# Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

| | |
|---|---|
| Action Agency: | United States Army Corp of Engineers, Honolulu District Regulatory Branch |
| Federal Action: | Authorization to Install New Net Pens and Ongoing, Revised Mariculture Operations by Blue Ocean Mariculture, LLC |
| Consultation Conducted by: | National Marine Fisheries Service, Pacific Islands Region, Protected Resources Division |
| NMFS File No. (PCTS and ECO): | PIR-2018-10334, PIRO-2018-00437 |
| PIRO Reference No.: | I-PI-18-1620-DG |
| Approved By: | MALLOY.SARAH.JOAN.1262526743 Digitally signed by MALLOY.SARAH.JOAN.1262526743 Date: 2022.08.11 06:47:08 -10'00'<br>Sarah Malloy<br>Acting Regional Administrator, Pacific Islands Region |
| Date Issued: | August 11, 2022 |

# Contents

1. INTRODUCTION 5
1.1. Consultation History ... 6
2. Description of the Proposed Action 8
2.1. Net Installation ... 9
2.2. Mariculture Operations ... 11
2.2.1. Feeding ... 12
2.2.2. Mortality Removal ... 12
2.2.3. Treatment ... 13
2.2.4. Harvesting ... 13
2.2.5. Net Drying ... 14
2.2.6. Inspections ... 14
Equipment Used to Support the Proposed Action ... 14
3. Approach to the Assessment 15
3.1. Overview of NMFS Assessment Framework ... 15
3.1.1. Jeopardy Analyses ... 16
3.2. Application of this Approach in this Consultation ... 19
3.2.1. Action Area ... 19
3.2.2. Approach to Evaluating Effects ... 21
3.2.3. Climate Change ... 22
3.2.4. Evidence Available for this Consultation ... 23
4. Status of Listed Resources 25
4.1. Species and Critical Habitat Not Considered Further ... 26
4.1.1. Hawaiian Monk Seals ... 26
4.1.2. Distribution and Population Structure ... 26
4.1.3. Status and Trends ... 28
4.1.4. Population Dynamics ... 29
4.1.5. Feeding Behavior ... 30
4.1.6. Threats to the Species ... 32
Food Limitation ... 32
Shark Predation ... 33

Male Aggression ....................................................34
Infectious Disease....................................................34
Habitat Loss ....................................................35
Marine Debris ....................................................35
Fishery Interactions ....................................................36
Intentional Killings ....................................................37
4.1.7. Conservation ....................................................37
5. Environmental Baseline 38
5.1 Surface Vessel Traffic and Noise ....................................................39
5.2 Previous Mariculture Operations ....................................................40
5.3 Changing Global Climate ....................................................41
5.4 Contaminants and Infectious Disease ....................................................43
5.5 Synthesis of the Environmental Baseline ....................................................43
6. Effects of the Action 44
6.1. Exposure ....................................................45
6.1.1. Spatial and Temporal Patterns of Exposure ....................................................45
6.1.2. Demographic Patterns of Exposure ....................................................46
6.1.3. Attraction to Net Pens ....................................................48
Pelleted food (intended for the farm fish) washing outside of the net pens ....................................................48
Farm fish escapes from the net pens ....................................................49
Increased aggregation of marine life ....................................................49
Feeding on farm fish through the net pen mesh ....................................................49
6.2. Response ....................................................50
6.2.1. Shift in monk seal haulout behavior ....................................................50
Alternate reasons for this shift in haulout behavior ....................................................61
6.2.2. Shift in monk seal feeding habits ....................................................64
Health Complications ....................................................65
Alternate reasons for the size of RW34 ....................................................69
Beneficial Effects of Potential Feeding ....................................................70
Harmful effects ....................................................71
Human-seal interactions ....................................................71
6.2.3. Entrapment in Net Pens ....................................................72

7. Cumulative effects 74
8. Integration and Synthesis 74
Attraction of Hawaiian monk seal to the net pen area ........76
Access to atypical food source ........76
Net Pen Entrapment ........78
9. Conclusion 78
10. Incidental take statement 79
10.1. MMPA Authorization ........79
10.2. Amount or Extent of Take ........79
10.3. Reasonable and Prudent Measures ........80
10.4. Terms and Conditions ........80
10.5 Conservation Recommendations ........82
11. Reinitiation Notice 82
12. Literature Cited 83
Appendix A: Listed Resources AND STRESSORS Not Considered Further 94
1. Wastes, discharges, or decreased water quality ........94
2. Direct Physical Impacts ........95
3. Vessel Strikes ........96
4. Entanglement with Lines or Netting ........98
5. Shift in Feeding Habits ........98
6. Attraction of Predators to the Area ........99
7. Disturbance from Human Activity or Equipment Operation ........100
8. Entrapment in Nets ........101
1. Addition of Man-made Structure in the Action Area ........102
2. Critical Habitat ........102
MHI IFKW ........102
Hawaiian Monk Seal Critical Habitat ........104
Appendix B: BLUE OCEAN MARICULTURE, HAWAIIAN MONK SEAL NET PEN REMOVAL PROTOCOL 105
Appendix C: CAMERA OPERATION AND COORDINATION PROTOCOL 109

# 1. INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1536(a)(2)) requires each federal agency to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species or its designated critical habitat, that agency is required to consult formally with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR 402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species or their designated critical habitat, and NMFS or the FWS concur with that conclusion (50 CFR 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, in accordance with the ESA Subsection 7(b)(3)(A), NMFS provides a reasonable and prudent alternative that allows 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 to minimize such impacts and terms and conditions to implement the reasonable and prudent measures. NMFS, by regulation has determined that an ITS must be prepared when take is "reasonably certain to occur" as a result of the proposed action. 50 C.F.R. 402.14(g)(7).

"Take" is defined by the ESA as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, any threatened or endangered species, or to attempt to engage in any such conduct. NMFS defines "harass" as to "create 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" (Wieting 2016). NMFS defines "harm" as "an act which actually kills or injures fish or wildlife." Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Take of species listed as endangered is prohibited at the time of listing, while take of threatened species may not be specifically prohibited unless NMFS has issued regulations prohibiting take under section 4(d) of the ESA.

For the actions described in this document, the action agency is the US Army Corps of Engineers (USACE). The USACE proposes to issue a permit pursuant to their authority under section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) authorizing the installation of new net pens and ongoing mariculture operations by the applicant, Blue Ocean Mariculture LLC. The consulting agency for this proposal is NMFS' Pacific Islands Regional Office, Protected Resources Division. This document represents NMFS' final biological opinion on the effects of the proposed action on endangered and threatened species and designated critical habitat. This biological opinion has been prepared in accordance with the requirements of section 7 of the

ESA, implementing regulations (50 CFR 402), agency policy, and guidance. It is based on information contained in the Army Corp of Engineers' 2018 biological evaluation (BE) on the installation of new net pens and ongoing mariculture operations by Blue Ocean Mariculture, LLC (USACE 2018), NMFS marine mammal stock assessment report (Caretta et al. 2020), *Main Hawaiian Islands Monk Seal Management Plan* (NMFS 2016a, the *Hawaiian Monk Seal Recovery Plan* (NMFS 2007), and the *Population Summary for Hawaiian Monk Seals* (NMFS 2019 and 2020a).

On July 5, 2022, the United States District Court for the Northern District of California issued an order vacating the 2019 regulations adopting changes to 50 CFR part 402 (84 FR 44976, August 27, 2019). This consultation was initiated when the 2019 regulations were still in effect. As reflected in this document, we are now applying the section 7 regulations that governed prior to adoption of the 2019 regulations. For purposes of this consultation, we considered whether the substantive analysis and its conclusions regarding the effects of the proposed actions articulated in the biological opinion and incidental take statement would be any different under the 2019 regulations. We have determined that our analysis and conclusions would not be any different.

### 1.1. Consultation History

Blue Ocean Mariculture is operating under the authority of a section 10 River and Harbors Act permit issued by the USACE and a National Pollutant Discharge Elimination System (NPDES) permit issued by the Environmental Protection Agency. ESA consultation for the first proposed mariculture operation was completed with USACE on November 4, 2003 (POH-2003-00-222, PIRO: I-PI-03-302-MMD). The Environmental Protection Agency did not consult with NMFS regarding the NPDES permit.

The most recent ESA consultation was on March 13, 2015 with USACE to accommodate changes in the applicant's Conservation District Use Permit to replace and expand the existing net pen grid system (NMFS PCTS: PIR-2015-9588, PIRO: I-PI-15-1242-AG). NMFS concurred with the USACE's and NMFS Federal Programs Office's determinations of not likely to adversely affect for green sea turtle, hawksbill sea turtle, humpback whale, Hawaiian monk seal and Hawaiian monk seal critical habitat, the Main Hawaiian Islands insular false killer whale (MHI IFKW), and MHI IFKW proposed critical habitat.

On March 5, 2017, NMFS was notified by the applicant, Blue Ocean Mariculture, that a deceased Hawaiian monk seal was found in an empty, recently retired, net pen on the farm site. On March 14, 2017, NMFS personnel visited the Blue Ocean Mariculture site to observe, inquire, and photo document the mariculture operations including the underwater net pen array where Blue Ocean crew were conducting their daily activities.

NMFS received a letter on July 31, 2017, from the USACE and Blue Ocean Mariculture providing requested information relating to the March 5$^{th}$ Hawaiian monk seal incident. In addition, the letter outlined corrective actions developed by the applicant described in the proposed action below.

On September 7, 2017, NMFS received a request from the USACE to reinitiate section 7 consultation. NMFS informed the USACE via email on September 19, 2017 that the species list was too broad and did not include information regarding what species the proposed activities were likely to adversely affect, or not likely to adversely affect.

On October 19, 2017, NMFS sent an initiation clarification letter to request the USACE to provide: 1) a description of the action being considered; 2) a description of the manner in which the action may affect any listed species or critical habitat, and an analysis of any cumulative effects; and 3) relevant reports, including any environmental impact statement, environmental assessment, or BE prepared.

On April 10, 2018, USACE resubmitted their request to reinitiate the consultation with a BE that included the information requested by NMFS in the letter sent on October 19, 2017. Consistent with 50 CFR 402.16, USACE requested a reinitiated consultation because the Blue Ocean Mariculture operations met two reinitiation triggers: 1) new information revealed effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; and 2) new species were listed and critical habitat designated that may be affected by the identified action. USACE determined, the proposed action would not likely adversely affect the following ESA-listed species: green sea turtle, Central North Pacific, hawksbill sea turtle, false killer whale Main Hawaiian Islands insular, oceanic whitetip shark, giant manta ray, Hawaiian monk seal critical habitat, and false killer whale Main Hawaiian Islands insular critical habitat. The USACE determined the proposed action would likely adversely affect Hawaiian monk seals.

On July 10, 2018, NMFS personnel visited the site to gather additional information to assess entanglement risks to Hawaiian monk seals.

On September 28, 2018, NMFS personnel emailed USACE to inform them that the BE and the protected species monitoring reports submitted by the applicant, Blue Ocean Mariculture, revealed an unusually large number of Hawaiian monk seal sightings at the net pen over the last few years. This constituted an effect not previously considered.

On May 24, 2019, NMFS personnel emailed USACE to inform them they had the following new information to consider in the analysis: an unusually large female monk seal that is known to visit the net pens and has been unsuccessful in weaning a pup in the last three years, a heat map analysis indicating a change in monk seal haul out behavior, and pictures from concerned citizens of monk seals on top of net pens that are raised in a semi-submerged position.

On July 29, 2019, NMFS personnel visited the site to gather additional information and discuss the potential attraction of Hawaiian monk seals to the net pen site and concerns for the potential changes in haul out behavior.

On March 3, 2020, Blue Ocean Mariculture reported a fish escape when their dive team discovered 50 - 100 Hawaiian Kampachi outside of one of the cages during their daily inspection. The fish escaped through a 5in x 3in hole which was created in the top woven hexagonal mesh made of Polyethylene Terephthalate monofilaments (Kikkonet) of cage 4.

On March 24, 2021, Blue Ocean Mariculture, reported a monk seal, believed to be R8HE, swimming inside a fully raised net pen. The seal was observed swimming freely and unhindered inside of a retired pen that had recently had its inventory of fish transferred. On March 31, the USACE provided NMFS with an incident report from Blue Ocean Mariculture describing a beach ball-sized hole in the copper alloy mesh mid panel on the north side of the net pen, a hole the seal created and entered to access the pen. The report documents that Blue Ocean Mariculture employees opened a portal on the west side of the net pen and entered the water to facilitate the seals' exit. The seal swam around the newly opened portal but did not swim out, but eventually swam out of the hole it created to enter the pen.

On May 25, 2021, the USACE provided updated standard operating protocols for their Unwanted Animal Procedure for NMFS' review and in July 2021, USACE finalized them and we initiated consultation.

## 2. DESCRIPTION OF THE PROPOSED ACTION

The action on which we are consulting is the USACE's 2015 permit authorizing the construction of an eight pen array, pursuant to its authority under section 10 of the Rivers and Harbors Act, and the ongoing mariculture operations by the applicant, Blue Ocean Mariculture, in navigable waters off Unualoha Point on Hawaii Island. We expect operations to continue into the foreseeable future. We consider the term "foreseeable future" to describe the extent to which we can reasonably rely on predictions about the future in making determinations about the future conservation status of the species. Because of the uncertainty of future conditions and information, we assume that we can only rely on our assessments and assumptions for approximately the next 10 years. We have assessed the effects of the action accordingly.

The USACE permit authorizes the installation of the net pens and ongoing mariculture operations by the applicant, Blue Ocean Mariculture. No further USACE permit actions are required unless the applicant modifies the design of the net pens from what the USACE has previously authorized. Each net pen (Figure 1) is 8,000 cubic meters ($m^3$) and submerged in waters 61-meters (m) deep. When submerged, the net pens sit 8 m deep within the water column, and the distance to the seafloor is greater than 20 m. The Blue Ocean Mariculture operates anchored, submerged net pens to raise Hawaiian Kampachi, fish also known as kahala (*Seriola rivoliana*). Fertilized eggs from local broodstock are reared in tanks located on Blue Ocean's land facility. Once fry are large enough, they are transferred into the ocean net pens where they grow-out to market size which is approximately 3-5 pounds. Once ideal harvest size is achieved, the fish are removed from the net pens and taken to shore to be distributed.

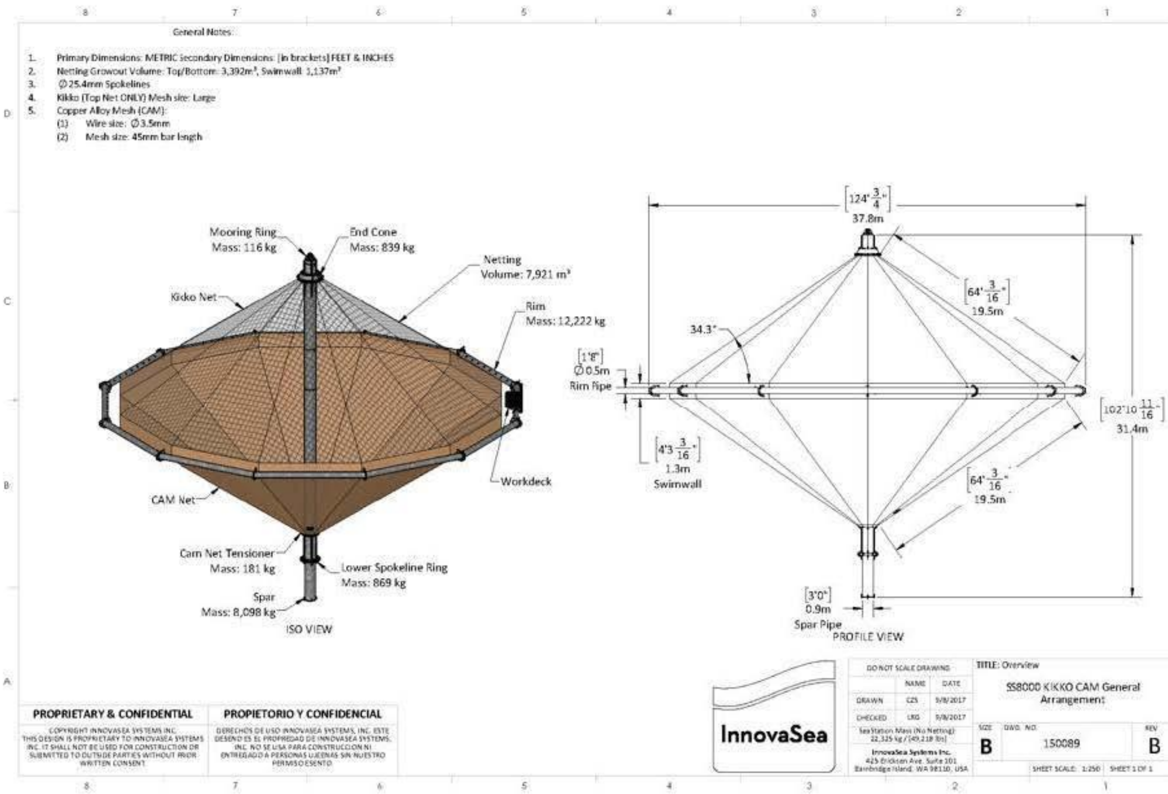


Figure 1 Kikko/Cam SeaStation 8000 (USACE 2018).

### 2.1. Net Installation

The net pen array is arranged in a 3x3 grid with eight pens around the perimeter and a vacant space in the middle. As demonstrated in Figure 2 below, the footprint of the net pen array is 5.76 hectares. All bottom anchoring elements are in place.

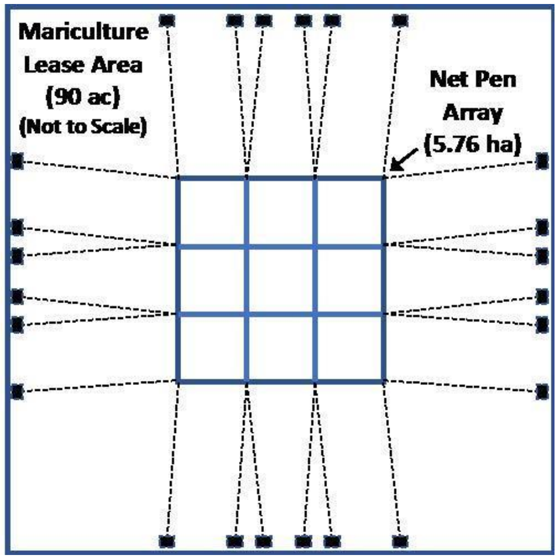


Figure 2. Net Pen array (USACE, 2018)

The process to install a net pen begins with a two-week onshore period during which the spar and netting are assembled, and the netting is bundled closely to the spar. The spar/net assembly is towed into the designated grid cell, where the spar is righted and secured to the grid system. The net pen rim is then towed into position over the spar/net bundle, connected to the spar with 24 spokelines and tensioned to specific loads. Finally, the net is unbundled and secured to the net pen frame. The offshore portion of the installation typically takes 3-5 working days with further minor tensioning occurring over the following 2-3 weeks.

The pens are constructed with both Kikkonet and copper alloy mesh (CAM) (Figure 1). According to Blue Ocean Mariculture, the anti-microbial properties of the CAM prohibit biofouling. As noted in USACE's 2018 BE, as a result of a deceased Hawaiian monk seal found in an empty, recently retired, net pen on the farm site, Blue Ocean Mariculture has incorporated the following revised protocols and crew retraining into their proposed action.

**Protocol Modification**. During installation or removal, a net pen shall be surfaced at all times to allow marine mammals to easily reach air at the surface. The applicant will also open the 6 x 10-foot portal and lower cage to allow the bottom of the portal to allow the animal to find and leave through the lowered portal. If seal does not exit through the portal after 30 minutes, the applicant will remove the top 15 feet of 4 upper panels to create a 32 x 15-foot exit at the top of the cage, The pen will then be lowered to a 15 ft. air gap with the bottom of the opening below the waterline. This partial submersion of the cage will confine the space that the animal has for surface breathing increasing the likelihood of the animal leaving the cage. If the animal is unable to leave the pen before 4pm, the pen will be lifted all the way up with the rim at the surface allowing for the animal to have access to the surface from anywhere in the pen..

**Crew Retraining**. No empty net pen shall be left unattended with an opening in the netting, regardless of the opening's size.

Although the net pens are fully enclosed and routinely positioned in a submerged state, cage installation procedures require that no partially assembled or disassembled cage be left unattended in a submerged state. Procedures also require that top netting is removed first during net pen removal. These procedures will ensure that any monk seal entering a cage during the installation or removal period will always have direct access to the surface.

In addition, as a result of a breach by a Hawaiian monk seal in a recently retired net pen on March 24, 2021, Blue Ocean Mariculture has incorporated the following measures to ensure the strength of the net pen.

**Stronger Net Pen Mesh**. The net pens are comprised of thicker, stronger mesh material. In comparison, the width of the mesh in the older pens was 3.0 mm for both the Kikko net on top, and CAM below, while the width of the mesh in the newer pens are 3.7 mm for the Kikko net and 4.0 mm for the CAM. According to Blue Ocean Mariculture, this adds to approximately 75% more mass, which will greatly decrease the likelihood that a seal or other animal could bite or break and push through the mesh and enter the pen.

**Net Pen Quality Control**. The strength of the netting material, determined by net mesh size, is essential to contain farmed fish as well as to keep predators from entering the pen. Therefore, to monitor the strength of the net pens, the width of the netting materials (Kikkonet and CAM) including the panels at the waterline, and the upper and bottom trapezoids, are measured with calipers each month. Prior to the incident in 2021, the previous threshold for net width was 2.0 mm. Since the netting in each panel is measured randomly and not every piece of netting is measured, Blue Ocean Mariculture expects a range of values within 0.5 mm above and below the actual measurement. The net measurement where the monk seal entered the pen in the 2021 incident was 1.5 mm. Therefore, the threshold for the net width has increased to 2.5 mm. When any netting is measured to be 2.5 mm, the contained fish will be removed and the net pen will be retired. Since Blue Ocean Mariculture expects a range of values within 0.5 mm of each measurement, as a precaution, they have agreed to raise the net pen to create a 15 ft. air gap whenever a mesh net measurement reaches 2.8 mm. Every month the mesh on every panel is measured with calipers including panels at the waterline, and the upper and bottom trapezoids.

**Net Pen Research**. As part of an adaptive management approach in designing the most efficient net pens, each pen has sacrificial thickets (composed of three different alloys of metal pieces attached to the net) that line the cage on all panels. The thickets get pulled every six months for a degradation analysis that informs Blue Ocean Mariculture where on the net pen degradation is happening the most, and how fast each type of alloy degrades.

**Net Pen Retirement**. Given that the attraction of fish in the retired net pen and the weakened, compromised mesh of the pen resulted in the 2021 breach by a monk seal, Blue Ocean Mariculture is working with a manufacturer to design a brand new sweep system that will remove all of the fish in one operation. As a result, once a net pen is retired, all fish will be removed in one day. On the second day, the 12 panels that comprise the top portion of the net pen will be removed. Consequently, it will be a 2-day process as opposed to the current 2-week process, and will shorten the time period wherein a net pen is vulnerable to a predator breach.

### 2.2. Mariculture Operations

Once a net pen is installed and operational, fish are introduced for culturing following the standard mariculture operations as outlined in Table 1. Standard mariculture operations (USACE 2018). below.

Table 1. Standard mariculture operations (USACE 2018).

| - | **Activities** | **Frequency** |
|---|---|---|
| Animal Husbandry | Feeding | Daily or 2-3 times a week |
| - | Mortality Removal/Net Pen Inspection | Daily |
| - | Treatment | As Needed (1-2x monthly) |
| Harvesting | Harvesting | Twice Weekly |
| Maintenance | Net Drying | Weekly |
| - | Inspections on Net Pen Array | Weekly |
| - | Repairs | As Needed |

### 2.2.1. **Feeding**

The feeding schedule in a given net pen changes weekly. Fish are fed in each cage depending on their biomass and growth rate. For example, the newest cohort in the ocean are being fed 2-4 times a day, 7 days of the week whereas the oldest cohort is only being fed 2-3 times a week. Each 30 to 120-minute feed event is monitored by divers or via camera to prevent excess feed from exiting the net pen. Divers communicate with feeders on the boat to adjust feed rates based on the feeding intensity of the fish ball. According to Blue Ocean Mariculture, this process ensures that all fish receive access to food and optimizes overall fish health. Feed is entrained in water and delivered to the submerged net pens from a stationary feed barge through a flexible 3" plastic hose.

Blue Ocean uses dry pellet feed, specifically formulated for warm water marine finfish. Feed composition is approximately 45% protein (primarily high quality fish meal), 25% lipids (e.g., fish oil), and 30% carbohydrates (e.g., wheat, corn gluten meal). Vitamins and minerals are supplemented for optimal fish health. No hormones are added, and feed production is quality controlled for PCBs, mercury, melamine and other adulterants. Blue Ocean requires its feed suppliers to monitor their feed products for a variety of adulterant, including PCBs, mercury, and melamine. Blue Ocean's feed supplier is certified to be free of these contaminants under the Global Aquaculture Alliance Best Aquaculture Practices and Global Good Aquaculture Practices programs. Blue Ocean is certified by the Aquaculture Stewardship Council, which ensures and verifies that ingredients meet its strict environmental requirements.

### 2.2.2. **Mortality Removal**

Dead or moribund fish are removed from each net pen by divers inside the net pen on a daily basis. Divers enter the net pen through a 6-foot zipper and check for mortalities around the bottom cone, mid-panel circumference, and surface areas. All mortalities are removed from the cages using mesh hand bags and returned to the vessel. No mortalities are discarded at sea. Mortalities are stored in leak proof bins inside water tight disposal bags on the vessel for on-shore disposal.

### 2.2.3. **Treatment**

The fish inside the net pens are occasionally treated with a hydrogen peroxide solution to remove ectoparasites (*Neobenedenia spp*.) from their skin. The treatment procedure is as follows:

- Raise the net pen to the surface to reduce the net pen water volume by 50% and to crowd the fish (10 minutes).
- Cover the underwater portion of the net pen with semi-permeable tarps to reduce water flow through the net pen (60-90 minutes).
- Pump the hydrogen peroxide solution from the vessel into the net pen for the prescribed period of time (45 minutes).
- Remove the tarps and submerge the net pen (60 minutes).

Peroxide treatments are administered under an FDA-approved protocol managed by USFWS. Every treatment is reported to USFWS and potential water quality impacts from treatments are monitored under a NPDES permit managed by the state of Hawaii. According to Blue Ocean, the CAM netting reduces the amount of biofouling on the net pens, which reduces the amount of available habitat and substrate for the ectoparasite reproductive cycle. Blue Ocean conducted 38 treatments at the farm site during 2017. The frequency of treatment activity relative to biomass inventory has decreased 64.7% with the introduction of the new CAM netting (Figure 3).

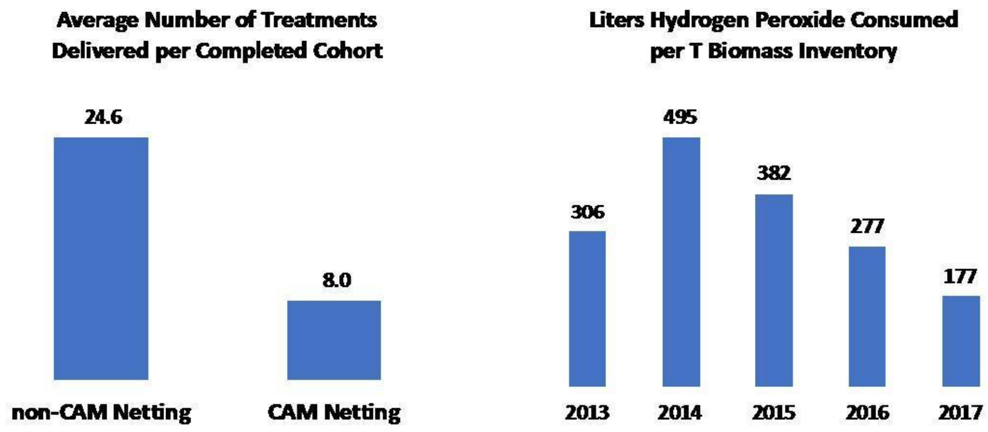


Figure 3. Effects of CAM netting on peroxide treatment need.

