emetic effect, possibly may induce premature parturition, auditory stimuli can provoke delayed arousal responses, although analgesic effects are short lived (up to 30 min) complete recovery can take up to four hours), muscle tremors, bradycardia, reduced respiratory rate, increased urination, hypersalivation, ataxia	Should not be used with epinephrine, can be given IM or IV, respiratory stimulants (doxapram) can aid in alleviating respiratory depression affect, reversal agents include Yohimbine, atipamezole, and tolazoline	Antarctic fur seal, South African fur seal, Subantaric fur seal, Galapagos sea lion
	Medetomidine	Used as a sedative for dogs and cats, small mammals, and exotics for procedures not requiring intubation or minor dental procedures	Bradycardia, occasional AV blocks, decreased respiration, urination, vomiting, hyperglycemia, rarely: apnea and death from circulatory failure, hypersensitivity	Should not be used during pregnancy, is not a muscle relaxant but does have large safety margin (at least for dogs), can be antagonized by Yohimbine, tolazoline, idazoxan, atipamezole	California sea lion, Stellar sea lion, Grey seal

	Dexmedetomidine	can be used for preanesthetic and sedation, analgesia	bradycardia, occasional AV blocks, decreased respiration, vomiting	Can be reversed with atipamezole, when given to dogs dosage is based upon surface area and not body weight, be administered either IM or IV, high safety margin, has not been tested with wildlife	Grey seal
Class	Name	Effect/uses	Dangers	Additional Information	Species Used
Cyclohexane: produce cataleptic state in which eyes remain open, used in conjunction with tranquilizers or sedatives to reduce risk of seizures	Ketamine	Inhibits NMDA-receptors so can be used to alleviate pain along with its anesthetic effects	can result in significant hypertension, hypersalivation, respiratory depression, emesis, erratic and prolonged recovery, dyspnea, spastic jerking movements, seizures, muscle tremors, hypertonicity, opisthotonos and cardiac arrest	Patients eyes will sometimes remain open, administered either IM or IV and has fairly rapid diffusion time, duration positively correlated with dosage amount but not intensity, should not be used alone because of its poor muscle relaxant qualities	South American fur seal, Antarctic fur seal, Galapagos fur seal, South African fur seal, Subantarctic fur seal, Galapagos sea lion,
	Tiletamine/Zolazepam	Used for restraint or anesthesia with muscle relaxation in short procedures, decreases both cardiac and blood pressure	Respiratory depression possible, apnea, tachycardia common, excessive salivation, cardiac arrest, muscle rigidity	Administration can be IM, subcutaneous (SQ) or IV and has very rapid onset, effect on respiration is unknown, long recovery time (up to four hours)	South American fur seal, New Zealand fur seal, Antarctic fur seal, Australian fur seal, Stellar sea lion, Australian sea lion, American sea lion, *New Zealand sea lion
Antagonist/ reversal agents: used to antagonize anesthesia and help animal return to normal faster than would	Tolazoline	Used to reverse xylazine by relaxing smooth muscle	Adverse effects have been primarily studied in horses and found to be tachycardia, peripheral vasodilatation, piloerection, and muscle fasciculations	Very rapid acting with IV administration but may require multiple doses due to short duration	

otherwise be seen, usually very safe	Atipamezole	Can be used to antagonize xylazine and medetomidine	Vomiting, diarrhea, hypersalivation, tremors, or excitation	Is very fast acting and capable of reversing drug effects fairly rapidly, very high safety margin	
	Flumazenil	Can be used to reverse benzodiazepine such as diazepam and midazolam	Prolonged exposure or use can lead to seizures, in humans injection site sensitivity. vomiting, vertigo, vasodilatation, ataxia and blurred vision have all been demonstrated	Potentially teratogenic at high dosages	
	Doxapram	CNS stimulant used to stimulate respiration during or after anesthesia as well as to speed up awakening and reflexes after anesthesia	Possibly linked with seizures, hypertension, arrhythmia, respiratory alkalosis	Has a narrow safety margin in humans, and increases myocardial oxygen demand while reducing cerebral blood flow	

Table 2. Basic checklist of equipment required for darting operation

Medical Equipment	**Darting Equipment**
Sedation, reversal, and euthanasia drug kit	Dart projector
Emergency crash kit	Projector maintenance materials such as cleaning rod and spare parts
Monitoring kit	Spare cartridges/charges
Wound care kit	Darts that vary in needle size, body, collar, and type
Biomedical sampling supplies	Transmitter receiver (if applicable)

Standard veterinarian care kit	Pole syringe
	Range finder
Additional Equipment	Metal detector
In-water capture materials	Multiple pairs of optics
Containment materials such as crowding boards	
Data Sheets	
Camera	
Video camera/GoPro	
Personal Protective Equipment	
Seal handling and capture kit	
VHF radios	