### 2.2.4. **Harvesting**

Fish are harvested from a single net pen twice weekly until all fish are harvested from the net pen. The harvest period for a single net pen can range from 2-6 months. During each 2-3-hour harvest event, the harvest vessel is secured to the net pen and a 10" flexible harvest hose is attached to a fitting on the net pen. The net pen is surfaced to crowd the fish, which are then pumped onto the harvest vessel through the harvest hose and counted. Once the requested number of fish are harvested, divers disconnect and retrieve the harvest hose and the harvest vessel returns to Honokohau Harbor to offload harvested fish.

### 2.2.5. **Net Drying**

Each net pen with a Polyethylene Terephthalate monofilaments (Kikkonet) top half is surfaced to the rim once per week for approximately 3 hours. The exposure to dry air and sunlight desiccates biofouling on the net, which contributes to a reduction in treatment frequency and an increase in water/oxygen flow for the fish.

### 2.2.6. **Inspections**

Net pen inspections and mortality retrieval dives occur every day regardless of the age of the cohort and associated feeding schedule. Every month the mesh on every panel is measured with calipers including panels at the waterline, and the upper and bottom trapezoids. Any broken net bars, holes, or unusual situations found during the inspection are fixed and reported immediately to the Farm Manager. Inspection dives on the net pen array are conducted weekly. Grid lines, node points, shackles, and fittings are inspected for unusual wear and to ensure that all cathodic protection hardware is in place. Grid tension is also checked and repaired as needed. Anchor leg tension is inspected monthly. All hardware attached to the anchors are welded in place and any failure of anchor tackle would result in loss of tension of the anchor lines.

## Equipment Used to Support the Proposed Action

Blue Ocean operates several vessels and assorted equipment offshore in support of the proposed action, including:

Vessels

- MV Kampachi 3: 74' LCM 8 landing craft (feeding), max speed = 8 kts
- MV Kampachi 4: 74' LCM 8 landing craft (harvest), max speed = 8 kts
- MV Hunakai: 17' aluminum skiff (crew transport), max speed = 20 kts

Above Water Equipment

- Air Compressor: 185 cfm
- Cranes: 3,000 lb (one on each LCM vessel)
- Various Water Pumps: Hydraulic
- Generators: (one on each LCM vessel)

Underwater Equipment

- Diver Recall System
- Camera System

All objects over 10 kg are deployed and recovered from waters in the action area with the assistance of boat cranes, lift bags and divers in the water. The cranes place and retrieve objects at a slow (6 cm/sec), controlled pace. Typical heavy objects deployed and recovered into the action area waters include:

- Small net bundles weighing 50-200 kg are placed into a cage or extracted from a cage at each change of harvest or addition of a new cohort, once every 2-3 months.
- Tarp bundles weighing 50-75 kg are deployed around the outside of a cage near the surface to enclose it for bath treatments, 1-2 times per month.
- Chain segments weighing 250 kg or more are positioned and attached to the bottom of a net pen, 1-2 times per year.

Each cage in the net pen array includes a 3,600 kg ballast block attached directly underneath the net pen. The block travels vertically through the water column from the bottom to a maximum of 25 m off the bottom when the cage is brought to the surface or submerged, 4-6 times daily. The block travels approximately 2.5 cm/sec. Objects under 10 kg are moved by divers underwater, occasionally with the assistance of small lift bags. These objects include mortality hand bags, shackles, and hand tools.

# 3. APPROACH TO THE ASSESSMENT

## 3.1. Overview of NMFS Assessment Framework

Biological opinions address two central questions: (1) has a Federal agency insured that an action it proposes to authorize, fund, or carry out is not likely to jeopardize the continued existence of endangered or threatened species, and (2) has a Federal agency insured that an action it proposes to authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat that has been designated for such species. Every section of a biological opinion from its opening page to its conclusion and all of the information, evidence, reasoning, and analyses presented in between is designed to help answer these two questions. What follows summarizes how NMFS' generally answers these two questions; that is followed by a description of how this biological opinion will apply this general approach to the USACE's proposal to issue a permit authorizing the construction and operation of an eight pen array.

Before we introduce the assessment methodology, we want to define the word "effect." An *effect* is a *change or departure* from a *prior state or condition* of a *system caused* by an *action or exposure* (Figure 4). Although Figure 4 depicts a negative effect, the definition itself is neutral: it applies it to activities that benefit endangered and threatened species as well as to activities that harm them. Whether the effect is positive (beneficial) or negative (adverse), an "effect" represents a change or departure from a prior condition (**a** in Figure 4); in consultations, the prior global condition of species and designated critical habitat is summarized in the *Status of Listed Species* narratives while their prior condition in a particular geographic area (the *Action Area*) is summarized in the *Environmental Baseline* section of this opinion. Extending this baseline condition over time to form a *future without the project* condition (line **b** in Figure 4); this is alternatively called a counterfactual because it describes the world as it might exist if a particular action did not occur. Although consultations do not address it explicitly, the future without project is implicit in almost every effects analysis.

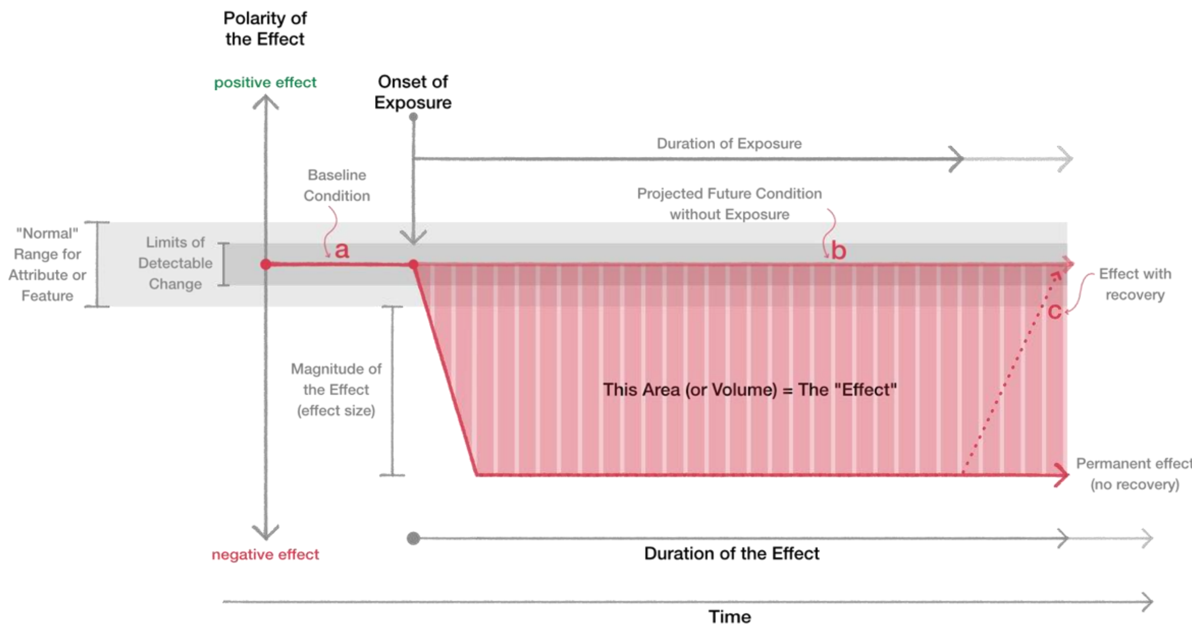


Figure 4. A schematic of the various elements encompassed by the word "effect." The vertical bars in the figure depict a series of annual "effects" (negative changes from a pre-existing or "baseline" condition) that are summed over time to estimate the action's full effect. See text for a more complete explanation of this figure.

As Figure 4 illustrates effects have several attributes: *polarity* (positive, negative, or both), *magnitude* (how much a proposed action causes individuals, populations, species, and habitat to depart from their prior state or condition) and *duration* (how long any departure persists). The last of these attributes—*duration*—implies the possibility of recovery which has the additional attributes *recovery rate* (how quickly recovery occurs over time; the slope of line **c** in Figure 4) and *degree of recovery* (complete or partial). For instance, the recovery rate allows us to estimate how long it would take for a population to recover.

As described in the following narratives, biological opinions apply this concept of effects to endangered and threatened species and designated critical habitat. Jeopardy analyses are designed to identify probable departures from the prior state or condition of individual members of listed species, populations of those individuals, and the species themselves. Destruction or adverse modification analyses are designed to identify departures in the area, quantity, quality, and availability of the physical and biological features that represent habitat for these species.

### 3.1.1. **Jeopardy Analyses**

The section 7 regulations define "jeopardize the continued existence of" as "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 a listed species in the wild by reducing the *reproduction, numbers, or distribution* of that species" (50 CFR 402.02, emphasis added). This definition requires our assessments to address four primary variables:

1. Reproduction
2. Numbers
3. Distribution
4. The probability of the proposed action will cause one or more of these variables to change in a way that represents an appreciable reduction in a species' likelihood of surviving and recovering in the wild.

*Reproduction* leads this list because it is "the most important determinant of population dynamics and growth" (Carey and Roach 2020). *Reproduction* encompasses the reproductive ecology of endangered and threatened species; specifically, the abundance of adults in their populations, the fertility or maternity (the number of live births rather than the number of eggs they produce) of those adults, the number of live young adults produce over their reproductive lifespans, how they rear their young (if they do), and the influence of habitat on their reproductive success, among others. Reducing one or more of these components of a population's reproductive ecology can alter its dynamics so reproduction is a central consideration of jeopardy analyses.

The second of these variables—*numbers*—receives the most attention in the majority of risk assessments and that is true for jeopardy analyses as well. Numbers or abundance usually represents the total number of individuals that comprise the species, a population, or a sub-population; it can also refer to the number of breeding adults or the number of individuals that become adults. For species faced with extinction or endangerment several numbers matter: the number of populations that comprise the species, the number of individuals in those populations, the proportion of reproductively active adults in those populations, the proportion of sub-adults that can be expected to recruit into the adult population in any time interval, the proportion of younger individuals that can be expected to become sub-adults, the proportion of individuals in the different genders (where applicable) in the different populations, and the number of individuals that move between populations over time (immigration and emigration). Reducing these numbers or proportions can alter the dynamics of wild populations in ways that can reinforce their tendency to decline, their rate of decline, or both. Conversely, increasing these numbers or proportions can help reverse a wild population's tendency to decline or cause the population to increase in abundance.

The third of these variables—*distribution*— refers to the number and geographic arrangement of the populations that comprise a species. Jeopardy analyses must focus on populations because the fate of species is determined by the fate of the populations that comprise them: species become extinct with the death of the last individual of the last population. For that reason, jeopardy analyses focus on changes in the *number of populations*, which provides the strongest evidence of a species' extinction risks or its probability of recovery. Jeopardy analyses also focus on changes in the spatial *distribution of the populations* that comprise a species because such changes provide insight into how a species is responding to long-term changes in its environment (for example, to climate change). The spatial distribution of a species' populations also determines, among other things, whether all of a species' populations are affected by the same natural and anthropogenic stressors and whether some populations occur in protected areas or are at least protected from stressors that afflict other populations.

To assess whether reductions in a species' reproduction, numbers, or distribution that are caused by an action measurably reduce the species' likelihood of surviving and recovering in the wild, NMFS' first assesses the status of the endangered or threatened species that may be affected by an action. That is the primary purpose of the narratives in the *Status of Listed Resources* sections of biological opinions. Those sections of biological opinions also present descriptions of the number of populations that comprise the species and their geographic distribution. Then NMFS' assessments focus on the status of those populations in a particular action area based on how prior activities in the action area have affected them. The *Environmental Baseline* sections of biological opinions contain these analyses; the baseline condition of the populations and individuals in an *Action Area* determines their probable responses to future actions.

To assess the effects of actions considered in biological opinions, NMFS' consultations use an *exposure–response–risk* assessment framework. The assessments that result from this framework begin by identifying the physical, chemical, or biotic aspects of proposed actions that are known or are likely to have individual, interactive, or cumulative direct and indirect effects on the environment (we use the term "potential stressors" for these aspects of an action). As part of this step, we identify the spatial extent of any potential stressors and recognize that the spatial extent of those stressors may change with time. The area that results from this step of our analyses is the *Action Area* for a consultation.

After they identify the *Action Area* for a consultation, jeopardy analyses then identify the listed species and designated critical habitat (collectively, "listed resources"; critical habitat is discussed further below) that are likely to occur in that *Action Area*. If we conclude that one or more species is likely to occur in an *Action Area* when the action would occur, jeopardy analyses try to estimate the number of individuals that are likely to be exposed to stressors caused the action: the intensity, duration, and frequency of any exposure (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an Action's effects and the populations or subpopulations those individuals represent.

Once we identify the individuals of listed species that are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those individuals are likely to respond given their exposure (these represent our *response analyses*). Our individual-level assessments conclude with an estimate of the probable consequences of these responses for the "fitness" of the individuals exposed to the action. Specifically, we estimate the probability that exposed individuals will experience changes in their growth, development, longevity, and the number of living young they produce over their lifetime. These estimates consider life history tradeoffs, which occur because individuals must allocate finite resources to growth, maintenance and surviving or producing offspring; energy that is diverted to recover from disease or injury is not available for reproduction.

If we conclude that an action can be expected to reduce the fitness of at least some individuals of threatened or endangered species, our jeopardy analyses then estimate the consequences of those changes on the viability of the population(s) those individuals represent. This step of our jeopardy analyses considers the abundance of the populations whose individuals are exposed to an action; their prior pattern of growth and decline over time in the face of other stressors; the proportion of individuals in different ages and stages; gender ratios; whether the populations are "open" or "closed" (how much they are influenced by immigration and emigration); and their ecology (for example, whether they mature early or late, whether they produce many young or a small number of them, etc.). Because the fate of species is determined by the fate of the populations that comprise them, this is a critical step in our jeopardy analyses.

The final step of our analyses assesses the probability of changes in the number of populations that comprise the species, the spatial distribution of those populations, and their expected patterns of growth and decline over time. In this step of our jeopardy analyses, we consider population-level changes based on our knowledge of the patterns that have led to the decline, collapse, or extinction of populations and species in the past as well as patterns that have led to their recovery from extinction. These patterns inform our jeopardy determinations.

## 3.2. Application of this Approach in this Consultation

NMFS has identified several aspects of the mariculture operation that present potential stressors to the environment, and threatened or endangered species or critical habitat that has been designated for them. A stressor is a physical, chemical, or biological agent that can induce a direct or indirect effect on the environment (*Action Area*), and can induce an adverse response from threatened and endangered species and their critical habitat. The specific stressors addressed in this consultation include:

1. Wastes, Discharges, or Decreased Water Quality
2. Vessel Operations
3. Lines, Nets and other material
4. Human Activity and Equipment Operation
5. Introduction of Food

### 3.2.1. **Action Area**

The *Action Area* includes all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). In this case it includes where the mariculture farm operates within the 90-acre lease boundary (Figure 5), and includes transit routes to and from the facility. The mariculture farm is located 0.5 miles off Unualoha Point on the Kona Coast of Hawaii Island. This includes the in-water area from the surface to 60 m deep (>20 m feet beyond the depth profile of the mariculture farm). The action area also includes the 4.5 nautical mile transit route for vessels accessing the farm site from Honokohau Harbor (Figure 6).

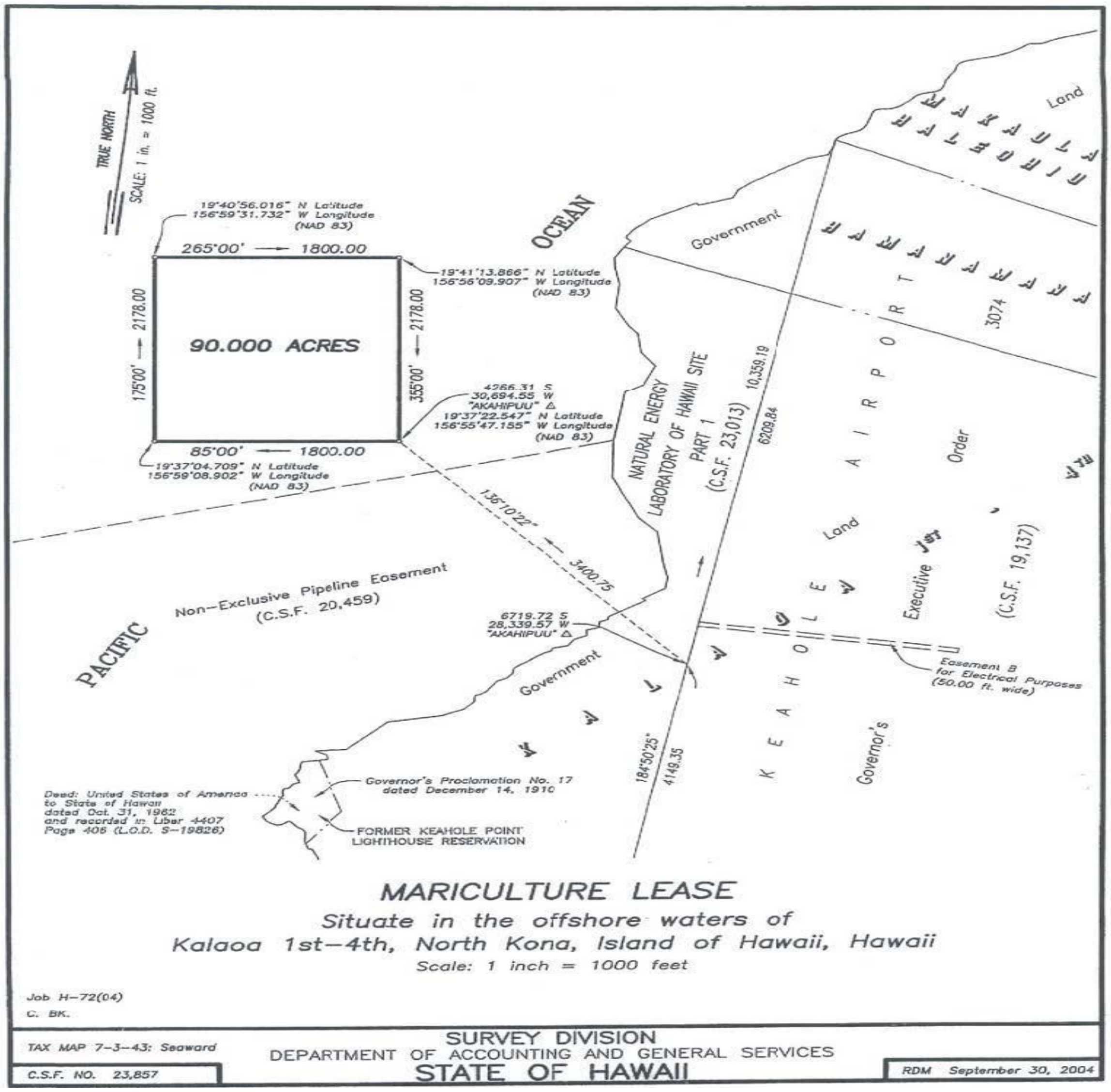

Figure 5. Mariculture Lease Area (USACE 2018).

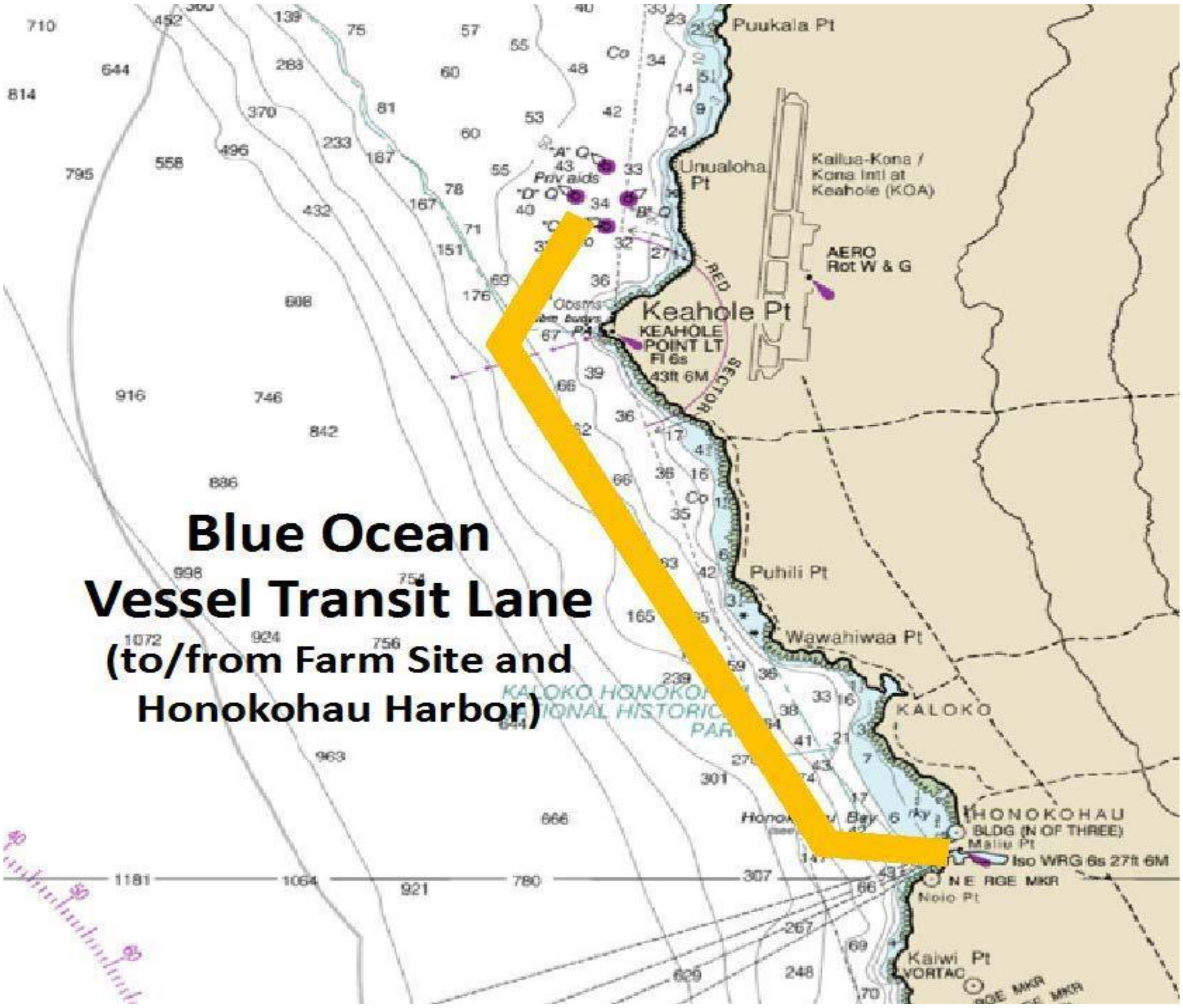


Figure 6. Vessel transit route between net pen farm site and Honokohau Harbor (USACE 2018).

### 3.2.2. **Approach to Evaluating Effects**

After identifying the *Action Area* for this consultation, we identified those activities and associated stressors that are likely to co-occur with (a) individuals of endangered or threatened species or areas designated as critical habitat for threatened or endangered species; (b) species that are food for endangered or threatened species; or (c) species that prey on or compete with endangered or threatened species. Our exposure characterization identifies:

- the exposure pathway (the course the stressor takes from the source to the listed resource or its prey);
- the exposed listed resource (what life history forms or stages of listed species are exposed; the number of individuals that are exposed; which populations the individuals represent); and
- the timing, duration, frequency, and severity of exposure.

We lay the foundation for our risk assessment and our understanding of the animal's pre-existing physical, physiological, or behavioral state in the *Status of Listed Resources* and the *Environmental Baseline* using qualitative and quantitative analytical methods.

We also describe how exposure might vary depending on the behavior of individual animals and their life history stages, etc. Our exposure analyses require knowledge of the action, and a species' population structure and distribution, migratory behaviors, life history strategy, and abundance. We used available data from the NMFS' monk seal and sightings database to describe the exposure of Hawaiian monk seals to the mariculture operations. In addition, we relied on the Protected Species Reporting and Monitoring Report, provided by Blue Ocean Mariculture, for other ESA-listed species potentially exposed to the associated stressors.

Next, we identified how listed species and their designated critical habitat are likely to respond once exposed to the action's stressors. These analyses evaluated whether the species responses were expected to be immediate or later in time, and considered the severity, frequency, and duration of those responses.

We captured the relevant life history information for each listed species that interacts with the proposed action, which allows us to: (a) visualize a species life history in a way that reveals the main variables that promote population growth (or decline); (b) explicitly identify the various stressors that are known to act on different life history stages; (c) identify the probable consequences of those stressors on those stages; (d) estimate how long an effect might take to be detected in census data; and (e) infer the probable effect on a species' pattern of growth or decline.

### 3.2.3. Climate Change

Future climate will depend on warming caused by past anthropogenic emissions, future anthropogenic emissions and natural climate variability. NMFS' policy (NMFS 2016a) is to use climate indicator values projected under the Intergovernmental Panel on Climate Change (IPCC)'s Representative Concentration Pathway (RCP) 8.5 when data are available, or best available science that is as consistent as possible with RCP 8.5. RCP 8.5, like the other RCPs, were produced from integrated assessment models and the published literature; RCP 8.5 is a high pathway for which radiative forcing reaches >8.5 $W/m^2$ by 2100 (relative to pre-industrial values) and continues to rise for some amount of time. A few projected global values under RCP 8.5 are noted in Table 2. Presently, the IPCC predicts that climate-related risks for natural and humans systems are higher for global warming of 1.5 ºC but lower than the 2 ºC presented in Table 2 (IPCC 2018). Changes in parameters will not be uniform, and IPCC projects that areas like the equatorial Pacific will likely experience an increase in annual mean precipitation under scenario 8.5, whereas other mid-latitude and subtropical dry regions will likely experience decreases in mean precipitation. Sea level rise is expected to continue to rise well beyond 2100 and while the magnitude and rate depends upon emissions pathways, low-lying coastal areas, deltas, and small islands will be at greater risk (IPCC 2018).

Table 2. Projections for certain climate parameters under Representative Concentration Pathway 8.5 (IPCC 2014).

| Projections | Scenarios (Mean and likely range) | |
|---|---|---|
| | **Years 2046-2065** | **Years 2081-2100** |
| Global mean surface temperature change (ºC) | 2.0 (1.4-2.6) | 3.7 (2.6-4.8) |
| Global mean sea level increase (m) | 0.30 (0.22-0.38) | 0.63 (0.45-0.82) |

We address the effects of climate, including changes in climate, in multiple sections of this assessment: *Status of Listed Resources*, *Environmental Baseline*, and the *Integration and Synthesis of Effects*. In the *Status of Listed Resources* and the *Environmental Baseline* we present an extensive review of the best scientific and commercial data available to describe how the listed species and its designated critical habitat is affected by climate change—the status of individuals, and its demographically independent units (subpopulations, populations), and critical habitat in the *Action Area* and range wide.

We do this by identifying species sensitivities to climate parameters and variability, and focusing on specific parameters that influence a species health and fitness, and the conservation value of their habitat. We examine habitat variables that are affected by climate change such as sea level rise, temperatures (water and air), and changes in weather patterns (precipitation), and we try to assess how species have coped with these stressors to date, and how they are likely to cope in a changing environment. We look for information to evaluate whether climate changes affect the species' ability to feed, reproduce, and carry out normal life functions, including movements and migrations.

We review existing studies and information on climate change and the local patterns of change to characterize the *Environmental Baseline* and *Action Area* changes to environmental conditions that would likely occur under RCP 8.5, and where available we use changing climatic parameters (magnitude, distribution, and rate of changes) information to inform our assessment. In our exposure analyses, we try to examine whether changes in climate related phenomena will alter the timing, location, or intensity of exposure to the action. In our response analyses we ask, whether and to what degree a species' responses to anthropogenic stressors would change as they are forced to cope with higher background levels of stress cause by climate-related phenomena.

### 3.2.4. **Evidence Available for this Consultation**

We used the following procedure to ensure that this consultation complies with NMFS' requirement to consider and use the best scientific and commercial data available. We started with the data and other information contained in the Army Corps of Engineers' 2018 BE on the Evaluation on the Installation of New Net Pens and Ongoing Mariculture Operations by Blue Ocean Mariculture, LLC, NMFS marine mammal stock assessment reports, and the Hawaiian monk seal recovery plan. We supplemented this information by conducting electronic searches of literature published in English or with English abstracts to cross search multiple databases for relevant scientific journals, open access resources, proceedings, web sites, doctoral dissertations, and master's theses.

For our literature searches, we used paired combinations of the keywords: “Hawaiian monk seal” “distribution”, “status”, “marine debris”, “male aggression”, “food limitation”, “fishery interactions”, “climate change”, “benthic surveys”, “Hawaii Island”, “aquaculture”, “coral reef health”, “hypothyroidism”, “adenovirus”, “mariculture”, “behavior modification,” and “entanglement”. Electronic searches have important limitations, however. First, often they only contain articles from a limited time span (e.g., First Search only provides access to master’s theses and doctoral dissertations completed since 1980 and Aquatic Sciences and Fisheries Abstracts only provide access to articles published since 1964). Second, electronic databases commonly do not include articles published in small or obscure journals or magazines that contain credible and relevant scientific and commercial data. Third electronic databases do not include unpublished reports from government agencies, consulting firms, and non-governmental organizations that also contain credible and relevant scientific and commercial data. To overcome these limitations, we supplemented our electronic searches by searching the literature cited sections and bibliographies of references we retrieved to identify additional papers that had not been captured in our electronic searches. We acquired references that, based on a reading of their titles and abstracts, appeared to comply with our keywords. If a references’ title did not allow us to eliminate it as irrelevant to this inquiry, we acquired the reference.

Finally, we relied on data from Blue Ocean Mariculture, LLC. Blue Ocean Mariculture has been providing a Protected Species Reporting and Monitoring Report to NMFS since 2010 on a quarterly basis. The monitoring report data fields include: the date and time of observations, the ESA listed species or marine mammals observed including the quantity, the behavioral activity, type of interaction or tag number, number of fish escapes, and the name of the employee documenting the event. Most often, the only information provided is the date and time, species name, and the name of the employee that documented the event. These reported observations are opportunistic and not standardized to any methodology, and therefore not suited for rigorous scientific analysis. However, this information is valuable when determining the general presence of ESA-listed species in the action area.

To supplement our searches, we examined the literature that cited in documents and any articles we collected through our electronic searches. If, based on a reading of the title or abstract of a reference, the reference appeared to comply with the keywords presented in the preceding paragraph, we acquired the reference. If a reference’s title did not allow us to eliminate it as irrelevant to this inquiry, we acquired it. We continued this process until we identified all of the relevant references cited by the introduction and discussion sections of the relevant papers, articles, books, and, reports and all of the references cited in the materials and methods, and results sections of those documents. We did not conduct hand searches of published journals for this consultation.

These procedures allowed us to identify relevant data and other information that was available for our analyses. In many cases, the data available were limited to a small number of datasets that either did not overlap or did not conflict. In those cases, none of these sources were “better’ than the alternatives and we used all of these data.

## 4. STATUS OF LISTED RESOURCES

Of the ESA-listed resources occurring in the action area, NMFS has determined that the installation of eight net pens and ongoing, revised mariculture operations may adversely affect only one; the endangered Hawaiian monk seal (Table 3).

Table 3. Listed resources within the action area likely to be adversely affected by the proposed action.

| SPECIES COMMON NAME | SCIENTIFIC NAME | STATUS | EFFECTIVE LISTING DATE | FEDERAL REGISTER REFERENCE |
|---|---|---|---|---|
| MARINE MAMMALS | | | | |
| Hawaiian monk seal | *Neomonachus schauinslandi* | Endangered | 11/23/1976 | 41 FR 51612 |

NMFS further determined that the proposed activities are not likely to adversely affect species and critical habitats listed in Table 4.

Table 4. List of species that may be affected, but are not likely to be adversely affected by the action.

| SPECIES COMMON NAME | SCIENTIFIC NAME | STATUS | EFFECTIVE LISTING DATE | FEDERAL REGISTER REFERENCE |
|---|---|---|---|---|
| SEA TURTLES | | | | |
| Green sea turtle, Central North Pacific | *Chelonia mydas* | Threatened | 5/06/2016 | 81 FR 20057 |
| Hawksbill sea turtle | *Eretmochelys imbricata* | Endangered | 6/03/1970 | 35 FR 8491 |
| MARINE MAMMALS | | | | |
| False killer whale Main Hawaiian Islands insular | *Pseudorca crassidens* | Endangered | 12/28/2012 | 77 FR 70915 |
| FISH | | | | |
| Oceanic whitetip shark | *Carcharhinus longimanus* | Threatened | 3/01/2018 | 83 FR 4153 |
| Giant manta ray | *Manta birostris* | Threatened | 2/21/2018 | 83 FR 2916 |
| CRITICAL HABITAT | | | | |
| Hawaiian monk seal critical habitat | | | 5/26/1988 revised on 8/21/2015 | 53 FR 18990<br>80 FR 50925 |

| *SPECIES COMMON NAME* | *SCIENTIFIC NAME* | *STATUS* | *EFFECTIVE LISTING DATE* | *FEDERAL REGISTER REFERENCE* |
|---|---|---|---|---|
| False killer whale Main Hawaiian Islands insular critical habitat | | | 7/24/2018 | 83 FR35062 |

### 4.1. Species and Critical Habitat Not Considered Further

As described in the *Approach to the Assessment* section of this biological opinion, NMFS uses two criteria to identify those endangered or threatened species or critical habitat that are not likely to be adversely affected by the installation of net pens and mariculture operations. The first criterion is exposure or some reasonable expectation of a co-occurrence between one or more potential stressor associated with the installation of net pens and the mariculture operations and a particular listed species or designated critical habitat. If we conclude that a listed species or designated critical habitat is extremely unlikely to be exposed to the installation of net pens and the mariculture operations, we conclude that the species and critical habitat is not likely to be adversely affected by those activities. The second criterion is the significance of a response given exposure. For example, if the resulting effect from exposure is too small to meaningfully measure, detect, or evaluate, it is not likely to adversely affect.

Based on the exposure and response analyses that we developed during the course of this consultation, and described in *Appendix **A*** of this biological opinion, NMFS has determined that the threatened and endangered species and designated critical habitats listed in Table 4 are not likely to be adversely affected by the Proposed Action. We will not address these resources in the remainder of this opinion.

#### 4.1.1. **Hawaiian Monk Seals**

This section presents biological and ecological information for Hawaiian monk seals affected by the proposed action relevant to formulating the Opinion including species-specific descriptions of distribution and abundance, life history characteristics (especially those affecting vulnerability to the proposed action), threats to the species, major conservation efforts, and other relevant information (USFWS & NMFS 1998). Factors affecting those species within the action area are described in more detail in the Environmental Baseline**.**

#### 4.1.2. **Distribution and Population Structure**

Endemic to the Hawaiian Islands, the Hawaiian monk seal is an endangered pinniped species distributed throughout the Hawaiian Islands with approximately 1,100 animals of the population located in remote Northwestern Hawaiian Islands (NWHI) as opposed to approximately 300 animals in the MHI (Carretta et al. 2021) (Figure 7). Prior to 2000, Hawaiian monk seals were rarely sighted in the MHI, with the exception of Niihau (Baker and Johanos 2004; Baker et al. 2011). Hawaiian monk seals are considered a panmictic population, meaning all individuals may breed together, and there are assumed to be no genetic or behavioral mating restrictions. However, research and recovery activities have typically focused on island or atoll aggregations (Schultz et al. 2011).

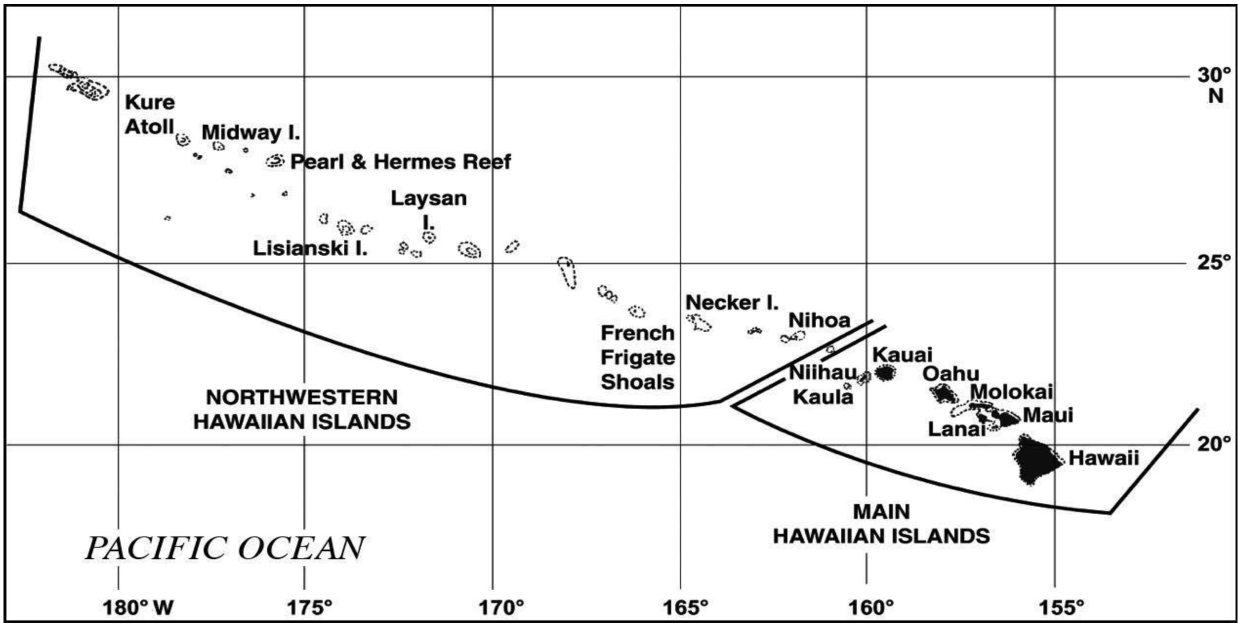


Figure 7. Hawaiian Archipelago and range of the Hawaiian monk seal. Dotted lines show 100 m bathymetric contours (Baker et al 2016).

The majority of the Hawaiian monk seals reside in the NWHI primarily at six island/atolls: French Frigate Shoals (FFS), Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll. At a lesser extent, some seals also occur at Necker Island, and Nihoa Island (Baker et al. 2016). More recently (mid-1990s'), seals are giving birth, nursing, resting and residing in the MHI (NMFS 2007).

Schultz et al. (2009) analyzed 154 microsatellite loci, and found the Hawaiian monk seal to exhibit extremely low genetic diversity finding unprecedented levels of allelic diversity and heterozygosity. To evaluate population structure, Schultz et al. (2011) sampled close to 85% of pups in cohorts from 1994-2007 from MHI, FFS, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll. In their study, Schultz et al. (2011) found no spatial or temporal genetic variation, and no evidence for isolation by distance. Consequently, a Bayesian clustering method indicated all seals comprise a single population, and therefore, there is no genetic subdivision among sites (Schultz et al. 2011).

Mark-resight data demonstrate that there is ample connectivity among sites within the NWHI, and especially within the MHI. There are records of seals tagged at birth, and seals tagged whose natal sites were uncertain, that documented movement between the NWHI and MHI (Johanos et al. 2014). However, seals on the different atolls and islands have exhibited varying degrees of demographic independence with some areas having more or less movement of individual seals among them than others (Johanos et al. 2014). For example, there is a higher degree of migration among the western sites in the NWHI (Pearl and Hermes Reef, Midway Atoll, and Kure Atoll) compared to the more isolated sites at Laysan, Lisianski and FFS (Johanos et al. 2014). Nonetheless, seals appear to be moving freely among island and atolls, and the genetic data confirm interisland mating (Schultz et al. 2011). The level of range-wide connectivity demonstrated by tagging and genetic data as well as the historical recolonizations confirm that this species is properly managed as a single population (Johanos et al. 2014; Schultz et al. 2011).

### 4.1.3. **Status and Trends**

The population summary for Hawaiian monk seals in 2019 provides the best estimate for the species as 1,428 (95% confidence interval 1361-1520; NMFS 2020a). Methods for abundance estimation vary by site and year depending on the type and quantity of data available (Baker et al. 2016). Total enumeration of individuals is the favored method, but requires sufficient field presence to convincingly identify all the seals present, which is typically not achieved at most sites (Baker et al. 2006). When total enumeration is not possible, capture-recapture estimates (using Program CAPTURE) are conducted (Baker 2004; Otis et al. 1978, Rexstad and Burnham 1991, White et al. 1982). When no reliable estimator is obtainable in Program CAPTURE (i.e., the model selection criterion is < 0.75, following Otis et al. 1978), total non-pup abundance is estimated using pre-existing information on the relationship between proportion of the population identified and field effort hours expended (referred to as discovery curve analysis). At rarely visited sites (Necker, Nihoa, Niihau and Lehua Islands) where data are insufficient to use any of the above methods, beach counts are corrected for the proportion of seals at sea.

Applying the analysis to all known and inferred deaths believed to have occurred 2004–2019, Harting et al. (2020) determined that the causes of death with the largest influence on the long-term intrinsic growth rate of MHI Hawaiian monk seals were anthropogenic trauma and drowning, and protozoal disease. They determined that anthropogenic causes of death had a larger effect on the growth rate than natural causes.

In the MHI other than Niihau and Lehua Islands, abundance is estimated as the minimum tally of all individuals identified by an established sighting network during the calendar year. At all sites, pups are tallied. There is compelling evidence that the abundance of seals in the MHI has been growing since 2013 with a record high number of births (48) in 2019 (Baker et al. 2016, NMFS 2020a). The estimated abundance of Hawaiian monk seals in the MHI (including Niihau/Lehua) is 268 pups including non-pups (Caretta et al. 2020).

The Hawaiian monk seal recovery plan lists three Recovery Criteria necessary for a reclassification of "threatened" under the ESA (NMFS 2007): 1) aggregate numbers that exceed 2,900 total individuals in the NWHI; 2) at least 5 of the 6 main sub-populations in the NWHI are above 100 individuals and the MHI population is above 500; and 3) survivorship of females in each subpopulation in the NWHI and in the MHI is high enough that, in conjunction with the birth rates in each subpopulation, the calculated population growth rate for each subpopulation is not negative.

A Monte Carlo approximation of the annual multiplicative rate of realized population growth during 2013-2019 estimated the Hawaiian monk seal population grew at an average rate of about 2% per year since 2013 (Caretta et al. 2020, NMFS 2020a). In the NWHI, the median estimated growth rate was also 1.02, and a 99% chance that the number of monk seals in this region increased from 2013 to 2018 (NMFS 2020a). Whereas the trend in the MHI is far less evident, due to the relatively large uncertainty in abundance at Niihau and Lehua Islands.

The median estimated growth rate in the MHI was 1.01, and 32% of the distribution is below 1, indicating a greater probability that the abundance in the MHI increased rather than declined during this period (NMFS 2020a). The overall trend since 2013 is encouraging, however it is important to recognize that the abundance of seals in the NWHI remain far below their historical peaks (NMFS 2020a).

Harting et al. (2020) determined that between 2004-2019, anthropogenic causes of death had a larger effect on the growth rate than natural causes. They also noted that the increase in mean growth rate associated with the removal of all anthropogenic causes of death rises from 1.043 to 1.090. Even with anthropogenic effects, the available data suggest that the calculated population growth rate for each subpopulation is positive.

As noted above, the baseline growth rate is above 1, indicating a positive growth in the MHI. However, the growth rate could be higher if any of these causes of death were eliminated. However, the growth rate is still positive even with the current mortalities. Evidence suggests that the abundance of seals residing in the MHI has been growing since 2013 with a record high number of births (48) in 2019 (NMFS 2020a). Although this number is far from the 500 MHI individuals necessary as outlined in the recovery criteria for reclassification as "threatened" in the Hawaiian monk seal recovery plan (NMFS 2007), abundance in the MHI is increasing towards that goal.

### 4.1.4. **Population Dynamics**

Life expectancy for the Hawaiian monk seal is 25-30 years, but few seals live this long. Adult Hawaiian monk seals can weigh up to 273-kg and reach lengths of 2.3 m (NMFS 2014). Adult female Hawaiian monk seals tend to be larger in size than the adult males (NMFS 2007). The onset of sexual maturity in female pinnipeds can be linked to some percentage of final body size (Laws 1956 as cited in NMFS 2007), therefore delay in maturation suggest low availability of nutritional food sources for immature seals (Baker et al. 2016). Although less is known about sexual maturity of male Hawaiian monk seals they are believed to mature at a rate similar to females (Antonelis et al. 2006).

Hawaiian monk seals spend a majority of their time in the ocean and utilize terrestrial habitat to haulout to rest, give birth, nurse, molt, and avoid predators (NMFS 2014). Sandy beaches and sandspits are the preferred terrestrial habitat of Hawaiian monk seals, although they occasionally haulout on other substrates like emergent reefs (Antonelis et al. 2006; Kenyon and Rice 1956). Some of the primary haul out habitat used in the Kona area are rocky beaches and lava rock shelves. While in their ocean environment, Hawaiian monk seals are found foraging, mating, playing, and resting (Antonelis et al. 2006). Footage from video cameras fitted to adult Hawaiian monk seals reveal 57% of the seal's time is spent foraging and traveling while 34% is spent resting and 9% interacting socially (Parrish et al. 2000). Although the Hawaiian monk seal is considered to be solitary, they do interact in small numbers when at sea and occur together ashore at some sites in the MHI (Littnan et al. 2006). Haulout aggregations have been noted since early studies in the NWHI as well as in the MHI (Kenyon and Rice 1959).

On average, female Hawaiian monk seals give birth for the first time between the ages of 5 and 9 with high variability in fecundity among populations (NMFS 2007). Mating is rarely observed and assumed to occur offshore although males have been known to mount females on land and in the surf (Johanos et al. 1994). The reproductive season for Hawaiian monk seals is less synchronized in contrast to pinnipeds in temperate and polar regions where seasonal changes influence pup survival (Johanos et al. 1994). Pups are born year round, though births are most common between February and August (NMFS 2007) and peak in late March and early April (Johanos et al. 1994). Although, individual pupping patterns may vary, Johanos et al. (1994)

found 381 days to be the mean interval for births in consecutive years. Robinson et al (2020) found this time interval to hold for the MHI as well. Female Hawaiian monk seals will haulout a few days before giving birth to a single pup (Johanos et al. 1994). Newborn pups are black in color, weigh approximately 16 kg and remain close to the mother (Kenyon and Rice 1959). During 6-6 weeks of nursing, the pup gains 50-80 kg, and the female monk seal is gaunt as a result of fasting during the nursing period (Kenyon and Rice 1959). Fueled by the fat accumulated during nursing, the pup will learn over a period of several months to forage and if successful, will regain post-weaning weight at approximately 2 years of age (Johanos et al. 1994). Meanwhile, the mother returns to sea to resume feeding and will begin mating in 3-4 weeks and, 5-6 weeks later she will haulout to molt (Johanos et al. 1994; Robinson et al. 2020).

### 4.1.5. **Feeding Behavior**

Hawaiian monk seals forage on a variety of species, but specifically target benthic prey species. Crittercam footage (small cameras that can be attached to a seal to study its behavior) and dietary analysis reveals that seals forage along the bottom, primarily on benthic or bottom-associated prey species (Goodman-Lowe, 1998; Longenecker et al. 2006; Parrish 2004). Goodman and Lowe (1998) identified inshore, benthic, and offshore teleost or bony fishes, as the most represented prey items in monk seal scat, followed by cephalopods and crustaceans; from the 940 scats sampled, the study identified 31 families of bony fishes and 13 families of cephalopods. Increased resolution of regurgitation samples reveals prey such as morid cod, which are a bottom-associated species typically found at subphotic depths (depths greater than 95m, Longenecker et al. 2006). Fatty acid analysis of monk seal dietary composition indicated that an even broader number of prey species may be utilized by Hawaiian monk seals (Iverson et al. 2006). Iverson et al. (2006) also demonstrated substantial variation in diet among individuals, demographic groups (between juveniles and adults/sub adults), and locations, indicating that individual monk seal foraging preferences and capabilities play a role in their selection of foraging habitat. The findings are consistent with seal foraging ecology studies evaluating seal movement in the marine environment discussed in more detail below.

Crittercam observations from FFS revealed that seals displayed active foraging behavior at various depths. At deeper depths behaviors were more focused towards foraging, (i.e., seals spent more time actively searching along or near the bottom for prey at deeper depths) (Parrish et al. 2000). Parrish et al. (2000) observed most feeding between 60-100 m. Parrish and Abernathy (2006) describe a majority of NWHI seals diving beyond the 40-m range as corresponding with slope habitats found between 50 and 300 m. This coincides with the habitat used by prey species often identified in Hawaiian monk seals' diet (Parrish 2004, Parrish and Abernathy 2006). Recent studies using crittercams in the MHI indicated that foraging habits were fairly similar, but trip distances were shorter and dives were shallower in the MHI (Wilson et al. 2017; 20017b).

Studies describe these preferred foraging habitats as areas of habitat uniformity with low-relief substrates such as sand and talus (rock debris) (Parrish et al. 2008, Parrish and Littnan 2007). In these habitats adult seals are able to dig out cryptic prey hiding in the bottom substrate or flip over large, loose talus fragments to reach the prey hiding underneath (Parrish et al. 2000). Although these sites are often greater distances from haulout sites, it appears that the less sheltered prey in the uniform habitat may make this area energetically preferable to the seals (Parrish et al. 2000).

Parrish et al. (2002) and Stewart et al. (2006) also revealed that Hawaiian monk seals forage in subphotic zones, or depths greater than 300 m (984 ft.), sometimes visiting patches of deep corals (Parrish 2004; Parrish et al. 2002). A summary of telemetry data from 37 male and female adults tagged throughout the NWHI revealed that 17 seals (46 percent of those sampled) appeared to be using subphotic foraging habitat (Parrish 2004). Parrish (2004) extrapolated this percentage out to suggest that a fourth of the entire population does some foraging in the subphotic habitat. As noted earlier, the proportion of dives at these deeper depths appears to be relatively low. Nonetheless, the use of these deeper habitats may reflect some Hawaiian monk seals taking advantage of readily available prey in a habitat with decreased inter-specific competition (Parrish et al. 2008).

Foraging studies at FFS with instrumented juvenile Hawaiian monk seals (1–3 years old) illustrated foraging behavior similar to that of adult Hawaiian monk seals. Feeding occurred both within shallow atoll lagoons 10–30 m and on deep reef slopes 50–100 m, usually over sand rather than talus (Parrish et al. 2005). Crittercam footage of juvenile seals foraging showed seals moving along the bottom, flushing prey with a variety of techniques, including probing the bottom with their nose, using their mouth to squirt streams of water at the substrate, and flipping small rocks with their heads and shoulders (Parrish et al. 2005). While juvenile seals are able to dive to depths similar to adults, the smaller seals likely do not yet have the size or experience to engage in the successful large talus-foraging behavior exhibited by adults (Parrish et al. 2005). Parrish (2004) noted that of the sand fields and coral reefs were used as primary foraging habitat for these young seals and that limited data also indicate that juvenile seals also forage at the deeper ranges used by adults (Parrish 2004).

Recent foraging ecology studies focused on the MHI provide new insight into the foraging preferences and behavior of Hawaiian monk seals and better explain the divergence in trends between seals residing in the NWHI and the MHI. The foraging behavior of 18 MHI seals was examined between 2004 and 2008 by Cahoon (2011), using two types of satellite-linked time-depth recorders. Monk seal foraging behavior was generally similar to the behavior of seals in the NWHI. For example, seals exhibited core areas over submerged banks, and most seals stayed close to their island of instrumentation with some seals traveling to nearby islands (Cahoon 2011). However, comparison of data from the two regions is also consistent with Baker and Johanos (2004) suggesting that MHI habitat offers favorable foraging conditions to seals. On average, foraging trip duration was shorter and foraging distance was less for MHI seals compared to their NWHI counterparts (Cahoon 2011). The healthy condition of seals in the MHI and the foraging behavior of seals in the MHI, suggests that MHI seals are able to acquire sufficient resources close to shore and are not limited by prey resources (Cahoon 2011).

Cahoon (2011) also indicated that MHI Hawaiian monk seals were predominantly diving to shallow depths in the MHI, but cautioned that behavior at these depths may not indicate foraging behavior, because seals may be participating in other behaviors unrelated to foraging, such as searching for rest areas or travelling, as noted by Parrish et al. (2000). Wilson et al. (2017, 20017b) used crittercams in the MHI and reported that trip distances were shorter and dives were shallower than those observed in the NWHI.

GPS tags have been used to track seals in the MHI in order to provide better spatial and temporal resolution to seal foraging behavior. Data from these tags demonstrate MHI seals dive at depths up to 489 m; although most dives take place at depths less than 100 m (NMFS 2014). NMFS' reports 95.4 percent of all recorded dives in the MHI have occurred at 100 m or less and 97.7 percent of dives occur at 200 m or less (NMFS 2014).

In general, the selection of foraging habitat by Hawaiian monk seals may be influenced by many factors, including environmental conditions that affect abundance and composition of prey assemblages, conditions that influence prey availability and capture success, such as intra-specific and inter-specific competition. Selection of foraging habitat is also influenced by individual differences among seals including, variation in size and age class, prey preferences, and favored foraging tactics. These variables all influence where, how, and when Hawaiian monk seals utilize foraging habitat within the marine environment. The Hawaiian monk seal has survived millions of years as a marine mammal in a low producing tropical environment by foraging across a wide expanse of habitat and by feeding on a wide-variety of bottom-associated prey species.

#### 4.1.6. **Threats to the Species**

As an endangered species, Hawaiian monk seals are extremely vulnerable to natural and anthropogenic threats. These threats may affect their continued recovery and existence. As a result of interisland mixing coupled with natural and human-caused factors and threats, there are variable demographic trends that have affected seals residing among the different sites over time (Gerrodette and Gilmartin, 1990; Craig and Ragen, 1999; and Polovina et al. 1994 as cited in NMFS 2007; Baker and Thompson 2007). To fully understand the factors causing declines, and to develop appropriate conservation policies and management, an understanding of the status and dynamics of each site is required. The discussion below includes the following natural and anthropogenic threats considered by scientist and managers to be crucial, serious, or moderate: food limitation, shark predation, male aggression, marine debris, infectious disease, habitat loss, fishery interactions, and intentional killings.

Harting et al. (2020) determined that between 2004–2019, the causes of death with the largest influence on the long-term intrinsic growth rate of MHI Hawaiian monk seals were anthropogenic trauma and drowning, and protozoal disease. They determined that these causes of death had a larger effect on the growth rate than natural causes, and found that of 114 non-fetal deaths, anthropogenic trauma was the greatest among all possible causes of death. This cause of death ranked high for all size and sex classes except nursing pups. Anthropogenic drowning had the next highest ranking, followed by protozoal disease, due largely to its prevalence as the leading cause of adult female deaths.

##### Food Limitation

Food limitation is regulating the population growth in the NWHI as it is a crucial threat to juvenile Hawaiian monk seal survival (Antonelis 2006; Baker 2008; Craig and Ragen 1999; Parrish et al. 2005). In contrast, seal pups in the MHI tend to gain greater weights and lengths at weaning (Baker and Johanos 2004). Robinson et al. (2020) shows longer nursing time in MHI suggesting better maternal condition, which helps to explain greater weaning sizes. However, since most of the monk seals reside in the NWHI, this threat is of highest concern (NMFS 2007).

Poor juvenile survival at FFS was first associated with limited food resources in the early 1990s (Craig and Ragen 1999). In addition, Reif et al. (2004) found adult Hawaiian monk seals had lower lengths and girths on FFS relative to those on the other NWHI. The size of weaned seals is a measure of prenatal investment and maternal energy investment to offspring during lactation

(Boness and Bowen 1996, NMFS 2007). Relatively low age-specific reproductive rates, which includes delayed maturity, have been observed on both FFS and Laysan Island (NMFS 2007).

Although, determining the causes and consequences of possible food limitation in Hawaiian monk seals is challenging and documenting the impact of food limitation is difficult, it remains the leading candidate of the cause of poor juvenile survival in the NWHI (Baker 2008). In addition, the Pacific Decadal Oscillation may have also contributed the decline in population between the 50s and 90s (Baker et al. 2012). Explanations for the limited food resources include: competition with fisheries, oceanographic change, and competition with other predators.

The lobster and bottomfish fishery were known to take prey items of the monk seal. However, the a Presidential Proclamation established the Papahanaumokuakea Marine National Monument in 2006, and the bottomfish fishery for commercial and non-commercial fisheries in the main Hawaiian Islands closed in 2011. The Monument is one of the largest and best-protected marine areas in the world, where commercial fishing efforts are now prohibited, and all other human activities require a permit (71 FR 36443; June 26, 2006). Changes in climate and oceanographic conditions may affect pinnipeds by changing availability of their prey (NMFS 2007). There can be little doubt that the prey base of Hawaiian monk seals undergoes considerable variation driven by environmental fluctuations (see section 5.0 *Environmental Baseline*). Hawaiian monk seals do not migrate; therefore, their foraging success depends on the available resources in proximity to their coral reef ecosystems (Antonelis 2003). As mentioned earlier, the NWHI are located within the Papahanaumokuakea Marine National Monument. The protected ecosystem of the NWHI, in comparison to the MHI, has a greater number of large predators.

The sharks, jack fishes and other demersal fishes that occur in the NWHI have been observed to compete directly with Hawaiian monk seals (Baker et al. 2012; Parrish et al. 2008). Since many of these predators grow to body sizes comparable to Hawaiian monk seals and larger, and since available diet studies indicate the apex predators are eating the same prey as the seals, it is reasonable to expect interspecific competition (NMFS 2007). Presumably, the impact of such interspecific competition for food would be the most severe on young Hawaiian monk seals as they are less able to defend their catch against competitors and may be less proficient at locating profitable foraging habitat and capturing prey (NMFS 2007).

### Shark Predation

Although shark predation is a natural phenomenon and plays an essential role in maintaining the ecosystem, it is considered a threat due to the small population of Hawaiian monk seals (NMFS 2007). Shark bites are commonly observed on seals throughout the NWHI and are used to identify individual seals (Harting 2010). Shark predation was once thought to be a minor component of monk seal mortality, with the assumption that tiger sharks were the common predator (Antonelis 2006).

Shark attacks on pups prior to or near weaning increased, especially at FFS where 18-30% of the annual cohort were attacked by Galapagos sharks (Antonelis 2006). This behavior was considered unusual and limited since it was not witnessed at the other five breeding sites (Antonelis 2006) and observations made from 1997-1999, indicate that 15-20 individual sharks were responsible for these attacks (Harting 2010). Monitoring and mitigation efforts that included harassment of sharks, intensive monitoring of shark-seal interactions, translocation of pups and shark removal (Harting 2010) were initiated to reduce the likelihood of the unusual shark behavior spreading to the other sites within the FFS atoll and NWHI (Antonelis 2006). Since the peak of pup losses from shark predation (1997-1999), the number of shark attacks and mortalities has declined across the FFS atoll (NMFS 2007). Mitigation efforts to remove sharks has had variable success in the past (Harting 2010) and efforts continue to target the small number of Galapagos sharks frequenting the shallow waters and pupping islets during the breading season on FFS (NMFS 2007).

### Male Aggression

The most common cause of lethal traumatic injuries to Hawaiian monk seals from 1981-1985 was male aggression or “mobbing” (Banish and Gilmartin 1992). Mobbing occurs when several male Hawaiian monk seals attempt to mount and mate with a single seal (Hiruki et al. 1993a, 1993b; NMFS 2007). Female seals are the typical victims, although, immature seals of both sexes are inflicted (Banish and Gilmartin 1992). Attacks by single adult males have resulted in several monk seal mortalities. This form of single male aggression occurs at most or all locations and appears to involve behavior which ranges from normal pinniped male harassment of younger animals, to an aberrant level of focused aggression, especially directed toward weaned pups (Johanos et al. 2010; NMFS 2007). In fact, two male seals were repeatedly found pinning and drowning newly weaned pups in shallow water (Mitchell, C. 2018. Pers. Comm.).

If a seal or pup is not drowned during the mobbing event, sub-lethal results from these attacks can result in large, deep dorsal wounds with exposed blubber or muscle which can lead to secondary effects such as: exposure, dehydration, infection, debilitation, and shark predation (Banish and Gilmartin 1992). Observations and research indicate that male aggression is a learned male behavior, probably associated with male-biased adult sex ratios (Gilmartin and Alcorn 1987, as cited in NMFS 2007; Johanos et al. 2010). The Pacific Islands Science Center’s Marine Mammal Research Program has developed guidelines for the assessment and, if necessary, the mitigation of single male aggression through displacement of males, translocation or lethal removal (NMFS 2007).

### Infectious Disease

As mentioned above, Hawaiian monk seals have extreme paucity of genetic diversity that may reduce their ability to risk attack from pathogens (Schultz et al. 2009, Hawley et al. 2005). Mortality events in the NWHI have led to concern about the presence of diseases in monk seal populations.

Moreover, there is heightened concern about monk seal exposure to diseases that they have not previously encountered, such as leptospirosis, toxoplasmosis, West Nile virus, etc. The lack of antibodies in Hawaiian monk seals to these diseases makes them extremely vulnerable to potential infection (Littnan et al 2006). While the frequency of disease outbreaks may be rare, their potentially devastating effects, should they spread throughout the population makes infectious diseases a serious threat (NMFS 2007).

Viruses that can cause epidemics resulting in dramatic mortality of pinnipeds, but have not been reported in the North Pacific to date, include morbilliviruses (Baker et al. 2017; Robinson et al. 2018), which have been detected in the North Pacific, in dolphin (Reidarson et al. 1998; West et al. 2021) and influenza. In 1999, the West Nile virus was introduced into the United States. The West Nile virus has now spread and remains as a continuing pathogen to animals and humans in 47 states (NMFS 2007). West Nile virus caused the deaths of captive harbor seals and one captive monk seal at Sea World, Texas, in 2004 (Dalton, personal communication, as cited in NMFS 2007). The lack of antibodies to these viruses in Hawaiian monk seals makes them potentially extremely vulnerable to infection.

Due to the ubiquitous presence of humans, pets, feral animals, livestock, and terrestrial wildlife, seals in the MHI population may be exposed to a larger suite of diseases in comparison to the seals residing in the remote NWHI (Littnan et al. 2006). However, seals from the MHI could potentially transfer disease to NWHI populations (Littnan et al. 2006). Although, no Hawaiian monk seals have been diagnosed with disease stemming from *Salmonella* or *Campylobacter spp.*, bacteria from human waste contamination of the marine environment, several weaned pups sampled in the NWHI and pups brought to oceanariums during 1985-1994, tested positive for fecal cultures for Salmonella (Littnan et al. 2006). *Toxoplasma gondii*, *Sarcocystis canis*, *Leptospira* spp., *Brucella* and *Salmonella* are common pathogenic viruses and bacteria associated with sources of land-based water runoff and sewage dispersal (Littnan et al. 2006). *T. gondii*, a microscopic parasite found in cat feces that causes toxoplasmosis, has killed at least 12 monk seals in the last two decades (Barbieri et al. 2016; Harting et al. 2020; NMFS 2020b). During a single week in 2018, three monk seals on Oahu died from toxoplasmosis and two additional monk seals were diagnosed with this cat-borne disease in 2019, and one of these seals has died (NMFS 2020b).

Bacterial infections can spread from bite wounds, male aggression injuries, and entanglement wounds (NMFS 2007). Although, MHI Hawaiian monk seals appear solitary when they haulout, they interact while at sea and occasionally occur together on shore (Kenyon and Rice 1959; Littnan et al. 2006). The interaction between the seals from the NWHI and MHI is not well known. The islands of Necker and Nihoa may serve as a bridge connecting the two colonies and therefore, potentially affect the transmission of disease (Littnan et al. 2006). A disease outbreak could have devastating effects especially if its spreads throughout the population.

### Habitat Loss

The human population and associated infrastructure development in the MHI continues to increase, including shoreline development. Development has led to shoreline armoring, which reduces beach size and access to monk seals, storm water runoff which carries pollutants and toxins, and much of the near shore areas inhabited by monk seals is subject to shoreline fishing. Continued monk seal growth in the MHI, or NWHI habitat loss to climate change forcing more seals into the MHI, could lead to a shortage of habitat and necessitate stronger protections and conservation measures (Baker et al. 2020).

### Marine Debris

Marine debris and derelict fishing gear are chronic forms of pollution found in the Hawaiian Islands. Hawaiian monk seals have one of the highest documented entanglement rates of any pinniped species (Henderson 1984, 1985, 1990). Historically, Hawaiian monk seals have become entangled in net, line (including monofilament nylon line), net/line combinations, straps, rings (including hagfish or eel traps), and other random items such as discarded lifejackets, buckets (portion of rims), bicycle tires, rubber hoses, etc. (Henderson 1990).

The unique and distinct bathymetry of the NWHI and the surrounding ocean currents attribute to the high deposition rates of marine debris in this region (Morishige et al. 2007; Henderson 2001 as cited in NMFS 2007). The shallow reefs that trap drifting debris are adjacent to beach haulouts that are commonly used by Hawaiian monk seals resulting in high entanglement risk zones (Boland and Donohue 2003). Seals residing on Lisianski in the NWHI, had the most entanglements, even though it does not consistently accumulate the highest amounts of potentially entangling debris on shore nor does it have the largest number of seal residents (Henderson 1990, 2001 as cited in NMFS 2007). Although only four deaths due to entanglement have been confirmed, the full extent of mortality related to marine debris remains unknown due in part to the short seasons of biologist presence in the NWHI to observe deaths and document potential causes (NMFS 2007).

An entangled monk seal may suffer from: 1) increased drag while swimming and foraging; 2) wounds that may become infected; 3) severance of body tissues; and 4) strangulation, drowning, starvation and shark attack (NMFS 2007). Between 1982 and 2006, a total of 268 entanglements of Hawaiian monk seals were documented. Out of the 268 entangled Hawaiian monk seals, 183 were released, 69 escaped unaided and 8 died (NMFS 2007). Mortality resulting from entanglement and associated fitness costs are direct and indirect effects of marine debris that contributes to this species lack of recovery (Boland and Donohue 2003).

### Fishery Interactions

Due to management actions (e.g. closure to fishing in the Papahanaumokuakea Marine National Monument), direct fishery interactions between commercial fisheries and Hawaiian monk seals in the NWHI are currently limited or nonexistent (NMFS 2007). Some evidence in the early 1990s suggests that longline operations may have been interacting with Hawaiian monk seals. In 1991, NMFS established a permanent 50-mile protected species zone around the NWHI that is closed to longline fishing (56 FR 52214, October 14, 1991). Since 1993, no interactions with Hawaiian monk seals in the Hawaii longline fisheries have been reported (NMFS unpublished observer data).

Although longline fisheries are no longer a concern, interactions with nearshore fisheries remain a serious threat to monk seals in the MHI, especially shore-casting and other recreational fisheries managed by the State of Hawaii. Recreational and commercial fishing activities in the MHI affect monk seals through direct and indirect interactions. The extensive use of gillnets in the MHI is thought to have caused the localized depletion of reef fish through its effectiveness and non-selectivity (Gulko et al. 2002), and has also resulted in breakage of coral colonies and the bycatch of endangered species, including Hawaiian monk seals. The first documented monk seal fisheries interaction in the MHI involved a report of a seal drowning in a gillnet off Kauai in 1976. Between 1994-2016, gillnet entanglements resulted in the death of six seals and suspected in the death of 10 other monk seals (Gobush et al. 2016; Harting et al. 2020).

There are no records of monk seals being hooked or entangled in the MHI until 1989. From 1995-2015 there have been seven mortalities attributed to hooking events; all involved seals that had ingested hooks (Gobush et al. 2016; Mercer 2020). Between 1989 and November of 2020, there have been 231 documented hooking events of monk seals (Mercer 2020). Out of these hooking events, 95 seals have been treated for complete removal of gear, and 32 hooked seals were treated for partial removal of gear such as trimming the trailing line (Mercer 2020). However, the majority of seal sighting information collected in the MHI is reported by the general public and is highly biased by location and reporting effort therefore, we expect there are monk seal-fisheries interactions go undocumented and unreported.

### Intentional Killings

As noted earlier, Harting et al. (2020) determined that between 2004–2019, the causes of death with the largest influence on the long-term intrinsic growth rate of MHI Hawaiian monk seals was anthropogenic trauma. They determined that anthropogenic causes of death had a larger effect on the population growth rate than natural causes, and found that of 114 non-fetal deaths, anthropogenic trauma was the greatest among all possible causes of death. Interactions between seals and humans have been a growing issue in the MHI, resulting in seal disturbance, harassment, injury, and even death. In the last 12 years there have been a number of cases of intentional harm to Hawaiian monk seals. These events sometimes result in mortality of the seal, although there have been reports of seals being hit with blunt objects or having objects such as rocks, coral, and logs thrown at them that did not result in death.

The earliest report of a seal being shot in the MHI was in 1989 on Kauai, where a local man admittedly shot an adult female seal in the face then decapitated and partially cut up the carcass. The case was investigated and went to trial and the man was sentenced to one-year imprisonment. This was at a time when there were only a few seals seen in the MHI. It was almost two decades later before there was another documented case of an intentional killing, and in 2009, four seals were killed by gunshot in the MHI. Three of these seals were killed on Kauai, including a pregnant female and her unborn pup, and one seal was killed on Molokai. The only other confirmed gunshot mortality occurred in 2012 on Kauai.

Intentional killings by blunt force trauma have been more difficult to confirm at times. In some rare cases the suspected blunt object, such as a large rock, has been found next to the carcass, but in other cases there was not enough evidence to determine what was used to kill the animal. In these cases, intentional harm is highly suspect based on the evidence and type of ante-mortem trauma present on the carcass, and having ruled out other causes of death from necropsy, the seal's recent sighting history, the condition of the carcass, and the location where the carcass was found. The first documented case occurred in 2011 on the Molokai. Several months later another monk seal was found dead on Molokai in the same general area as the one before. Cause of death was determined to be blunt force trauma to the head in both cases. The number of intentional killings is likely underestimated as it is extremely unlikely that all carcasses are discovered and reported, and intent can be difficult to determine. This threat continues to be a concern for the recovery of the species in the MHI.

#### 4.1.7. Conservation

For each threat identified as a source of negative impacts to monk seals, NMFS, with assistance from our partners, has developed, and implemented targeted conservation and recovery efforts to address that threat. Many of our efforts involve "interventions" targeted at improving the probability of survival for an individual animal (e.g., disentanglement, translocating vulnerable weaned pups from areas of high shark predation to areas of low predation, bringing compromised animals in for rehabilitation, etc.).

NMFS determined that about 30 percent of seals are alive today due to direct interventions to protect and support their survival (Harting et al. 2014). Indirect interventions, such as removing dangerous debris from pupping areas, likely contribute to a higher number of saved seals (Amlin, A. 2020. Pers. Comm.).

As the number of monk seals residing in the MHI continues to grow, interactions with people will likely continue to increase. NOAA and partners have focused much attention on education and outreach to increase understanding of the species needs, and message peaceful coexistence in hopes that this will minimize these conflicts, and enhance the recovery potential and conservation of the monk seal (NMFS 2015).

# 5. ENVIRONMENTAL BASELINE

By regulation, the environmental baseline for a biological opinion 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 (50 CFR 402.02). 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 Consultation Handbook further clarifies that the environmental baseline is "an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the Action Area" (USFWS and NMFS 1998). The purpose of describing the environmental baseline in this manner in a biological opinion is to provide context for effects of the proposed action on listed species.

The past and present impacts of human and natural factors leading to the status of the ESA-listed marine species addressed by this opinion within the Action Area include fishery interactions, vessel strikes and noise, climate change, marine debris, and contaminants. As described in the *Status of Listed Species* section, the action area is within Hawaiian monk seal critical habitat, and therefore plays a significant role in its recovery. Although the proposed action is expected to have insignificant effects to Hawaiian monk seal critical habitat, the action area has habitat features utilized by monk seals and is considered essential to Hawaiian monk seal conservation. The environmental baseline for Hawaiian monk seals addressed by this opinion are described below.

Information in this section is summarized from the several past consultations on the different mariculture operations off Unualoha Point (POH-2003-00-222, PIRO: I-PI-03-302-MMD) (NMFS PCTS: PIR-2009-02013, PIRO: I-PI-09-754-LVA) (I/PIR/2011/02499, I-PI-11-915-LVA) (PIR-2015-9747, I-PI-15-1329-AG). We also used the 2016 *Main Hawaiian Islands Monk Seal Management Plan* (NMFS 2016b), *Recovery Plan for the Hawaiian monk seal* (NMFS 2007), the *Preliminary assessment of monk seal-fishery interactions in the main Hawaiian Islands* (Madge 2016) and the other sources as cited in subsequent subsections. Fisheries Interactions

As described above in the *Status of Listed Resources* section, the Hawaiian monk seal has been and continues to be affected by nearshore fishery interactions. Between 1976 and 2014, 140 hookings and entanglements in active fishing gear have been documented (Gobush et al. 2016; NMFS 2016b). Monk seal injuries have been associated with a variety of hook types from small *damashi* (fly) hooks, which are frequently used to target *menpachi* and *akule* (bigeye scad); J hooks of various sizes which are used to target any number of species by various methods; and large circle hooks which are the most common hooks used, and are frequently associated with the *ulua* (trevally) fishery (Madge 2016).

The proposed action area is located directly offshore of the Natural Energy Laboratory of Hawaii and Kona International airport facilities along the Unualoha Point or Makako Bay shorelines. While there are no public approved shore-based recreation locations in the area, there are public shore recreation areas at Kekaha Kai State Park (Mahaiula) three miles north and Wawaloli Park two miles south. Shoreline fishing is occasionally conducted at Keahole Point, approximately 1-km south of the mariculture farm site.

The boat-based fisheries operating in nearshore waters (within three miles of the coast, including in the action area) utilize nets, traps, handlines, and to a lesser extent troll gear (Madge 2016). Boat-based line methods include: handline, deep-sea handline; inshore handline; *kaka* line; shortline; vertical line; *ika-shibi*; *palu ahi*; and trolling with bait, lures, or greenstick (Madge 2016). Trolling is conducted by towing lures or baited hooks from a moving vessel, using big-game type rods and reels or hydraulic haulers, outriggers, and other gear (NMFS 2009). Boat-based handline fisheries are conducted nearshore for *akule* and *opelu* (mackerel scad) and deep-sea for bottomfish species (Madge 2016).

Data collection encompassing the full possible range of fisheries-monk seal interactions is incomplete and there are no documented monk seal interactions with fishermen in the action area (Madge 2016); however, fishermen are known to troll lures in the action area and occasionally lost fishing gear is found entangled on the facility's grid lines as a result of fishermen trolling too close to the mooring grid (DLNR 2003). Therefore, Hawaiian monk seals in the action area are exposed to potential hookings and gear entanglements from boat-based fisheries and related vessel traffic.

### 5.1 Surface Vessel Traffic and Noise

Recreational vessels and vessels associated with the mariculture operation pose the greatest threat to Hawaiian monk seals in the action area when considering vessel strikes. Hawaiian Monk Seals are highly agile and vessel strikes with monk seals are infrequent (Carretta et al. 2021). According to the Pacific Islands Fisheries Science Center's (PIFSC) database there have been only four verified vessel strikes of Hawaiian monk seals between 1981 and 2016 (John Henderson, PIFSC 5/4/17).

According to a boat-based recreational use survey (DLNR 2003) of the action area during August and September in 2001, out of 92 boat observations, the most common recreational boat use was diving along the Unualoha shoreline (49%). Other common uses included diving along the Makako Bay or Hoʻona Bay shoreline (23%) and transiting offshore or inshore of the net pen site (18%). Observations were classified by location (net pen site, offshore of the net pen site, Unualoha Shore, Makako Bay, and Hoʻona Bay) and activity (diving, trolling, sailing, and transiting).

In addition to creating a risk of vessel strike, much of the increase in sound in the ocean environment over the past several decades are due to increased shipping, as vessels become more numerous and of larger tonnage (NRC 2003; Hildebrand 2009; Mckenna et al. 2012). Although, large ships will not be within the action area, the low-frequency sound from vessel traffic can be heard far from its source. While commercial shipping appears to be a primary source of anthropogenic noise pollution in the ocean, 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.

Like other marine mammals, the Hawaiian monk seal may be impacted by anthropogenic sound from vessel traffic in various ways. It can produce direct physical harm or may illicit behavioral responses including, but not limited to, cessation of feeding, resting, or social interactions, changes in habitat to avoid areas of higher sound levels, or changes in diving behavior (MMC 2007).

### 5.2 Previous Mariculture Operations

The mariculture facility off Unualoha Point along the Kona Coast on Hawaii Island has been in operation since 2003 when the USACE requested a consultation (POH-2003-00-222, PIRO: I-PI-03-302-MMD) to permit the operation of a fish farm to accommodate an array of submersible fish cages with a mooring and anchor array.

The most recent ESA consultation was on March 13, 2015 with USACE to accommodate changes in the Conservation District Use Permit to replace the existing net pen grid system with additional net pens with increased net pen volume (NMFS PCTS: PIR-2015-9588, PIRO: I-PI-15-1242-AG).

In 2014, Blue Ocean Mariculture employees began to record any observations of marine mammals in the action area and shared these reports with NMFS. These sightings are documented by employees from 8:00am to 3:00pm. Sightings are direct observations from either Blue Ocean employees on the vessel or in the water as they tend to other mariculture duties. Therefore, sightings are opportunistic and not conducted at designated times throughout the day.

There were only 12 documented observations of Hawaiian monk seals in 2014 however this number grew to 50 in 2015. In 2016, the number of monk seal observations dropped to 27 and increased to 87, 178, 290, and 232 in 2017, 2018, 2019, and 2020 respectively (Figure 8). As of June 2022, there have been 69 observations of monk seals. However, it is important to note that these observations are opportunistic and not standardized to any methodology that would allow us to determine whether the emerging number of observations represents a significant increase in the number of monk seals visiting the site, or merely a reflection of the increased effort of employees to look for monk seals.

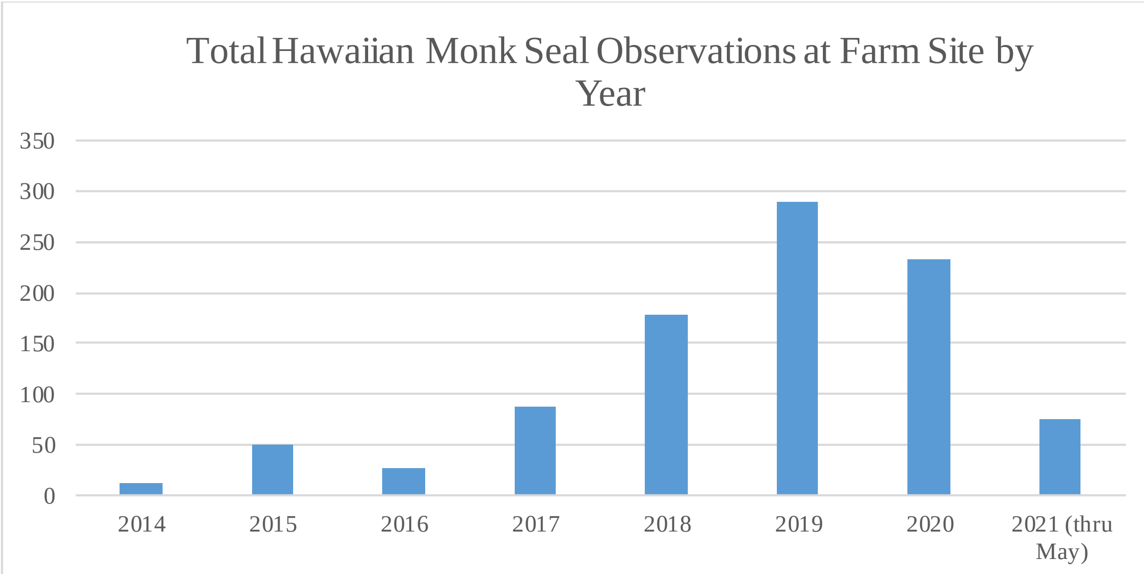

Figure 8. Hawaiian monk seal observations documented by Blue Ocean Mariculture employees from 2014 through May 2021. Observation data is derived from the protected species reporting and monitoring reports submitted to NMFS.

In 2017, NMFS was notified by Blue Ocean Mariculture that a dead adult male Hawaiian monk seal identified as RB18, was found in an empty, recently retired, net pen on the farm site. According to Blue Ocean Mariculture, the monk seal entered the submerged net pen through a 1,600-sf opening in the netting created by their crew the previous day, but did not exit the pen when it required air.

The most recent incident was on March 24, 2021, when Blue Ocean Mariculture reported a monk seal, believed to be R8HE, swimming inside a fully raised net pen. The seal was observed swimming freely and unhindered inside of a retired pen that had recently had its inventory of fish transferred. The monk seal is assumed to have entered the retired pen by pushing its body weight up against a weak panel creating a beach ball-sized hole in the CAM netting on the north side of the pen. Fortunately, as a result of a protocol change stemming from the 2017 incident described above, the pen had been raised with a 15-ft air gap, so the seal could swim to the surface when it required air. To release the seal, Blue Ocean Mariculture employees opened a portal on the west side of the net pen to facilitate the seals' exit. The seal swam around the newly opened portal but did not swim out and eventually swam out of the hole it created to enter the pen.

### 5.3 Changing Global Climate

Climate change is projected to have substantial direct and indirect effects on the structure and function of the marine ecosystems and the species and populations that occur in the marine environment. Habitat loss or alteration, distribution changes, abundance of prey and predators are examples of primary effects of climate change on individual species. Secondary effects include increased stress, disease susceptibility, and predation. The risk of extinction due to climate change is expected to be greatest for those species already vulnerable (Isaac 2008).

Climatic changes are likely to result in changes to the range and distribution of prey species as well as to the composition and dynamics of the surrounding marine system (Parmesan 2006). Warming trends in tropical systems may be associated with range shifts towards more temperate areas (Parmesan 2006). The bathymetric features and isolation of the Hawaiian Islands may not provide the additional available habitat for large- scale dramatic shifts. Therefore, there is uncertainty on these effects to the Hawaiian ecosystem. Impacts may be seen locally in changes in species composition and distribution. The biological diversity of tropical systems may be at stake as the combined forces of warming temperatures and ocean acidification put additional stress on ecosystems built around coral reefs (Hoegh-Guldberg et al. 2007; Parmesan 2006). With increased acidification, calcium- dependent species seem to be at the highest risk. When entire systems are built around those species (e.g., coral) then habitat loss for the reef-dependent species could result in broad scale shifts that, in turn, may be felt by higher predators (Hoegh-Guldberg et al. 2007). The varied diet of the Hawaiian monk seal is likely to be impacted by changes in prey diversity, abundance, or dynamics.

There can be little doubt that the prey base of Hawaiian monk seals undergoes considerable variation driven by environmental fluctuations. Climate changes in the central North Pacific from the mid-1970s to the 1980s appear to have reduced productivity by 30-50% at various trophic levels (Polovina et al. 1994 as cited in NMFS 2007). The trend for the density of reef fishes declined by an average of 27% between 1980-1983 and 1992, but it could not be determined if this value was different than zero due to the low statistical power (0.80) of the analysis (DeMartini et al. 1996).

In the 1980s, the survival rate of monk seal pups declined by varying degrees from about 90% to 40% in 1992 (Polovina 1994 as cited in NMFS 2007), coincident with a change in climate. It is conceivable that the lower system productivity at this time caused adult females to have lower foraging success, resulting in pups with smaller size at weaning and lower survival. However, it may be that food availability for juveniles is the primary bottleneck, as Craig and Ragen (1999) found in the mid-1990s when even large weaned pups at FFS had very poor subsequent survival. Weaned pup size was greatest following El Niño events at Laysan and FFS, further suggesting a possible linkage between oceanographic change and female foraging success prior to parturition (Antonelis et al. 2003).

Rises in sea level will decrease terrestrial haulout areas utilized by Hawaiian monk seals for refuge from predators, birth, nursing, resting, and molting; especially in the low lying areas of the Northwest Hawaiian Islands (Baker et al. 2006). Additionally, there is a general consensus that the intensity of tropical storms may increase as a result of global warming (IPCC 2007). This increase in intensity may lead to dramatic shifts in the coastlines and changes to available haulout sites, due to erosion from intensified storm activity (Baker et al. 2020). Changes that may occur to the coastline are not predictable at this time. Overcrowding at haulout sites or competition for suitable haulout areas from land loss could result in demographic changes for the species. However, these changes would be difficult to understand or predict, since density dependence in terms of the amount of terrestrial habitat available has not been documented for the species (Baker et al. 2006). In the MHI, habitat loss resulting from sea level rise may be less extreme. The loss of suitable haulout areas may increase interaction with humans, as Hawaiian monk seals and humans compete for viable coastal habitat and available resources.

Ocean warming in tropical climates raises additional concern with regards to disease. Growth rates of marine bacteria and fungi are positively correlated with temperature and increased ocean temperatures may also increase the range of pathogens (Harvell et al. 2002; Parmesan 2006). The complexity of ecological interactions in these marine systems makes it difficult to predict what these large scale global changes will do to the dynamics and demographics of species in these systems or the action area.

### 5.4 Contaminants and Infectious Disease

Persistent organic pollutants (POPs) are organic molecules, such as polychlorinated hydrocarbons, which persist in the environment and bioaccumulate with potential adverse impacts on human and animal health. The majority of POPs originate from industrial, urban, and agricultural activities from both local and remote sources (Lopez et al. 2012). Historic military use of the NWHI has resulted in known and unknown contamination of this remote island environment (Antonelis 2006). The Hawaiian Islands are susceptible to local sources of POPs as well as those transported across the Pacific Ocean (Lopez et al. 2012).

Not surprisingly, Lopez et al. (2012) found that seals that spent time around Oahu, an island with a long history of military activities and Superfund sites, as well as the largest populations and industrial operations in current times, had higher levels of POPs in their serum in comparison to the other islands. However, given the overall success and reproductive rate of seals in the MHI, POP contamination does not appear to limit growth at the population level although it may adversely affect the health of individual seals (Lopez et al. 2012).

A study by Opp et al. (2015) analyzed hair from 51 adult female seals in the NWHI and MHI to quantify total mercury concentration and stable isotope ratios of carbon and nitrogen as indicators of feeding ecology. Elevated mercury concentrations, above adverse outcomes criteria levels of > 20ppm, were evident in some individual seals ($n = 8$) residing in the NWHI suggesting that these seals may be foraging at higher trophic levels based on radioisotope values (Opp et al. (2015). There are many unknowns regarding the effects of contaminants on the Hawaiian monk seals health and reproduction. According to Opp et al. (2015), these preliminary results suggest that potential causes for elevated mercury levels in some seals warrants further exploration.

Due to the ubiquitous presence of humans, pets, feral animals, livestock, and terrestrial wildlife, seals residing in the MHI are exposed to a larger suite of diseases in comparison to the seals in the remote NWHI (Littnan et al. 2006). Consequently, *Toxoplasma gondii*, a microscopic parasite found in cat feces that causes toxoplasmosis, has killed at least 13 monk seals in the MHI in the last two decades (NMFS 2020b). During a single week in 2018, three monk seals on Oahu died from toxoplasmosis and in 2020, two additional seals were diagnosed with this cat-borne disease, and both of these seals have died (NMFS 2020b). While feral cats in the MHI are a leading cause of monk seal mortality, and a growing concern, there have been no known toxoplasmosis deaths documented on the island of Hawaii (Amlin, A. 2020. Pers. Comm.) however, it is important to note that not all seals that perish are found and necropsied.

### 5.5 Synthesis of the Environmental Baseline

Hawaiian monk seals have been exposed to a wide variety of the past and present state, federal, and private actions in the *Action Area*, which includes of all proposed federal projects in the *Action Area* that have already undergone formal or early consultation, and state or private actions that are contemporaneous with this consultation. While the impact of those activities on the status, trend, or the demographic processes of Hawaiian monk seals is largely unknown, some are likely to have had and will continue to have lasting effects on individuals that use this action area. The preceding section addresses the effects fisheries interactions, vessel strikes and vessel noise, previous mariculture operations, global climate change, pollution from contaminants, and infectious disease has had on Hawaiian monk seals. Some of these stressors have resulted in mortality (e.g., net pen entrapment), whereas other stressors (e.g., noise) may induce sub-lethal responses like changes in behavior that could impact important biological functions such as feeding or breeding.

The stress regime created by the activities discussed in this *Environmental Baseline* continues to have a serious and adverse impact on Hawaiian monk seals in the action area even though there is compelling evidence that the abundance of seals has been growing since 2013. While there may be an increasing population trend, monk seals are still at risk of extinction due to both environmental and demographic stochasticity.

Although fisheries interactions account for at least 231 documented hooking events of monk seals between 1989 and November of 2020 in all of Hawaii (Mercer 2020), due to the limited availability for the public to engage in shoreline fishing near the action area, the distance of the action area from the shoreline, and the risk of fishing gear entanglement in the net pen array from boat-based fisheries, the risk of fisheries interactions with monk seals is relatively low compared to other areas.

Of the other activities and their associated stressors, the propensity of vessel strikes to go unnoticed or unreported by vessel operators impedes an accurate assessment of the magnitude this threat poses to Hawaiian monk seals.

Lastly, of all activities and their associated stressors in the action area, mariculture operations present the highest risk to Hawaiian monk seals. Since 2003, Hawaiian monk seals in the action area have been exposed to risks of entanglement and entrapment, and have been attracted to the net pen array.

# 6. Effects of the Action

Under the ESA, "effects of the action" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that shall be added to the environmental baseline. 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 (see 50 CFR 402.17).

We are evaluating the effects of continuing the operation of the five existing net pens, and the effects associated with adding three net pens to the existing array. As the net pens are presently operating, all data and observations presented in the BE and reports are from the existing net pens, so we can expect all of those effects to continue. We also considered the proposed increase of three additional net pens to the action area, and any increases in the amount, extent, severity, frequency, duration, or probability of exposures, injuries, or other harmful stressors. We evaluated the effects of both the existing net pens, and the predicted effects from the addition of net pens.

The stressors likely to adversely affect Hawaiian monk seals associated with the proposed action include the attraction of monk seals to the action area, and associated behavioral changes and potential dietary shifts, and entrapment in a net pen. We determined the increase of the number of net pens in the action area, exposure to wastes, discharges, or decreased water quality, direct physical impact, vessel collisions, attraction of predators to the area, entanglement in net pens, and disturbance from human activity are not likely to adversely affect Hawaiian monk seals (Appendix A).

In this section we evaluate the exposure and response only to the stressors that are likely to adversely affect Hawaiian monk seals; attraction of ESA-listed species to the area and net pen entrapment.

### 6.1. Exposure

As discussed in the Approach to the Assessment section of this opinion, exposure analyses are central to our assessment of the effects of actions as part of these analyses, we try to estimate the number, age (or life stage), and gender of the individuals that are likely to be exposed and identify the populations or subpopulations those individuals represent.

#### 6.1.1. Spatial and Temporal Patterns of Exposure

In January of 2020, Blue Ocean employees began using an updated, more comprehensive reporting and monitoring report supplied by NMFS. Additional data elements collected include: the net pen number where the seal was observed, status of the net pen, i.e. raised or submerged, how the seal was observed, i.e. while diving or in a vessel, and identifying marks or scars. Since the inception of this form in January 2020, the following seals have been identified by tag number: RL50 (23 observations), RB00 (12 observations), R8HE (16 observations), and RW34 (14 observations). The exhibited behavior of these seals was interacting with pen, interacting with other species (e.g., sharks), and swimming. As demonstrated below in Table 5, since 2018 the identification of individual seals from flipper tags or bleach-markings, and identifying physical descriptions (i.e., large seal, and scar on back) has increased.

Table 5. Number of identifications of each seal documented by Blue Ocean Mariculture from 2016 through May 2021. Observation data is derived from the protected species reporting and monitoring reports submitted to NMFS. *HI was the applied bleach number for RW34.

| Year | R8HE (big scar on back) | RB00 | RL50 | RK26 | RW34, HI* (large seal) |
|---|---|---|---|---|---|
| 2016 | | | | | |
| 2017 | 1 | | | | 1 |
| 2018 | 1 | 1 | | 1 | 1 |
| 2019 | | 2 | 9 | 1 | 7 |
| 2020 | 13 | 9 | 22 | | 2 |
| 2021 | 1 | | 1 | 1 | 3 |

Since 2014, Blue Ocean Mariculture employees have been providing a protected species reporting and monitoring report to NMFS on a quarterly basis. Reported observations are opportunistic and not standardized to any methodology that would allow us to determine whether there is an increasing trend in monk seals visiting the site. However, there have been more reported observations of Hawaiian monk seals over time in Blue Ocean's monitoring reports.

The monitoring report data fields include: 1) the date and time of the observation; 2) the ESA-listed species or marine mammals observed including the quantity, the behavioral activity, type of interaction, and tag number; 3) number of fish escapes; and 4) the name of the Blue Ocean employee documenting the event. Previous to improvements, the only information provided was the date and time, species name, and the name of the employee documenting the observation. Blue Ocean Mariculture employees derived data from the protected species reporting and monitoring reports submitted to NMFS. There were only 12 documented observations of Hawaiian monk seals in 2014, however, this number grew consistently to 290 in 2020.

When the number of monk seal observations are grouped by month (Figure 9), an increase of documented observations during August and September is evident. The reason for this increase during these two months is unknown. These observations are documented during daylight hours from 8am to 3pm each day of the week. Consequently, we do not know the frequency of monk seal visits to the net pens during the hours outside of this period. Because the mariculture net pens are less than a mile from the shoreline, if monk seals from the other islands are visiting the net pen, we would expect to see them haulout on the island of Hawaii before returning to their preferred island (Mercer, T. 2018. Pers. Comm.). Therefore, based on the typical behavior of Hawaiian monk seals and the NOAA monk seal sighting database, the seals that regularly haulout on Hawaii Island are thought to forage locally in nearshore waters of Hawaii Island. However, this may include seals that are feeding at the net pens as well as those using more natural food sources (Mercer, T. 2018. Pers. Comm.).

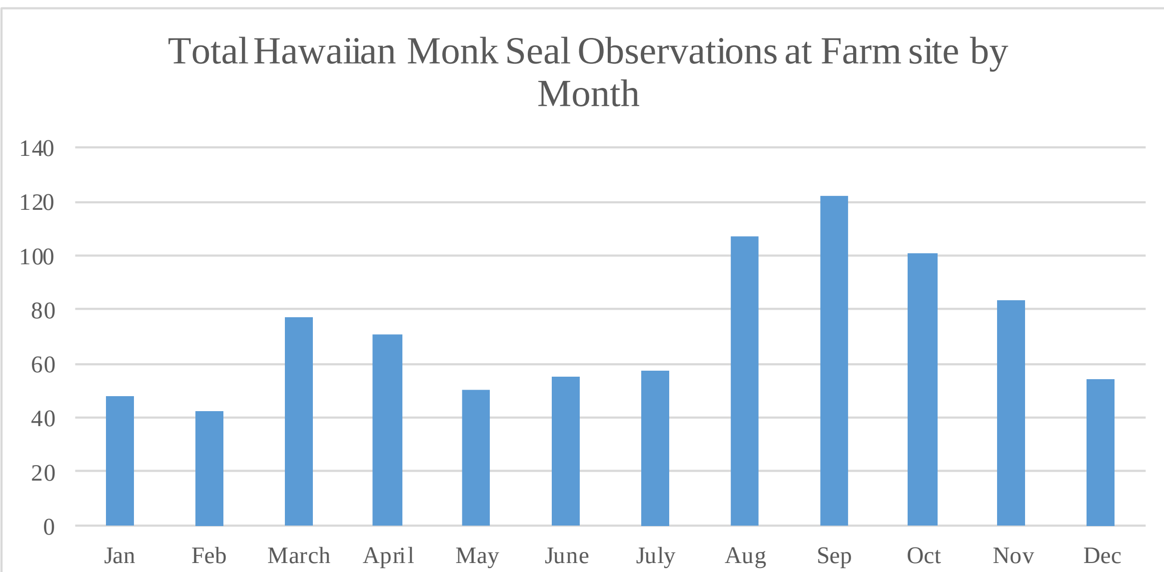


Figure 9. Hawaiian monk seal observations documented by Blue Ocean Mariculture employees from 2014 through May 2021. Observation data is derived from the protected species reporting and monitoring reports submitted to NMFS.

### 6.1.2. **Demographic Patterns of Exposure**

The NOAA monk seal sighting database contains sighting information and observations of monk seal haulouts on all islands in Hawaii. These sightings and observations stem from public reports and data collected from NOAA partners. The seals on Hawaii Island, are regularly documented by the Marine Mammal Center Ke Kai Ola (KKO) monk seal volunteers as well as the public at large. NMFS queried the monk seal sighting database for all seals regularly sighted on Hawaii Island from 2009-2018. "Regularly sighted" was defined as 50 or more sightings within the last 10 years. Seals were eliminated from the analysis if the seal identification number was not available or if a seal was in rehab at the KKO. Notable exclusions include two seals; RO42 who was born on Hawaii Island in 2006 and translocated for human interaction and safety concerns to Nihoa in 2009, and RN02, born on Hawaii Island in 2013 and translocated for human interaction and safety concerns to Niihau in 2013. In addition, all sightings are associated with a beach with a standardized name; therefore, sightings with no location recorded were excluded from the analysis.

The ten seals included in the sample that regularly haulout on Hawaii Island include six females and four males. However, as noted in Table 6, two female Hawaiian monk seals have not been sighted in at least two years and are presumed dead, and RB18, as described in the *Consultation History*, was found dead in a net pen at the Blue Ocean Mariculture farm in 2017. As of March 2022, there are seven monk seals that regularly haulout on Hawaii Island, and five of them (highlighted in blue) have been documented by their tag number on the protected species monitoring form maintained by Blue Ocean Mariculture. However, we presume that RA20 also frequents the pen area since she hauls out within 5 km of the mariculture farm, and because her distinguishing marks are less obvious, she may be more difficult to identify. Consequently, if monk seals from the other islands are visiting the net pen, we would expect to see them haulout on the island of Hawaii before returning to their preferred island (Mercer, T. 2018. Pers. Comm.). Several of the females on Big Island are of prime breeding age, and some pups have recently been added to the local population (e.g. RL50). In total, at least six seals are likely exposed to the mariculture farm and its activities, and this number may increase as more pups are reared on the island of Hawaii and may learn to frequent the farm to feed on pen-raised Kampachi. Based on the abundance estimate by Caretta et al. (2021), ~2% of seals that reside on the MHIs are exposed to the mariculture operations.

Table 6. Hawaiian monk seals that have regularly hauled out on Hawaii Island from 2009-2019. The seals highlighted in blue have been identified by Blue Ocean Mariculture employees at the net pen array (NMFS unpublished data).

| No. | Gender | Age | Tag # |
|---|---|---|---|
| 1 | female | Juvenile, 5 yr. | RK26 |
| 2 | female | Adult, 15 yr. | RA20 |
| 3 | female | Adult, 12 yr.[1] | R8HE |
| 4 | female | Adult, 15 yr. | RW34 |

| No. | Gender | Age | Tag # |
|---|---|---|---|
| 5 | female | Adult, 16 yr. | RB00 |
| 6 | male | Adult, 20 yr. | RI05 |
| 7 | male | Died in the net pen in 2017 | RB18 |
| 8 | female | Not sighted since 2016, presumed dead | R4DF |
| 9 | male | Not sighted since 2013, presumed dead | R015 |
| 10 | male | Juvenile, 5 yr.[2] | RL50 |

[1]This seal was not given a cohort tag because it was not initially tagged as a pup, therefore her age is an estimate.
[2] This seal was weaned after the heat map analysis was completed. He hauls out near the net pen array and Blue Ocean employees have observed him at the farm and notified NMFS on April 22, 2020 that RL50 had a hook in its mouth.

### 6.1.3. **Attraction to Net Pens**

The potential for attraction of Hawaiian monk seals to the net pens may be associated with the following scenarios:

- Feeding on pelleted food washed outside of net pen
- Feeding on farm fish escapes from the net pens
- Increased aggregation of marine life in net pen area
- Feeding on farm fish through the net pen mesh

#### Pelleted food (intended for the farm fish) washing outside of the net pens

While no monk seal has been observed consuming pelleted food, the attraction of these animals to the net pens could conceivably occur if large amounts of fish food regularly escaped from the net pens and monk seals consumed the pelleted food. Fish in a given net pen are fed daily, 2-4 per day and each 30 to120-minute feed event is monitored by divers or via camera to prevent excess feed from exiting the net pen. Divers communicate with feeders on the boat to adjust feed rates based on the feeding intensity of the fish ball. As described in USACE's BE, feed is delivered to the submerged net pens from a stationary feed barge through a flexible 3" plastic hose to minimize feed escaping the net pens. Based on the diet and typical foraging behavior of monk seals, and Blue Ocean Mariculture's protocols to limit the amount of pellets that escape, this scenario is extremely unlikely and therefore discountable and not considered further in this analysis.

## Farm fish escapes from the net pens

Hawaiian monk seals may be attracted to the net pens to forage on farmed fish that escape from the net pens. USACE notes in their 2018 BE that when fish escape from the net pen, they tend to stay near the pen, often below it for protection from predators. Escaped production fish can become an easily accessible food source for Hawaiian monk seals. As part of the submerged land lease, when an escape event occurs, Blue Ocean Mariculture must inform Hawaii's Department of Land and Natural Resources. Historical fish escapes have been a result of breaks or tears in the net pen netting caused by a failure in the netting material, improper rigging, or from predators in pursuit of contained fish, as described in USACE's BE. To date, no fish have escaped during the harvesting process (Korte, T. 2018. Pers. Comm.). There have been 12 escape events at the farm site since 2011 and the most recent fish escape was in March of 2020, when a monk seal likely grabbed and removed a previous patch repair creating a hole in the Kikkonet releasing 50-100 Hawaiian Kampachi (Korte, T. 2018. Pers. Comm.).

As noted earlier, to reduce the frequency of escapes, in 2015 Blue Ocean Mariculture eliminated older, Dyneema (nylon) netting from its net pens as part of the most recently permitted action and now uses a combination of Kikkonet (polyester monofilament) and CAM (metal copper alloy mesh). As described in the BE, net pens are inspected daily during the feed observation and mortality retrieval dives. Any broken net bars, holes, or unusual situations found during the inspection are fixed and reported immediately. Inspection dives on the net pen array are conducted weekly. Anchor tension is inspected monthly. Due to the improved inspection and maintenance protocols, we assume a few fish may escape the net pens occasionally, but a large event is not reasonably to certain to occur.

## Increased aggregation of marine life

The aggregate effect of mariculture net pens is analogous to the effect of fish aggregation devices (FADs) (Sanchez-Jerez et al. 2011). According to Dempster et al. (2002) and Bjorndal and Skar (1992), sea-cage fish farms act as FADs but with higher food availability which enhances the attractive effect when compared to traditional FADs. Although monk seals are not typically mid-water foragers, they could be attracted to the farm to feed on marine biota attracted to the area. While an unusual feeding strategy for monk seals, Blue Ocean Mariculture's offshore farm manager Tyler Korte, noticed an increase in monk seal visits to the farm shortly after a mackerel scad (locally known as opelu) spawning event and witnessed monk seals feeding on scraps of fish remaining after bottlenose dolphins were feeding on the opelu (Korte, T. 2019. Pers. Comm.). Common marine species sighted at the Blue Ocean Mariculture farm tend to be large predators and include opelu, barracuda, giant trevally (locally known as ulua), oceanic black tip sharks, tiger sharks, bottlenose dolphins, and the occasional whale shark.

## Feeding on farm fish through the net pen mesh

The Hawaiian monk seals that are attracted to the net pens are presumed to be foraging on farm fish inside the net pen, specifically dead farm fish. Moribund fish are lifted by the current and pushed against the cages, where monk seals could grab a tail or other piece of the body. Even if a moribund fish reaches the bottom of the net pen, and does so before or after manual removal by BOM staff, the strong currents can lift them up and push them up against the net pen wall (Korte, T. 2021. Pers. Comm.). As described in USCE's 2018 BE, moribund fish are removed daily by divers inside each net pen. To limit the number of mortalities in the net pens, fish are culled at the hatchery, wherein small or deformed fish are discarded. Mortalities may stem from a fish being out competed for food and over time, the stress from the feeding events causing it to die (Korte, T. 2018. Pers. Comm.). According to Tyler Korte, the Farm Manager, Hawaiian Kampachi are monitored for mortality, and have a natural mortality rate of 0.01%. If mortality is observed to be > 0.04%, they inspect the pens again later in the day to remove any additional moribund fish (Korte, T. 2018. Pers. Comm.). Mortalities are typically collected post feeding. Divers enter the net pen through a 6-foot zipper and check for mortalities around the bottom cone, mid-panel circumference, and surface areas. All mortalities are removed from the cages using mesh hand bags and returned to the vessel. As noted in USACE's 2018 BE, mortalities are stored in leak proof bins inside water tight disposal bags on the vessel for on-shore disposal, and no mortalities are intentionally discarded at sea. Blue Ocean Mariculture staff estimate the mortality rate by hand counting each fish that transitions to an offshore net pen and documenting mortalities into a daily log.

As described in USACE's BE, in April 2015, a diver saw a monk seal interacting with the pen When the seal noticed the diver inside the net pen collecting dead fish, the monk seal opened its mouth showing its teeth, presumably as a threat display. Videos and pictures taken by the public and posted on social media clearly show monk seals exhibiting prey seeking behaviors (i.e. as swimming back and forth adjacent to the net pen focused on the exterior netting), and a monk seal next to a net pen with a Hawaiian Kampachi in its mouth with an interested bottlenose dolphin nearby. Given the above evidence, we assume monk seals regularly feed on fish from the net pens.

### 6.2. Response

A response analysis determines how listed individuals are likely to respond after being exposed to an action's effects on the environment, or directly on the listed species themselves. Our assessments try to detect the range of probable responses and how these might reduce the fitness of the individuals. Ideally, our response analyses consider and weigh evidence of adverse consequences, or beneficial consequences.

The most significant response of Hawaiian monk seals to the attraction to the net pens is the resulting behavior modification, such as shifts in monk seal haulout behavior and changes in feeding behavior, including learned feeding behavior by pups. These responses have likely resulted in health implications, including decreased fitness, unnatural weight gain, increased lactation periods, and increased human-seal interactions. As described in the consultation history and exposure section, over a 7-year period, two monk seals have become entrapped in a net pen, and resulted in the death of one seal.

#### 6.2.1. **Shift in monk seal haulout behavior**

To assess whether there had been a detectable change in monk seal haulout behavior, NMFS compiled monk seal sightings into haulout area "heat maps" for the Hawaii Island seals. This analysis included all seals regularly sighted on Hawaii Island from 2009-2018. The nine seals included in the haul out analysis are listed in Table 6; RL50 was only weaned in 2019 and not included in the analysis.

Near-net pen beaches are defined as those beaches within 5 km north or south of the mariculture farm (Figure 10). The haulout area analysis (Figures 11- 19) computed the proportion of each sample seal's reported haulout that was on beaches near net pens, and these proportions were plotted for each year the seal was sighted. A single coordinate was used to plot each beach location which was derived from the place names data layers for the State of Hawaii. The kernel density estimator was used in ArcGIS to identify hot spots in point aggregation, and:

- Point density was computed in circular neighborhoods with 5 km radius (0.045 degree map units)
- Heat maps were plotted with a cell size of 1 km (0.009 degree map units)
- Heat maps were plotted on a color ramp indicating deciles (every 10%) of point concentration

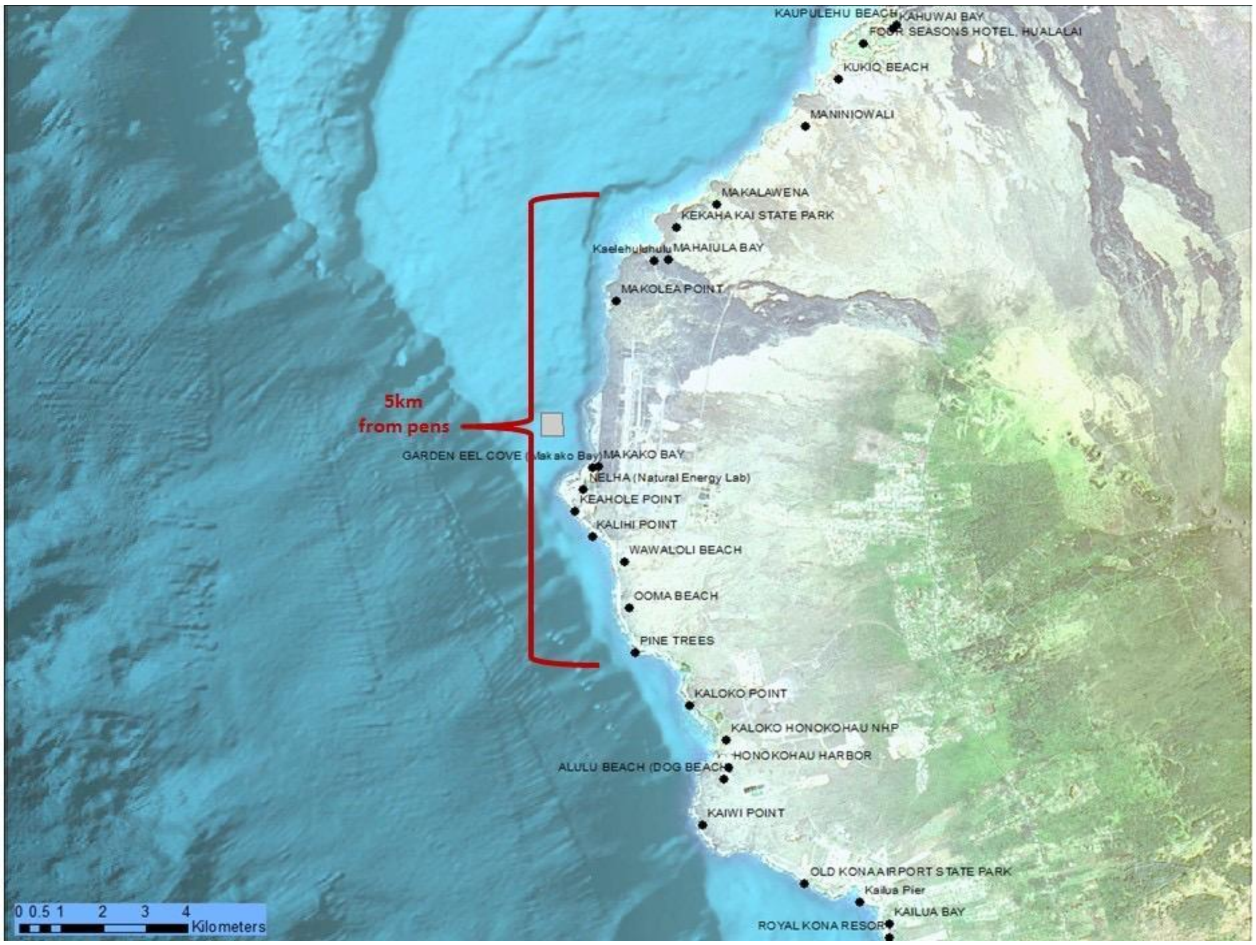


Figure 10. Near-net pen beaches are defined as those beaches within 5 km north or south of the mariculture farm (NMFS unpublished data).

The female pup weaned in 2018, RK26, has only been sighted hauling out at near-pen beaches (Figure 11). Her mother, RA20, also frequents near-pen beaches and is discussed in more detail below. On June 19th 2018, RK26 was observed by Blue Ocean employees and her tag numbers (K26/K27) were recorded on the protected species monitoring report.

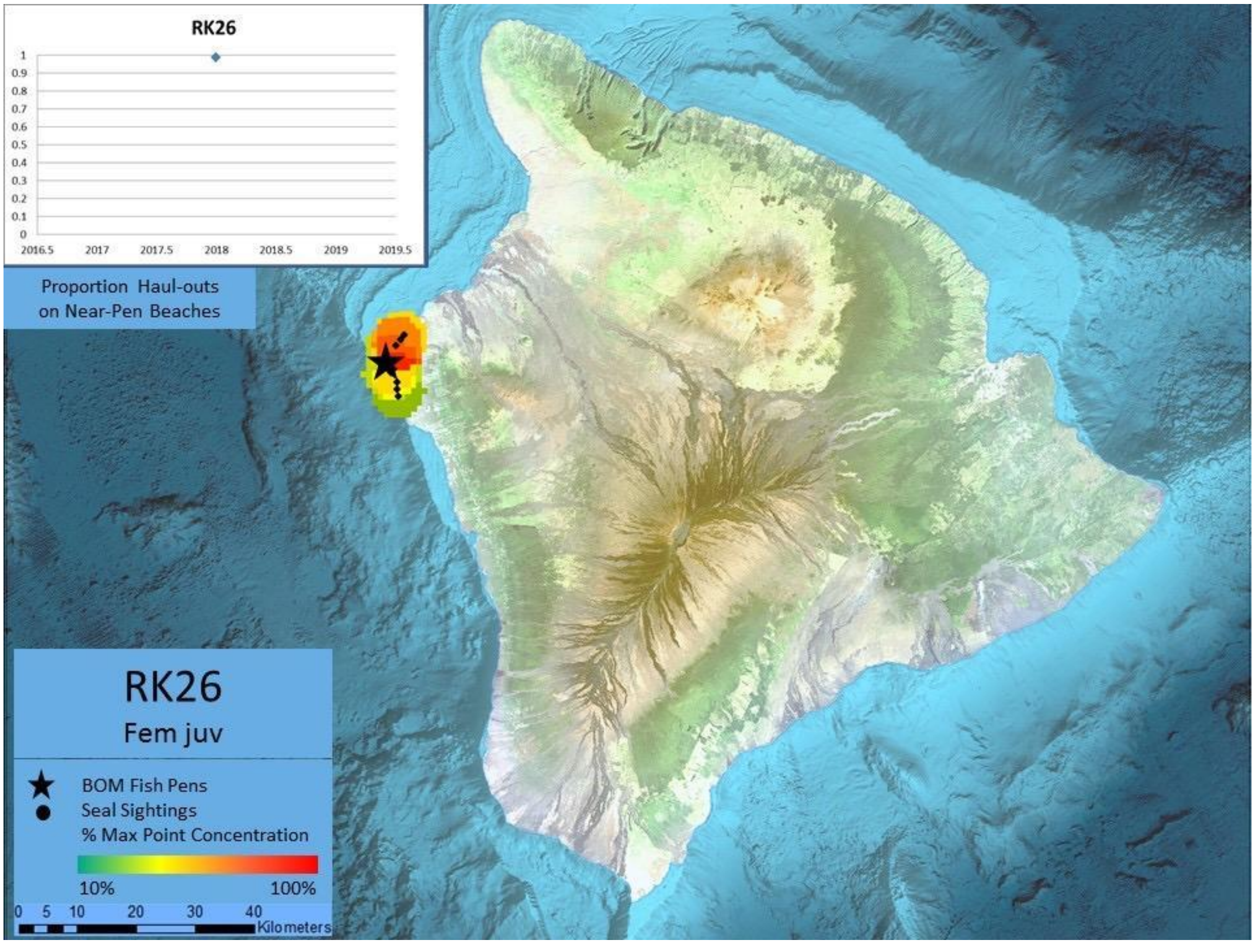


Figure 11. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal RK26 (NMFS unpublished data).

The fourteen year old adult female, RA20, tends to haulout on the northwestern side of Hawaii Island as seen in Figure 12 below. In 2016, her haulout preference shifted to near-net pen beaches and at least 70% of her haulouts were within 5 km of the mariculture farm. The percentage of haulouts at near-net pen beaches drops in 2017-2018 but remains above 45%.

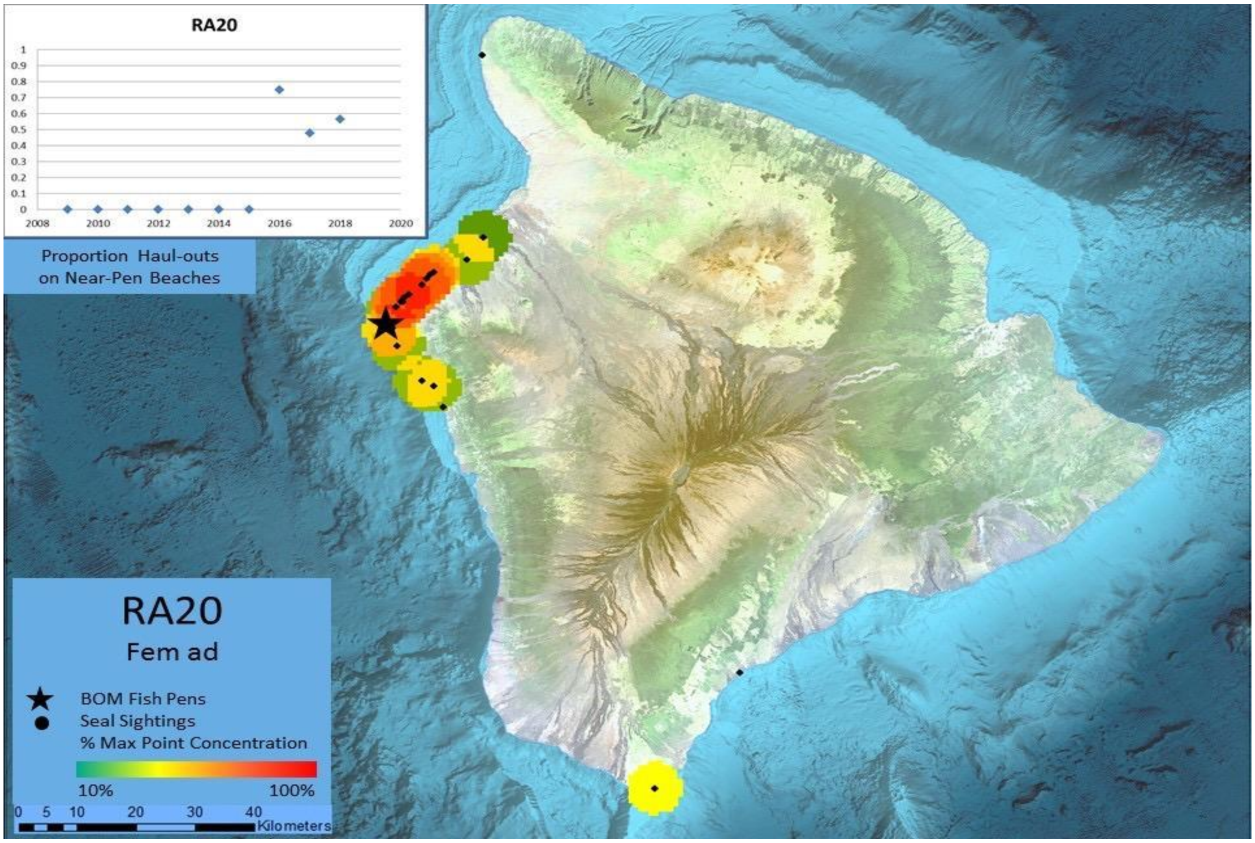

Figure 12. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal RA20 (NMFS unpublished data).

Since 2015, the adult female monk seal R8HE in Figure 13 below has been commonly sighted at near-net pen beaches and in 2017, 100% of her haulouts were recorded at near-net pen beaches. She is presumed to be the seal that breached the retired net pen on March 25, 2021.

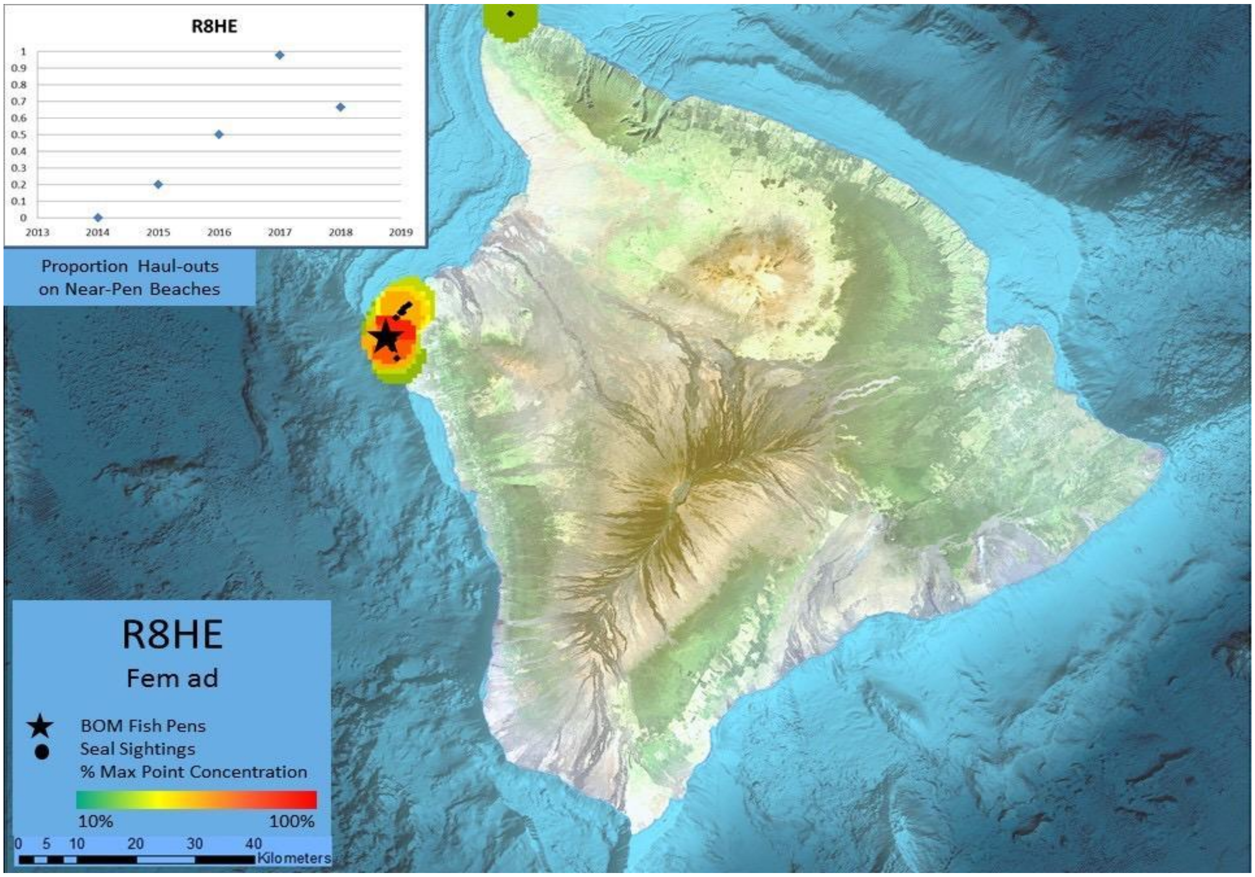


Figure 13. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal R8HE (NMFS unpublished data).

Adult female RW34, has also showed a preference for near-net pen beaches (Figure 14). The proportion of haulouts on near-net pen beaches grew from 40% in 2015 to close to 100% in 2018.

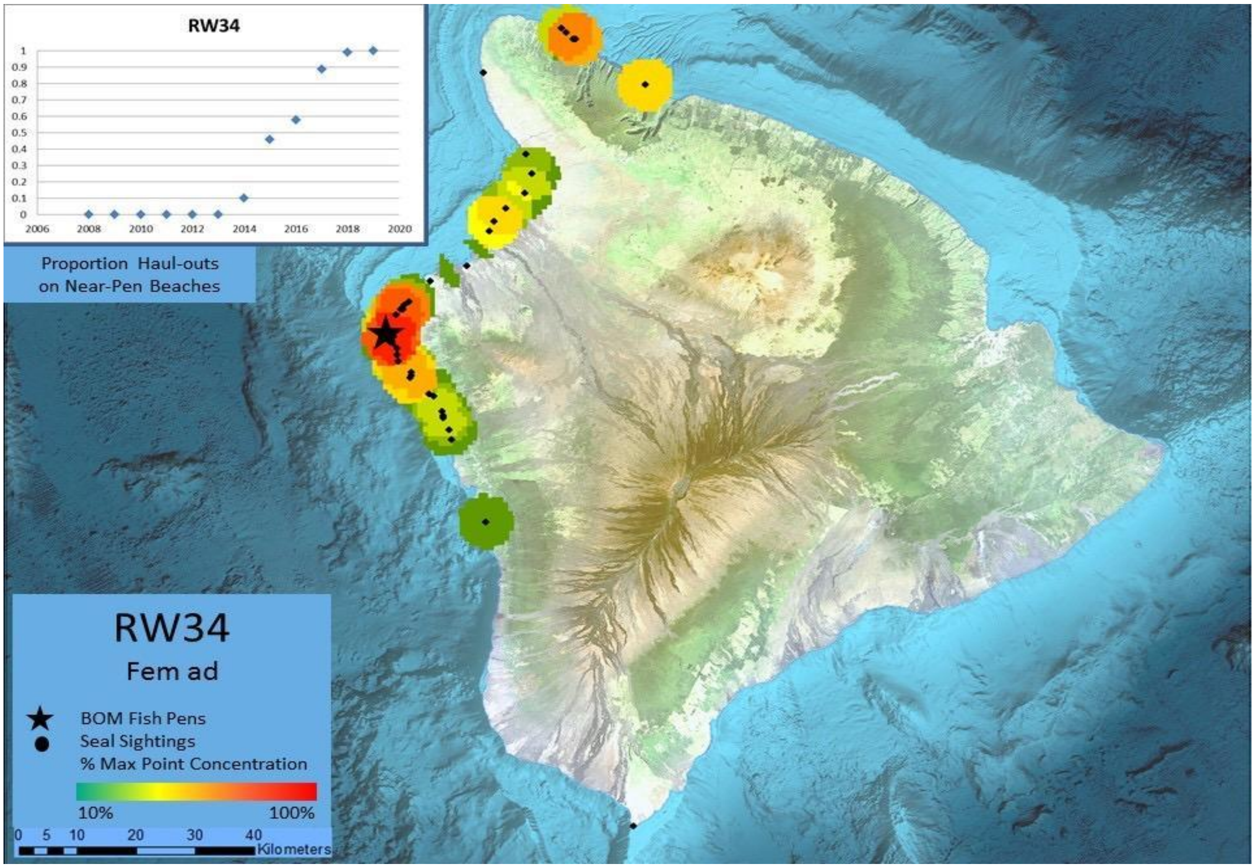


Figure 14. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal RW34 (NMFS unpublished data).

Since 2017, adult female RB00, as seen in Figure 15, has been commonly sighted at near-net pen beaches, around 40% of her haulouts were 5km from the mariculture farm. RB00 was observed by Blue Ocean employees and her tag number (B01) was recorded on the protected species monitoring report.

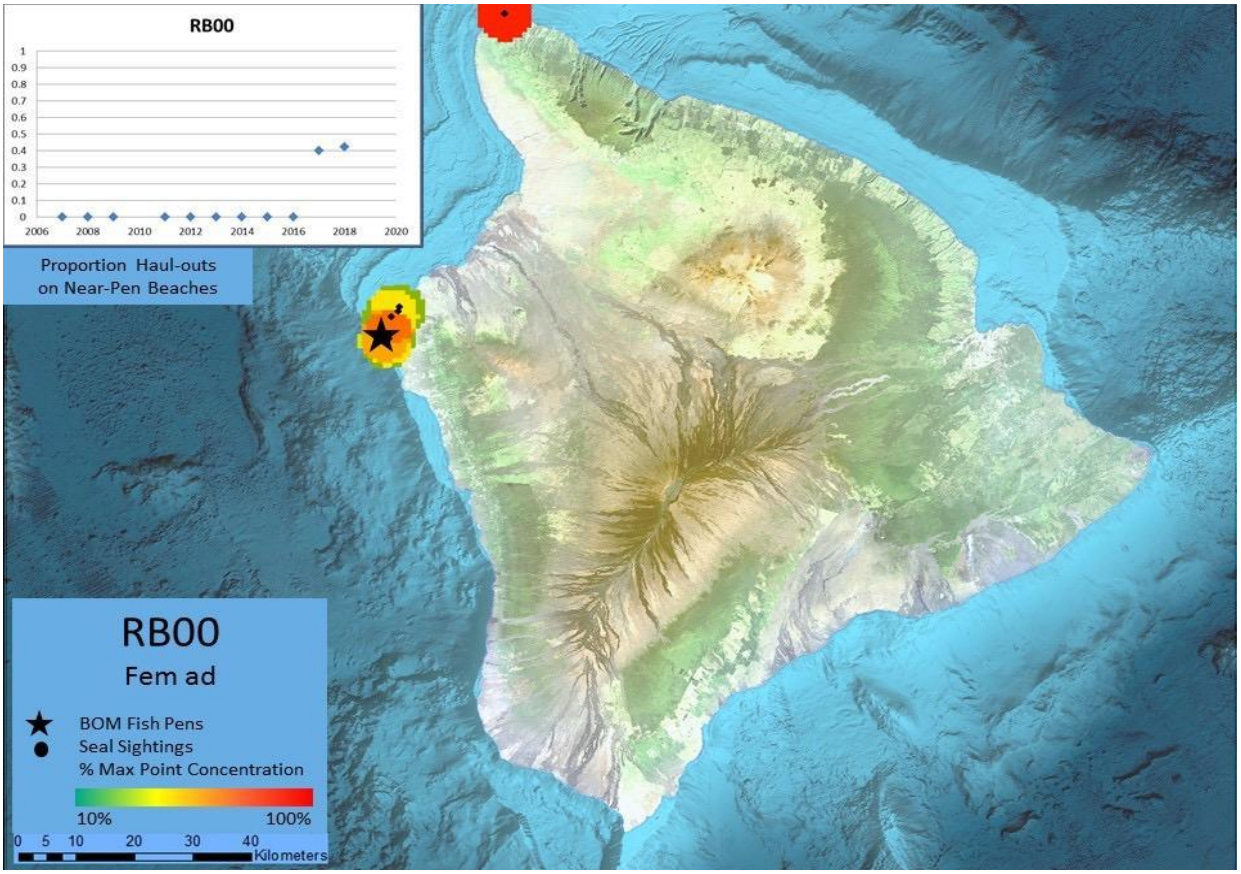


Figure 15. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal RB00 (NMFS unpublished data).

The only adult male monk seal that is regularly sighted on Hawaii Island, tends to haulout on the northwestern tip of the island as seen in Figure 16 below. He has not shown a preference for near-net pen net beaches.

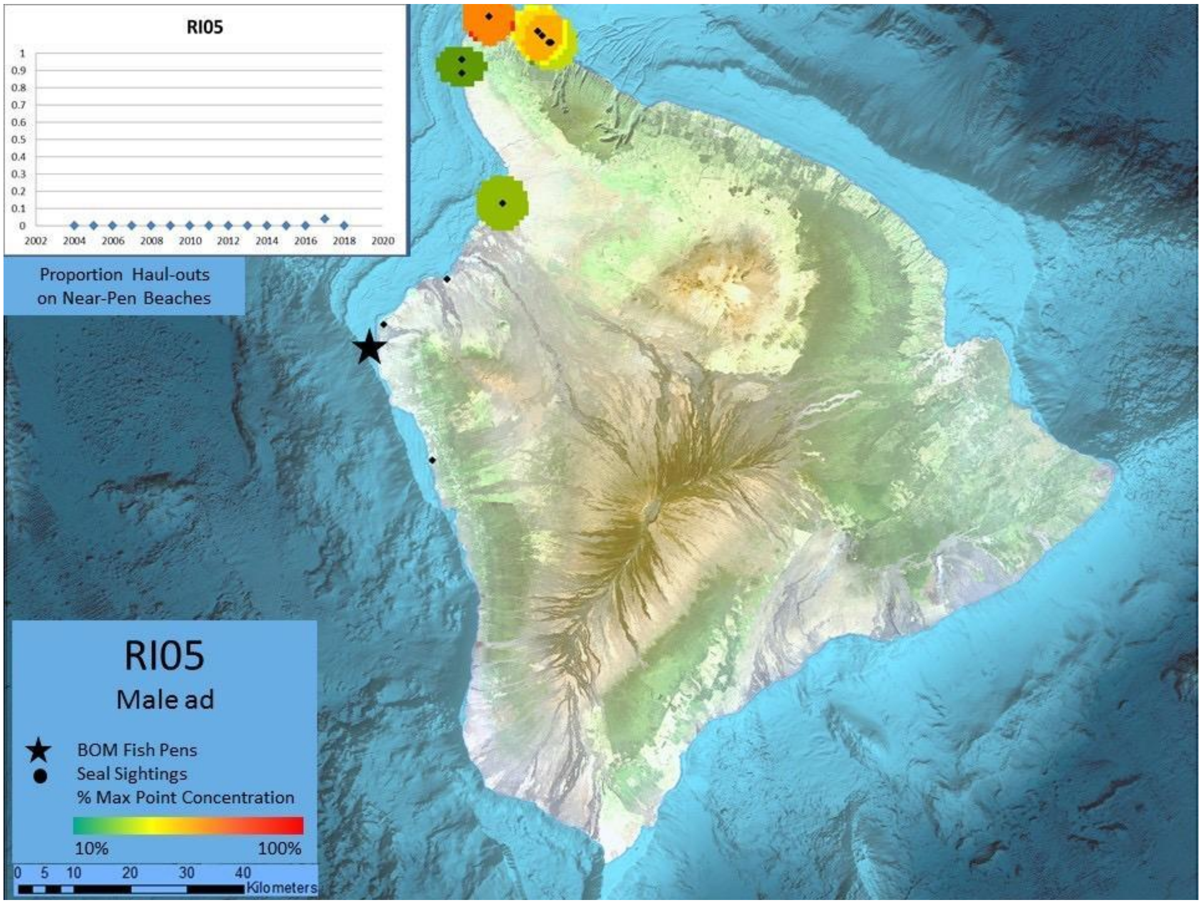


Figure 16. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal RI05 (NMFS unpublished data).

Conversely, RB18, the adult male monk seal that died from becoming entrapped in a net pen in 2017, had been sighted all over Hawaii Island, however the proportion of its haulouts near-net pen beaches spiked in 2017 to 60% (Figure 17).

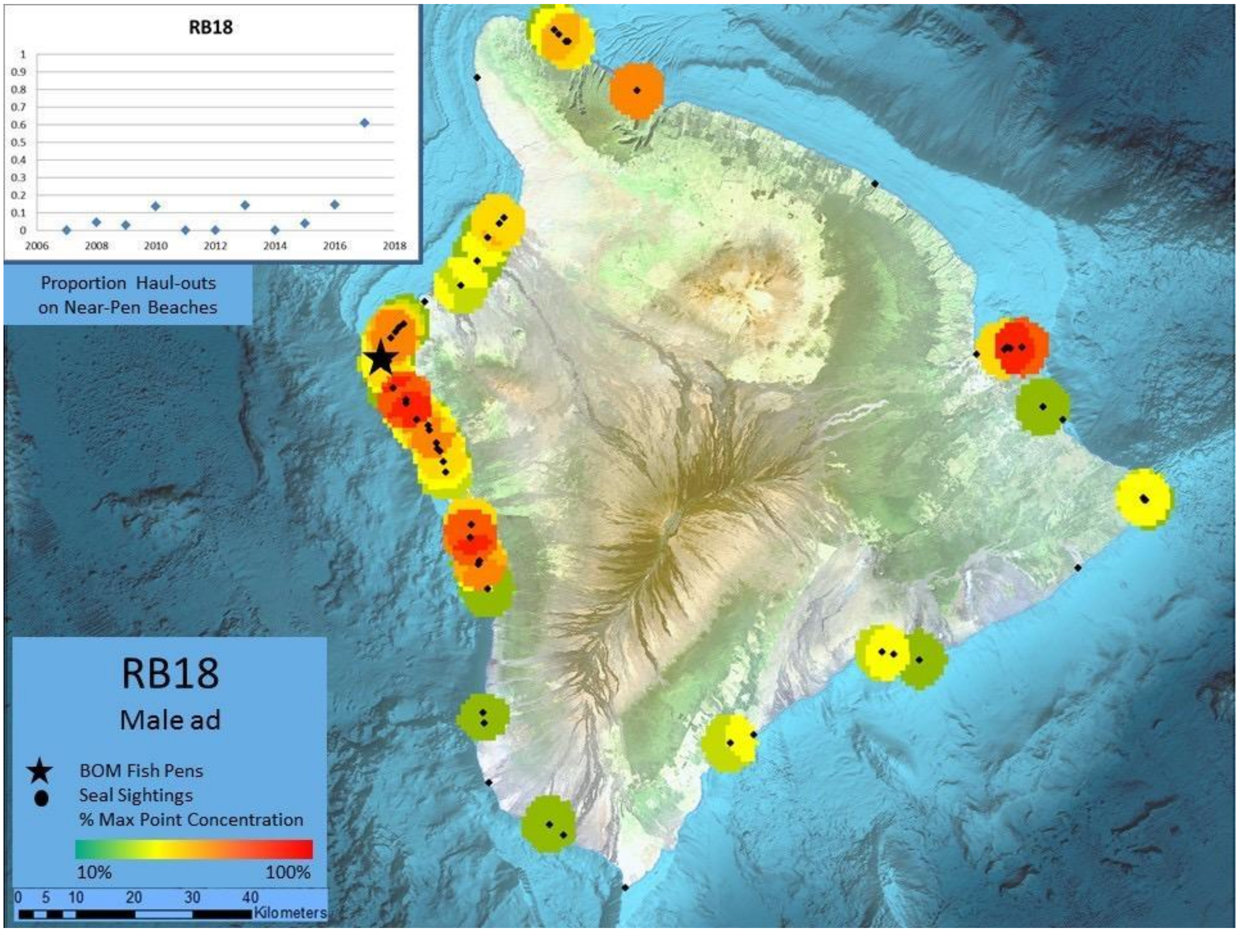


Figure 17. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal RB18 (NMFS unpublished data).

There are two adult females (Figure 18 and Figure 19) that have not been sighted since 2013 and 2016, R015 and R4DF respectively. R4DF has been sighted along the southeast and west side of Hawaii Island, and 20% of her haulouts were at near-net pen beaches in 2016. Alternatively, R015 was sighted on the north and east side of the island and did not demonstrate a preference for near-net pen beaches.

Our analysis suggests there has been a shift in monk seal haulout behavior for six of the nine seals discussed above. This shift appears to correspond with the expansion of the mariculture operation in 2015. The haulout area "heat map" analysis computed the proportion of each sample seal's haulout on beaches near net pens for each year (between 2009-2018) the seal was sighted. The analysis suggests there has been a shift in seal haulout behavior for the six seals described above. As a result of an easily accessible food source at the mariculture net pens, and based on several lines of information, it is our opinion that these seals are abandoning their former haulout areas on the island for beaches within 5 km of mariculture operations. However, given the current available information, we are not reasonably certain this is a net adverse effect to the MHI population.

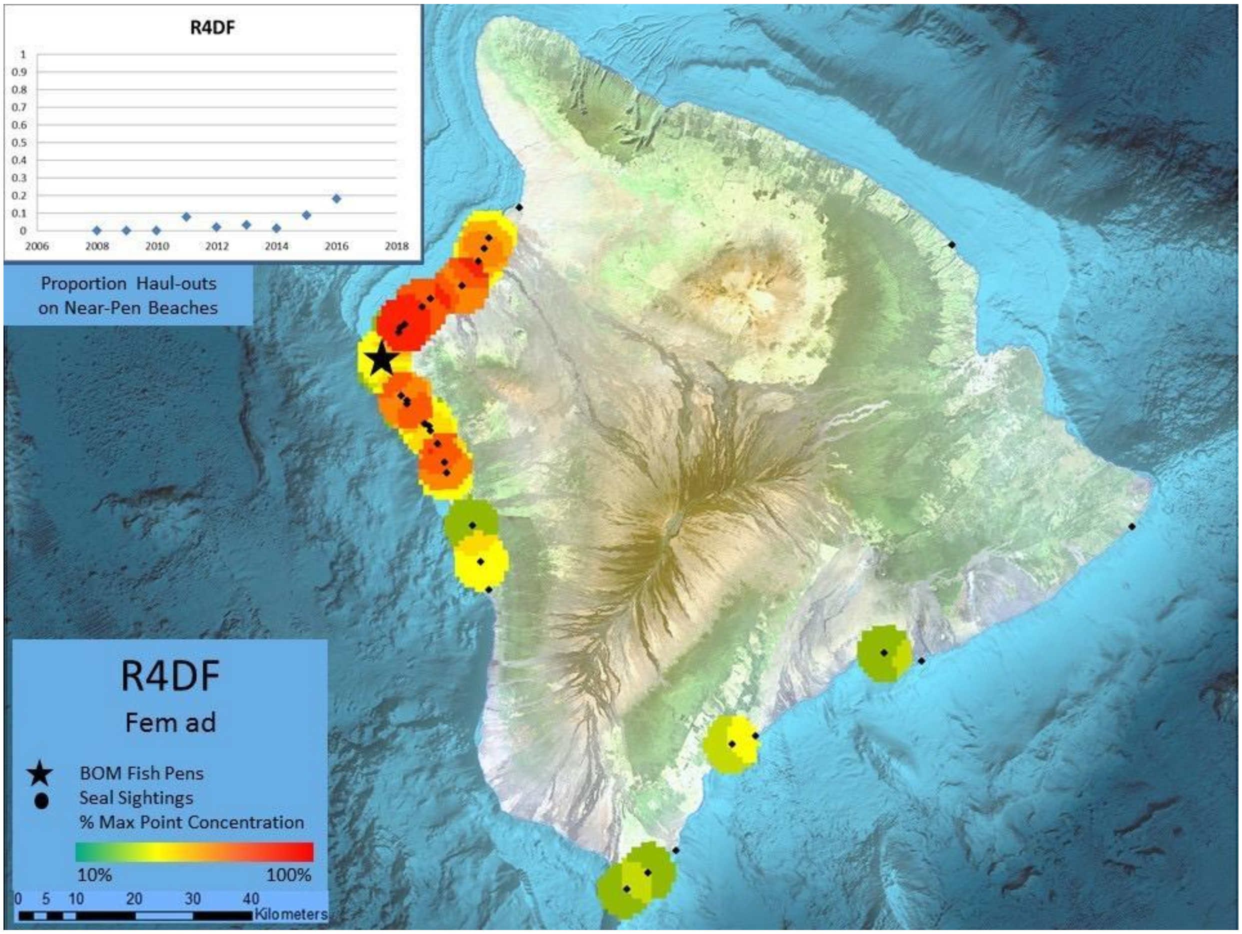


Figure 18. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal R4DF (NMFS unpublished data).

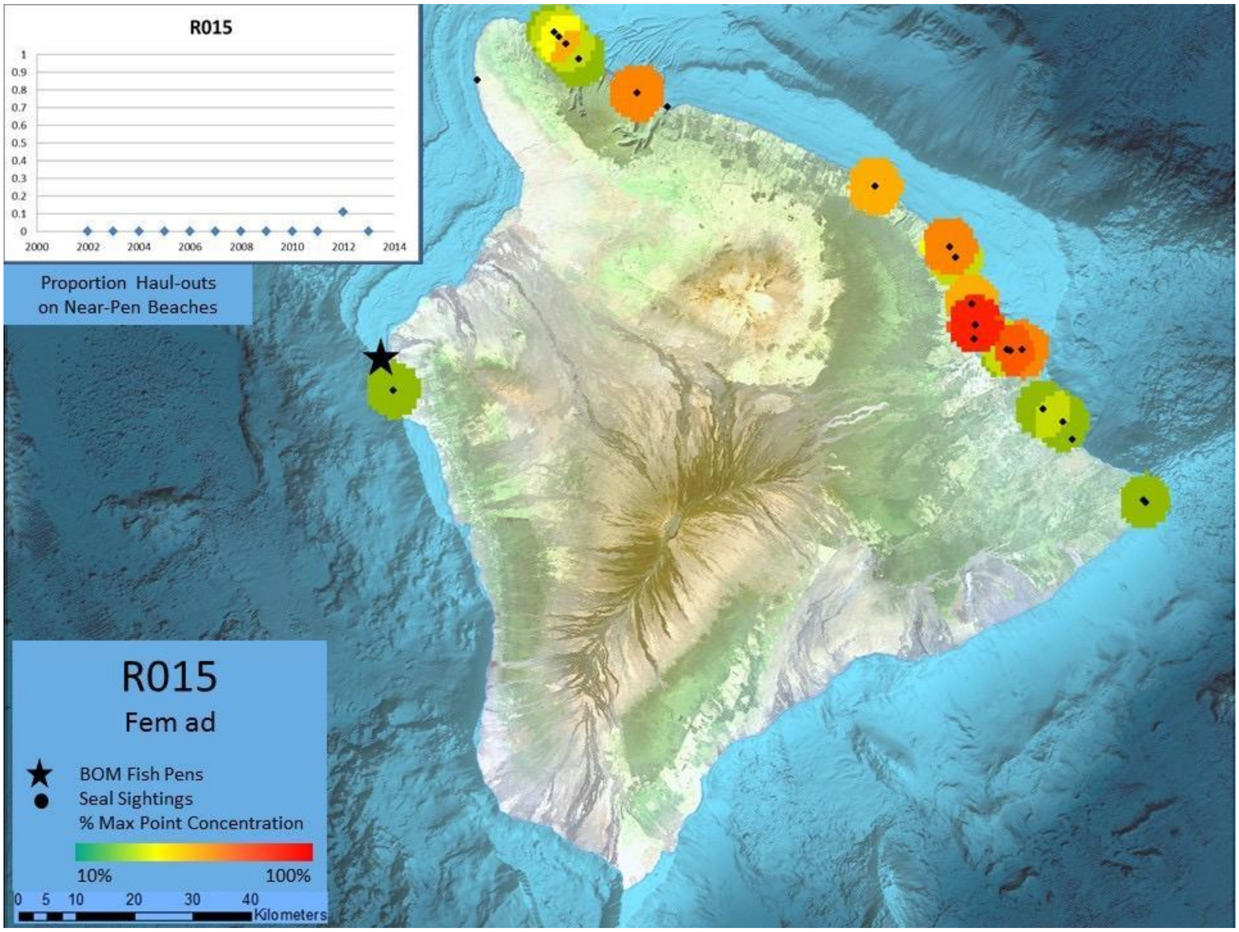


Figure 19. Proportion of haulouts on near-net pen beaches and haulout heat maps for monk seal R015 (NMFS unpublished data).

## Alternate reasons for this shift in haulout behavior

Alternate reasons for this shift in haulout behavior could stem from a bias in the sighting data or from effects of climate change.

*Sighting Data*

As described earlier, the NOAA monk seal sighting database is the repository for sighting information and observations of monk seals, and on Hawaii Island, KKO (located near Blue Ocean Mariculture in Kailua-Kona) coordinates monk seal volunteers and operates the monk seal hotline. A bias in the sighting data could skew the haulout locations to be centered in Kailua-Kona. However, other NOAA partners and the public from other regions on Hawaii island also call the hotline to report seal sightings. For example, the NOAA database continues to receive sighting information from the hotline on RI05, the seal that primarily hauls out in the north and northwestern region of the island. Although we expect there to be more sightings of seals in densely populated regions such as Kailua-Kona, we don't expect the bias to be so strong that it masks the underlying trend; six of the seven seals that reside on Hawaii Island regularly haulout at beaches within 5 km of the mariculture operations.

*Climate Change*

As described in the *Environmental Baseline*, the biological diversity of tropical systems may be at stake as the combined forces of warming temperatures and ocean acidification put additional stress on ecosystems built around coral reefs (Hoegh-Guldberg et al. 2007; Parmesan 2006). With increased acidification, calcium-dependent species seem to be at the highest risk. When entire systems are built around those species (e.g., coral) then habitat loss for the reef-dependent species could result in broad scale shifts that, in turn, may be felt by higher predators (Hoegh-Guldberg et al. 2007). The varied diet of the Hawaiian monk seal is likely to be impacted by changes in prey diversity, abundance, or dynamics.

While monk seals use several types of bottom habitat other than coral, the loss of coral habitat as a result of climate change could be a possible explanation for the shift in monk seal haulout locations from other regions on Hawaii Island to beaches within 5 km of the mariculture operations. As described above, once a monk seal feeds and is satiated, it will typically haulout to rest (Mercer, T. 2018. Pers. Comm.), therefore, haulout locations are primarily associated with underwater conditions and favorable foraging habitats as opposed to beach conditions (i.e., sandy, rocky, etc.).

As described in the *Status of Listed Resources,* Hawaiian monk seals are "generalist" feeders, and are primarily "benthic" foragers (bottom feeders), eating a variety of prey, up to 40 different families of fish, cephalopods, and crustaceans. Habitat types regularly utilized for foraging include sand terraces, talus slopes, submerged reefs and banks, nearby seamounts, barrier reefs, and slopes of reefs (Parrish et al., 2002; Parrish et al.,2000). As a result, critical habitat for monk seals residing in the MHI include marine habitat from the 200 m depth contour line, including the seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, through the water's edge 5 m into the terrestrial environment (80 FR 50925).

To evaluate any significant changes in the coral and benthic environment between 2014 and 2018 (the time period Blue Ocean employees began to document an increasing number of monk seal observations at the net pen) we searched the literature for benthic and biota surveys on Hawaii Island. From our searches we found two surveys; an annual monitoring of the Natural Energy Laboratory of Hawaii Authority (NELHA) shoreline (Howland 2015; Burns and Kramer 2018), a data report from the Pacific Reef Assessment and Monitoring Program (NOAA 2019); and a mapping approach that quantified the distribution, and relative condition of coral reefs in the MHI (Asner et al. 2020).

The monitoring of the NELHA shoreline was initiated in 1989 to monitor any effects from the research, education, and commercial activities that focus on development of sustainable industries. The monitoring surveys the ecological characteristics of both the nearshore and marine benthic communities from Hoona Bay (north) to Wawaloli Beach Park (south), a distance of approximately two miles. A total of 18 transects are completed for both the benthic monitoring and fish assemblage monitoring (Howland 2015 and Burns and Kramer 2018). While results from this monitoring program have been variable from year to year and site to site, data from 2015 through 2018, indicate similar values of abundance and diversity of fish biota, benthic conditions, and increasing coral cover (Howland 2015 and Burns and Kramer 2018).

Stationary point count surveys from the Pacific Reef Assessment and Monitoring Program were conducted on all regions of Hawaii Island (except the coastline along Volcanoes National Park) in 2010 ($n$ = 43), 2013 ($n$ = 58), 2015 ($n$ = 97), 2016 ($n$ = 59), and 2019 ($n$ = 73; NOAA 2019). This survey data included the status and trends of coral reef fishes and benthic assemblages. The percent coverage and mean size of fish has remained stable with a slight decrease in mean size in 2016. There is a gradual decrease in percent coverage of hard coral from 2010 to 2019 (Figure 20; NOAA 2019), and less microalgae and encrusting algae in 2016-2017 when compared to previous years. Survey site data indicate the total fish biomass and the percentage of hard coral cover are the greatest in Hilo, West Hawaii, Kailua-Kona, and the Southport region. Therefore, beaches within 5 km of mariculture operations in Kailua-Kona are not the only region with habitat preferred by monk seals.

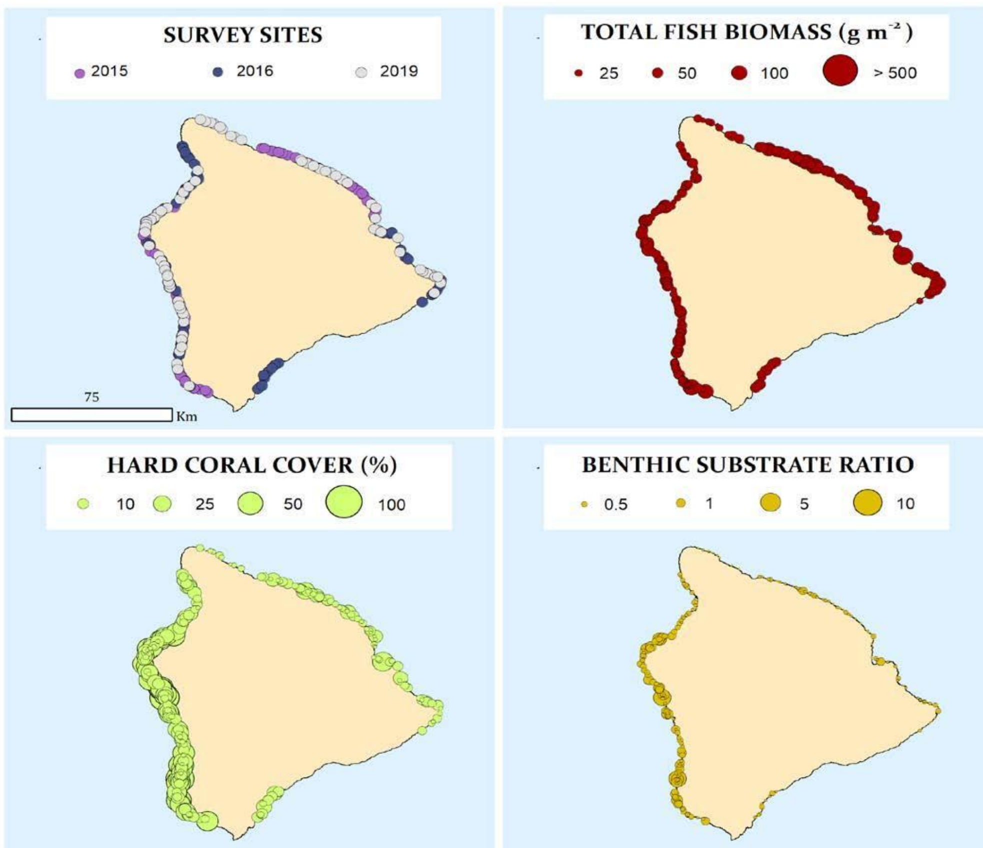


Figure 20. Hawaii Island site survey data for 2015, 2016, and 2019. Site location identified by year, total fish biomass recorded at each site, hard coral cover (%) assessed by rapid visual assessment, and benthic substrate ratio [hard coral + crustose coralline algae ⁄ (100 − hard coral + crustose coralline + sand)] (NOAA 2017).

Further, an airborne mapping approach by Asner et al. (2020) that combined laser-guided imaging spectroscopy and deep learning models to quantify the distribution and relative condition of live corals, demonstrates that the top five live coral hot spots in the MHI (Figure 21) are found on Hawaii Island in Kiholo Bay, Keawaiki, Anaehoomalu, Keaukaha, and Papa Bay – beaches greater than 5 km north or south of the mariculture farm. In summary, the change in monk seal haulout behavior does not appear to be correlated with any climate change driven changes in benthic substrate changes or forage area or any bias in the sighting data. Available evidence suggests intrinsic rewards from the mariculture operations have caused monk seals to shift their haulout preference from other regions on the island to beaches within 5 km of the net pens.

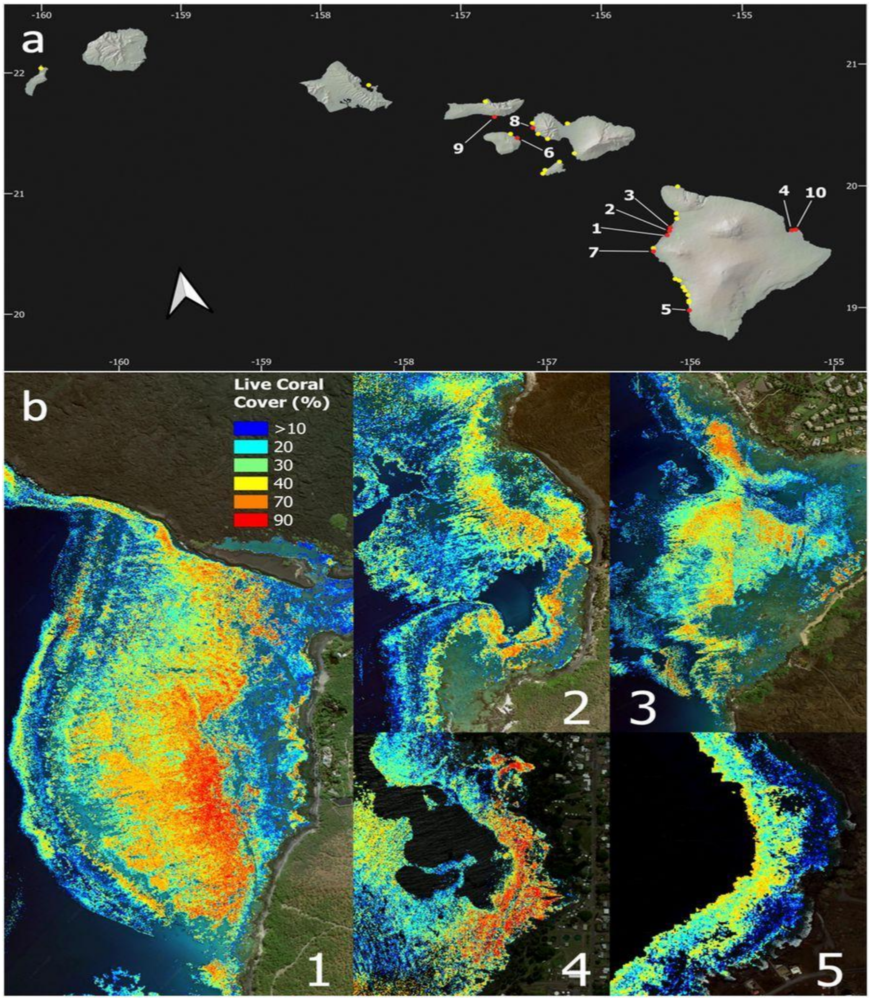


Figure 21. (A) Top 20 reefs (red and yellow dots) based on live coral cover density (B) Zoom maps of the top five live coral cover sites on Hawaii Island: (1) Kiholo Bay; (2) Keawaiki; (3) Anaehoomalu; (4) Keaukaha; and (5) Papa Bay (Asner et al. 2020).

#### 6.2.2. Shift in monk seal feeding habits

Conversations with Tyler Korte, the Blue Ocean Mariculture offshore manager (Korte, T. 2019. Pers. Comm.), the monk seal interaction documentation reports, the videos and pictures posted on social media, the report in 2020 of a monk seal grabbing and removing a previous patch repair, and the most recent breach (March 2021) of a monk seal in a retired pen where few Kampachi remained, indicate that monk seals are feeding on farm fish from the net pens. As a probable result, the female seal RW34, is estimated to be 600-800 lbs, substantially larger than an average adult female (500 lbs.).

Hawaiian monk seals eat a variety of prey, up to 40 different families of fish, cephalopods, and crustaceans. Therefore, it is not normal for a Hawaiian monk seal's diet to consist of primarily a single species of fish, nor is it typical for seals to forage from a mariculture net pen.

Additionally, monk seals typically swim and dive for each prey item, working harder than they would from feeding from the net pen. The seals feeding from net pens are not burning calories and expending energy as they naturally would during their typical foraging events (Cahoon 2011; Wilson 2017). Monk seals feeding from nets pens likely do not expend as much energy feeding on net pen fish as foraging for them in the wild, resulting in a higher net caloric and nutritional intake.

As described in USACE's BE, the primary mechanism for fish escapes is a break or tear in the cage netting caused by a failure in the netting material, improper rigging, or predators breaking or tearing the netting in pursuit of production fish inside the net pen. Escaped fish typically remain near their net pen for 2-3 days after the escape event. During this period, Blue Ocean divers attempt to recover as many of the escaped fish as possible. The recovery rate of escaped fish in 2016 and 2017 was approximately 40%. However, no Hawaiian monk seal has ever been observed feeding on an escaped fish.

Videos and pictures taken by the public and posted on social media clearly show monk seals exhibiting prey seeking behaviors (i.e. as swimming back and forth adjacent to the net pen focused on the exterior netting. As mentioned above, the most recent fish escape was likely a result of a monk seal grabbing and removing a previous patch repair in an apparent attempt to feed on the contained fish.

While we do not have data to demonstrate a statistically significant correlation, it is NMFS' opinion that the supplemented, readily available source of food that stems from feeding on farm raised Hawaiian Kampachi is having an effect on the body condition of female monk seals and causing abnormal rates of growth. This change in body condition can have different consequences; complications to a seal's health and fitness, and an increased lactation period.

### Health Complications

RW34 has been unsuccessful at weaning a pup over the last three years and it is NMFS' opinion that her lack of success is linked to her body condition. She gave birth in 2015 and 2016 to pups that died. Both were considered healthy with no congenital deformities. Necropsy results revealed that both pups had evidence of trauma (i.e., compressed chest, and fluid in the lungs). There were no signs of infection or malnourishment. Scientists analyzed the different factors that could have resulted in such traumatic injuries. One theory was that at night, a male monk seal may have been aggressively interacting with the mother seal and in doing so incidentally crushed the pup. However, the monk seal born in 2015 was three weeks old at the time of death, and at this age, was strong enough to move to avoid such injuries (Barbieri, M. 2018. Pers. Comm.). NMFS suspects that RW34 rolled over onto the pups, and due to her large size, caused them to hemorrhage and die.

Since both pups were born at Keokea Beach, a rocky, boulder beach on the North Kohala shoreline, the environment where RW34 was located is also considered a contributing factor. The adverse effects from rolling onto a pup in a rocky environment would be more severe than if the pup and mom pair were lying on sand (Barbieri, M. 2018. Pers. Comm.). Her 2017 pup also died. The dead pup observed in 2017 died from malnutrition. Soon after birth, observers noted the pup was actively searching for a teat, however, RW34 was not presenting herself to facilitate nursing. Due to her excessive weight, she may not have been able to roll to her side to nurse her pup and if she did, she was at risk of rolling onto the pup and crushing it. RW34 is commonly seen resting and "hauling out" in tide pools and shallow water. The shallow water provides buoyancy to support her weight, which is presumed to be a less exhausting alternative to hauling out on the beach.

Due to her size (estimated 600-800 lbs.), RW34 is considered obese with an extremely large axillary girth. Similar to obese humans, the excess weight may cause complications such as high blood pressure, heart disease, fatty liver disease, etc. If RW34 continues to eat farm raised fish and limits her physical activity as seen by "hauling out" in tide pools, her life expectancy may be shorter than typically expected. Moreover, RW34's failure to successfully wean a pup over the past eight years, and potentially into the future, limits her lifetime reproduction success (NMFS 2019).

RW34 was born in 2008, and based on a NMFS' internal report, *Quantifying the population-level cost of a female seal mortality in the MHI* (NMFS 2019), once a female pup matures (at approximately 5 years), she is likely to produce more than 7 pups during her lifetime as depicted in the graph below (Figure 22). When we consider the survival estimates as demonstrated in Figure 23(including the 90% survival rate from birth to weaning, weaning to 1-year (82%), 1-year to 2-year (80%) 2-year to 3-year (83%), and 3-year to 4-year (90%), we would expect 4 ($n$ = 3.08) out of 7 pups to reach maturity (NMFS 2019). Analyzing the full measure of a female seal's contribution to future abundance and considering average mortality rates, if RW34 is unable to successfully wean any pups in the future due to her body condition as a result of feeding at the mariculture net pens, her reproductive potential would be atypically low, representing the loss of 4 - 7 monk seal pups, as well as their future progeny.

However, the three females that are reproductively successful that frequent the net pens had pups that nursed longer and did not lose as much body weight as would otherwise be expected. Longer nursing periods tend to lead to larger weaned pups (Mercer, T. 2020. Pers. Comm.). Such pups grow more rapidly post weaning, and have higher average first-year survival rates (Baker and Johanos 2004, Baker et al. 2014, and Robinson et al. 2020). As this is a relatively new occurrence, it is too early to truly understand how much impact the fish at the net pens are having on fecundity. We anticipate as much as a 4% increase in survivorship for each pup of the three mothering females due to larger pup size at weening. We still do not know what percentage of their diet, if any, is from fish at the net pens. As such, it is difficult to know how much the net pens are contributing to their fecundity. Furthermore, we do not know how long the three mothering monk seals will be reproducing with increased nursing (and subsequent increased weaner size), and if or when they will grow to a size like RW34 and become unable to reproduce. Considering many female monk seals do not reproduce at all from various reasons (i.e., premature death, injuries, or other circumstances), we are optimistic it may at least partially support successful reproducing female monk seals, despite being detrimental to RW34.

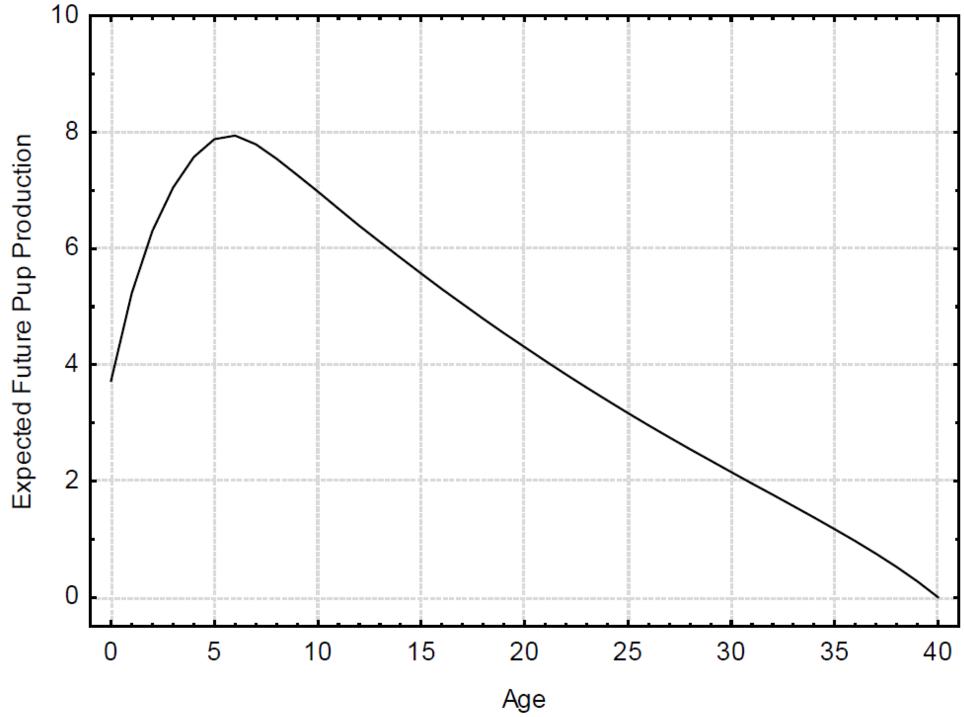


Figure 22. The expected number of future pups for an average MHI female monk seal by age (NMFS 2019).

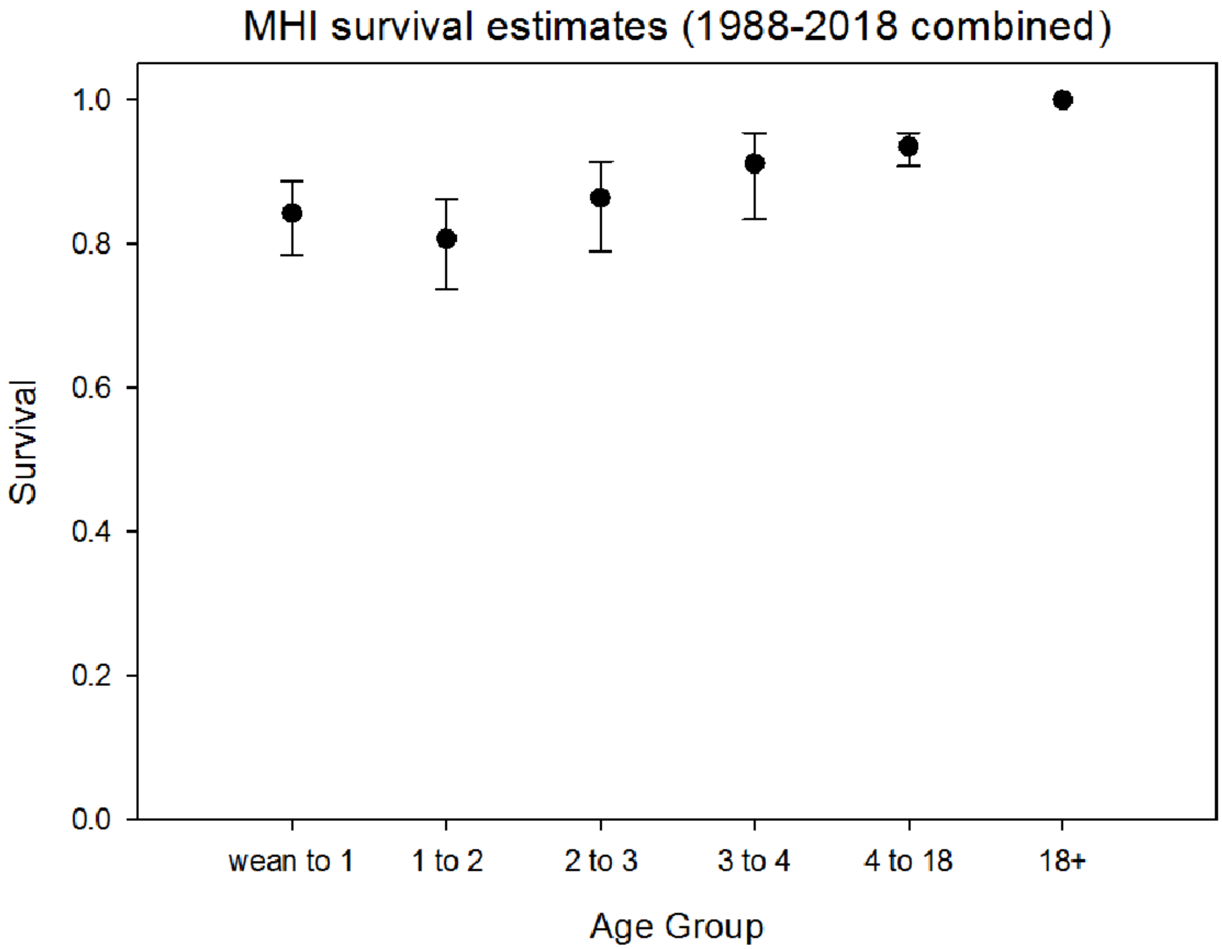


Figure 23. Time invariant age-specific survival rates for monk seals that reside in the MHI (NMFS 2019).

Besides RW34, other female seals that frequent the mariculture net pens include a juvenile (RK26), and three successfully reproductive adults (R8HE, RB00, and RA20). While the estimated size and condition of these adult female monk seals have not been quantitatively assessed, anecdotally they appeared larger and fatter than the average pregnant female prior to pupping. After weaning their pups over an extended nursing period, all three seals returned to an average sized adult seal (Mercer, T. 2020. Pers. Comm.). However, if these seals continue to gain weight by feeding on farmed fish while limiting their physical activity, they too could be at risk of becoming obese like RW34. If they become pregnant, they could likewise fail to give birth or nurse their pups.

As described in the *Exposure* section in Table 6, there is one male monk seal RL50 born in 2019 that also frequents the net pens. The only other male monk seal that was a frequent visitor to the net pens was RB18, and as described in the *Consultation History* and the *Exposure Analysis*, he died in a recently retired net pen on the farm site in 2017. KKO employees have reported that RL50 is larger than an average sized juvenile seal. It is difficult to track male reproduction and there has been limited success with genetic parentage tests since the seals have such low genetic diversity (Robinson et al. 2021). Therefore, it is unknown whether RL50's reproductive ability would be affected if he were to become obese like RW34. However, we would assume, like

RW34, that the excess weight may cause health complications. Further, the fact that RL50 (like the female seal RK26) is a juvenile is also concerning because he may not effectively learn and experience how to naturally forage if he becomes habituated to feed on farm fish. If juvenile seals become habituated to farmed fish, and if in the future they become hindered from accessing fish from the net pens due to mitigation measures.

### Alternate reasons for the size of RW34

Alternate reasons for the size of RW34 seem less probable than proximity to an easy food source at the net pen. Although no studies on marine mammals have been linked to obesity (Barbieri, M. 2021 Pers. Comm.), a review of literature on chronic obesity in wild animals found it to be rare and associated with contaminants, hypothyroidism, or a viral infection such as adenovirus (Lopez et al. 2012; Ylitalo et al. 2008; Hall et al. 2006; Peterson 2019; Gobush 2012; Cortes-Hinojosa et al. 2016: Wellehan, and Cortes-Hinojosa 2019).

#### *Contaminants*

As described in the *Environmental Baseline* section, contaminants such as organochlorines, polychlorinated biphenyls, and polybrominated diphenyl ethers are persistent organic pollutants (POPs) that originate from industrial, urban, and agricultural activities from both local and remote sources (Lopez et al. 2012). Ylitalo et al. (2008) and Lopez et al. (2012) indicate that in monk seals, adult females have lower levels of contaminants in blubber when compared to males because they are presumably offloading contaminants in milk to their young. From studies on other large mammal species, we know that females offload the highest levels of contaminants to first born young because those are contaminant levels that have been building up over the course of the female's lifetime, whereas in subsequent years it is more of an annual burden (Barbieri, M. 2021 Pers. Comm.). Even if RW34 was a first born pup (she was the 7th born pup to RO15), high levels of contaminants in marine mammals have not been linked to obesity but to a failure to thrive and survive as has been observed in first born calves of bottlenose dolphins (Hall et al. 2006). Although contaminants are not routinely measured in monk seals, and RW34 has never been measured for contaminants specifically (Barbieri, M. 2021 Pers. Comm.), we do know that RW34 successfully nursed and weaned one pup in her lifetime, back when her size was that of a normal monk seal. Therefore, contaminants would likely have been offloaded in that pup, and it is highly unlikely that any remaining contaminates are causing her to gain weight.

#### *Hypothyroidism*

Hypothyroidism, a thyroid hormone deficiency linked to infertility and slow metabolism and consequently weight gain in humans (Gaitonde et al. 2012) is an endocrine disorder relatively common in dogs but rarely diagnosed in other species (Peterson 2019). Hypothyroidism is not routinely measured in monk seals (Barbieri, M. 2021 Pers. Comm.) however a study by Gobush (2012) focusing on stress hormones (not obesity), measured the biologically active form of thyroid hormone T3. This study found that the levels of T3 vary with age, sex, breeding site, and time, and there was no statistically significant difference in T3 levels between seals that reside in the MHI or NWHI (Gobush 2012). According to monk seal veterinarian Dr. Michelle Barbieri (2021 Pers. Comm.), hypothyroidism is not a clinical presentation ever seen in this species across their range over decades of research.

#### *Adenovirus*

Adenovirus, a non-enveloped, double-stranded DNA virus, infects a wide range of vertebrates including pinnipeds such as the California sea lion and more recently a captive Hawaiian monk seal (Cortes-Hinojosa et al. 2016: Wellehan and Cortes-Hinojosa 2019). The human adenovirus (Ad-36) has been associated with obesity in humans, and significant weight gain in male rhesus and marmoset monkeys (Dhurandhar et al. 2002). However, the strain (CSLAdV-1) of adenovirus, as was detected in a 26-yr-old male Hawaiian monk seal kept in an aquarium, typically causes anorexia, diarrhea, and viral hepatitis in pinnipeds, as has been recorded in California sea lions (Cortes-Hinojosa et al. 2016). Although, these virus-specific signs were not exhibited by this monk seal before he died, his appetite waxed and waned, and subsequently he lost weight (Cortes-Hinojosa et al. 2016).

In summary, RW34 successfully nursed and weaned one pup in her lifetime, therefore contaminants would likely have been offloaded in that pup. In addition, hypothyroidism and adenovirus-36 are not clinical presentations ever seen in any other members of this species, despite decades of research and observations across their range. RW34 does not manifest any unique exposure to contaminants or pathogens. Therefore, if RW34's anomalous large size was a result of contaminants, hypothyroidism or viral infections, we would expect to see other seals of similar weight and size in the Main Hawaiian Islands. However, this is not the case. The correlation of RW34 with the location of the net pens, and her likely feeding from them, is the probable cause of her obesity.

### Beneficial Effects of Potential Feeding

As described above, there are three reproductively successful females that frequent the net pens: R8HE, RB00, and RA20. Based on recent data (Robinson et al. 2020), the average nursing period for a MHI female seal is about 44 days. During this time, she does not eat and tends to lose weight. However, these seals nursed for 46-54 days and did not lose as much body weight as expected. Nursing duration generally correlates with the mother's body condition (fatter moms tend to nurse their pups longer); and longer nursing periods tend to lead to weaned pups with larger axillary girth measurements (Mercer, T. 2020. Pers. Comm.; Table 7). As a result of the increased lactation period, weaned pups are larger and grow more rapidly post weaning, and on average, have a higher first-year survival rate (Baker and Johanos 2004, Baker et al. 2014, and Robinson et al. 2020).

Table 7. Pups of monk seals that frequent the net pens and nursing period. *Ag= auxiliary girth. PK1** weaned in 2020, and COVID 19 restrictions did not allow the tagging and measuring of this pup (Robinson et al. 2020).

| Monk Seal | Year | Location | Days nursing | Monk seal pup | AG* cm |
|---|---|---|---|---|---|
| R8HE | 2018 | Maui | 51 | RKA0 | 128 |
| RA20 | 2018 | Hawaii | 46 | RK26 | 129.5 |
| | 2019 | Hawaii | 49 | RL50 | 135 |
| RB00 | 2019 | Kauai | 54 | RL08 | 143 |
| | 2020 | Kauai | 45 | PK1** | NA |

Interactions between Hawaiian monk seals and net pens are a relatively new phenomenon. We have very little data, and recorded observations are limited to the last several years. Because it happened slowly over time and was the first and only known instance, it was difficult to notice RW34's deteriorating health and reproductive condition and associate it with the net pens. The applicant, PIFSC, and NMFS Regional Office agreed to gather information from various sources including video recording, tagging, and other means described in the BE. The combination of regular observance and unusual size led us to assume that RW34 is either exclusively feeding on fish produced at the net pens or is heavily supplemented by it. We do not know to what degree the other reproductive females who are observed at the site are feeding on fish produced at the net pens. But, we have preliminary video confirmation that monk seals are at least supplementing their diet with fish produced at the net pens. However, while one of the females is only 5 years old, the other two are 12 and 16, meaning they have had ample opportunity to become as obese as RW34, but have not. Thus, we have no evidence to conclude that the other seals will end up like RW34 and fail to reproduce. The preliminary observations appear to suggest that they and their offspring could be benefiting from the fish at net pens.

## Harmful effects

### Human-seal interactions

An indirect response of monk seals having access to an atypical food source is increased human-seal interactions. As noted in USACE's 2018 BE, although Blue Ocean employees do not follow, approach, or engage with marine mammals or ESA-listed species, they are close enough to some seals to read and record the flipper tag numbers on the protected species reporting and monitoring report. Due to the small size of the tags, the ability to read the tag numbers indicates that the employee and the seal were in close proximity, which suggests the seal is close enough to notice and respond to the Blue Ocean employee (Littnan, C. 2018 Pers. Comm.). As a result, the seals that regularly feed at the net pens are at risk of becoming habituated and associating people with food.

Two of the monk seals observed in the net pen area are young seals (RK26 and RL50), and since weaned pups and juveniles are playful and extremely impressionable, they are particularly vulnerable to close encounters with people (Littnan, C. 2018 Pers. Comm.). Habituated seals, especially juvenile seals, have interacted with recreational divers or swimmers. If a seal has a strong association of humans and food, they may become aggressive "beggars." Aggressive seals have been known to block swimmers or divers trying to exit the water onto land. There is at least one reported incident of a monk seal grabbing and holding an adult person under water and also another seal grabbing onto a spear fisherman under water on Molokai. Additional reports document seals "grabbing onto" people in the water with their fore flippers as well as biting and nipping at people in the water.

Habituated seals that develop behavioral responses such as the examples above, are labeled by NMFS as a "seal of concern". Typically, being labeled a "seal of concern" means that NMFS will increase monitoring of that seal because they may seek out interactions with people, and may become a hazard or a threat to people. If a conditioned seal continues to seek human interaction, it may be translocated or taken into captivity which are not preferred management measures and are not always viable options.

As previously described in the *Exposure* section, the April 2015 Blue Ocean Mariculture incident report described a Hawaiian monk seal opening its mouth and showing its teeth to a diver inside the pen. An aggressive seal could create a dangerous encounter for both the seal and the diver. If a diver's safety is threatened by an aggressive seal, the diver may, in defense, harm an aggressive seal.

To date, we have not labeled any of the seals at the net pen site a "seal of concern" or determined any need to be moved because they are too aggressive or habituated to humans. While it is possible that monk seals could habituate to humans, there is no evidence to suggest any have or will. Therefore, we are not reasonably certain habituation will be a consequence of the proposed action.

### 6.2.3. **Entrapment in Net Pens**

As a result of monk seals being attracted to mariculture operations, they are at risk of becoming entrapped in a net pen. As noted in the *Consultation History* section, in 2017 a dead Hawaiian monk seal was found in an empty, recently retired net pen on the mariculture farm site. The monk seal entered the submerged net pen through a 1,600 square foot opening in the netting created by Blue Ocean's crew the previous day to allow an unwanted shark to escape the net. Unfortunately, the seal did not exit the pen through the opening when it required air. The monk seal's death appears to have been caused by a unique chain of circumstances. Specifically, the recent completion of harvesting activity from the net pen and the net pen's planned removal, the on-site crew's decision to remove a large panel of netting rather than execute the normal safe release protocol for removal of the unwanted shark, and the monk seal's apparent inability to locate the opening in the net pen when it required air.

A more recent incident occurred on March 24, 2021, when Blue Ocean Mariculture reported a monk seal, believed to be R8HE, swimming inside a fully raised net pen. The seal was observed swimming freely and unhindered inside of a retired pen that had recently had its inventory of fish transferred. While we do not have data to definitively say how the seal entered, based on the data at hand and the expertise of PIRO and PIFSC scientists, it is NMFS' opinion, and the opinion of the applicant, that the monk seal entered the retired pen by pushing its body weight up against a weak panel creating a beach ball-sized hole in the CAM netting on the north side of the pen.

Fortunately, as a result of a protocol change stemming from the 2017 incident described above, the pen was raised with a 15-ft air gap, so the seal could swim to the surface when it required air. To release the seal, Blue Ocean Mariculture employees opened a portal on the west side of the net pen and entered the water to facilitate the seals' exit. The seal swam around the newly opened portal but did not swim out of it. The seal eventually swam out of the hole it created to enter the pen.

As discussed in the *Description of the Proposed Action* section of this biological opinion, Blue Ocean's internal review of these incidents identified and implemented several changes to their offshore protocols and incorporated these changes into their proposed action.

- **Protocol Modification**. During installation or removal, a net pen shall be surfaced with a 15-ft air gap at all times to allow marine mammals to easily surface for air.
- **Crew Retraining**. Except during installation or removal, no empty net pen shall be left unattended with an opening in the netting, regardless of the opening's size.
- **Stronger Net Pen Mesh**. The remaining net pens (currently four) are comprised of thicker, stronger mesh material. In comparison, the thickness of the mesh in the older pens was 3.0 mm for both the Kikko net and CAM while the thickness of the mesh in the newer pens are 3.7 mm for the Kikko net and 4.0 mm for the CAM. According to Blue Ocean Mariculture, this adds to approximately 75% more mass, which will greatly decrease the likelihood that a seal or other animal could bite or break and push through the mesh and enter the pen.

- **Net Pen Quality Control**. The strength of the netting material, determined by net mesh size, is essential to contain farmed fish as well as to keep predators from entering the pen. Therefore, to monitor the strength of the net pens, the thickness of the netting materials (Kikkonet and CAM) including the panels at the waterline, and the upper and bottom trapezoids, are measured with calipers each month. Prior to the incident in 2021, the previous threshold for net width was 2.0 mm. Since the netting in each panel is measured randomly and not every piece of netting is measured, Blue Ocean Mariculture expects a range of values within 0.5 mm above and below the actual measurement. The net measurement where the monk seal entered the pen in the 2021 incident was 1.5 mm. Therefore, the threshold for the net width has increased to 2.5 mm. When any netting is measured to be 2.5 mm, the contained fish will be removed and the net pen will be retired. Since Blue Ocean Mariculture expects a range of values within 0.5 mm of each measurement, as a precaution, they have agreed to raise the net pen to create a 15 ft. air gap whenever a mesh net measurement reaches 2.8 mm.
- **Net Pen Research**. As part of an adaptive management approach in designing the most efficient net pens, each pen has sacrificial thickets (composed of three different alloys of metal pieces attached to the net of metal pieces attached to the net) that line the cage on all panels. The thickets get pulled every six months for a degradation analysis that informs Blue Ocean Mariculture where on the net pen degradation is happening the most, and how fast each type of alloy degrades.
- **Net Pen Retirement**. As described above, there have been two occasions since 2014 under the current configuration of the mariculture site that monk seals have entered retired net pens. While we cannot know whether the protocol revisions will help to reduce entrapment, they have helped to reduce the likelihood of mortality of a trapped seal. Due to adaptive management and updated protocols, the seal trapped in 2021 was released alive. Previous incidents confirm that it is possible for monk seals to become trapped in a net pen, therefore, we expect that Hawaiian monk seals will be at risk of entrapment in the net pens in the future.

Open ocean net pen mariculture is an emerging industry; there are many unknowns including the strength and true deterioration rate of the CAM and Kikko net pen materials and their ability to withstand the pressure of a monk seal or any other marine animal pushing up against it. Therefore, we expect that Hawaiian monk seals to be at risk of net pen entrapment. Existing data indicate two monk seal entrapments in the last eight years. Given the changes in protocols, that the risk of entrapment has been reduced greatly, but we are reasonably certain another monk seal will be entrapped over the next 10 years. However, we are reasonably certain any seal will be released alive due to the updated protocols outlined in the Blue Ocean Mariculture, Hawaiian monk seal net pen removal protocol in *Appendix B*. We do not expect any mortalities as a result of future net pen entrapment.

While we do not expect any monk seal to die from net entrapment, we do expect sublethal responses that may range from those that are temporary in nature such as elevated stress levels to injuries that may affect feeding, movement, or even breeding success. These effects may decline over time as monk seals heal from any injuries, and we can monitor the extent to which such sublethal injuries persist by observation documentation on the protected species monitoring form, and from haulout sighting data.

## 7. Cumulative effects

"Cumulative effects," as considered under the ESA, 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 CFR §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.

The submerged land lease (S-5721) acquired by Blue Ocean Mariculture from the State of Hawaii, Board of Land and Natural Resources, commenced on November 1, 2004 and expires on October 31, 2024. If Blue Ocean Mariculture does expand its operations, this action would require an amended Letter of Permission from the USACE, and therefore, a consultation pursuant to section 7 of the ESA, and so would not be considered under this cumulative effects analysis.

Based on past accounts of tour and dive boats in the submerged land lease area, as well as some anecdotal evidence from the photos and videos on social media, there may be an increase of vessels and people in the action area. Although Blue Ocean Mariculture's lease is not exclusive and does permit transiting through and fishing in the lease area, anchoring, SCUBA-diving, and swimming are not allowed. However, there have been anecdotal reports of tour boats in the area because they are certain to see a Hawaiian monk seal (Nikolai, H. 2020. Pers. Comm.). Some of these tour boats are dive and snorkel boats wherein passengers enter the water in the lease area. According to the submerged land lease, Hawaii State law decrees that the company must accept all liability for any accidents or injuries that occur with the lease area. Therefore, when Blue Ocean employees see a tour group they use a loud speaker to talk to divers and respectfully ask they not dive in the lease area. Blue Ocean Mariculture handles these instances with care because if they approach the divers with too much force, they fear retaliation that could result in cut or torn nets (Korte, T. 2018. Pers. Comm.). As the public becomes more aware of the presence of monk seals in the action area, we expect an increase of vessel traffic in the area and people in the water.

NMFS conducted electronic searches of literature using Google, and other electronic search engines. Those searches produced no evidence of other future private action in the action area that would not require federal authorization or funding and is reasonably certain to occur. As a result, NMFS is not aware of any other actions likely to occur in the action area during the foreseeable future.

## 8. Integration and Synthesis

The purpose of this biological opinion is to determine if the proposed action is likely to have effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (50 CFR 402.02), otherwise known as the jeopardy determination. This is done by considering the effects of the action within the context of the *Status of Listed Resources* together with the *Environmental Baseline* and the *Cumulative Effects*, as described in the *Approach to the Assessment* section.

We determine if effects of the action to individuals of listed species resulting from the proposed action is sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks).

In order to make that determination, we use a population's base condition (established in the *Status of Listed Species* and *Environmental Baseline* sections of this opinion) as context for the overall effects of the action on affected populations. Finally, our opinion determines if changes in population viability, based on the *Effects of the Action* and the *Cumulative Effects*, are likely to be sufficient to reduce viability of the species those populations comprise. The following discussion summarizes the probability of risk the proposed action poses to Hawaiian monk seal.

This section of the opinion evaluates: 1) increases in the extinction probability of the species as it was listed; and 2) reductions in their probability of being conserved (that is, of reaching the point where they no longer warrant the protections of the ESA). These two probabilities correspond to the species' likelihood of surviving in the wild (that is, avoiding extinction) and their likelihood of recovering in the wild (that is, being conserved). Our analyses give equal consideration to both probabilities. As part of these analyses, we consider the action's effects on the reproduction, numbers, and distribution of each species.

As described in the *Status of Listed Resources,* the Hawaiian monk seal is listed as endangered under the ESA. The population summary for Hawaiian monk seals in 2019 provides the best estimate of the species as 1,428 (95% confidence interval 1361-1520) with roughly 20% of the population inhabiting the MHI (NMFS 2020a). The Hawaiian monk seal recovery plan lists three Recovery Criteria necessary for a reclassification of "threatened" under the ESA (NMFS 2007):

1. aggregate numbers exceed 2,900 total individuals in the NWHI;
2. at least 5 of the 6 main sub-population in the NWHI are above 100 individuals and the MHI population is above 500; and
3. survivorship of females in each subpopulation in the NWHI and in the MHI is high enough that, in conjunction with the birth rates in each subpopulation, the calculated population growth rate for each subpopulation is not negative.

As described in the *Status of Listed Resources,* Harting et al. (2020) determined that between 2004-2019, the causes of death with the largest influence on the long-term intrinsic growth rate of MHI Hawaiian monk seals were anthropogenic trauma and drowning, and protozoal disease. They determined that anthropogenic causes of death had a larger effect on the growth rate than natural causes. They note that the increase in mean growth rate associated with the removal of all anthropogenic causes of death rises from 1.043 to 1.090, which is substantial.

Hawaiian monk seals that reside in the MHI have been, and continue to be affected by nearshore fisheries, especially shore-casting and other recreational fisheries managed by the State of Hawaii. From 1995-2015 there have been seven mortalities attributed to hooking events; all involved seals that had ingested hooks (Gobush et al. 2016, NMFS unpub. data). And between 1989 and November of 2020, there have been 231 documented hooking events of monk seals (Mercer 2020). Interactions between seals and humans have been a growing issue in the MHI, resulting in seal disturbance, harassment, injury, and even death.

However, due to the limited availability for the public to engage in shoreline fishing near the action area, and the distance of the action area from the shoreline, as well as the comparatively low risk of fishing gear entanglement in the action area from boat-based fisheries, the risk of fishing interactions in the action area with monk seals is relatively low.

As described in the *Effects Analysis*, the stressors likely to adversely affect Hawaiian monk seals associated with the proposed action include the attraction of monk seals to the action area including associated behavioral changes, and entrapment in a net pen.

### Attraction of Hawaiian monk seal to the net pen area

Though the number fluctuates, at the time of the publication of this document there are seven seals that reside on the island of Hawaii. Only one seal, RI05, an adult male monk seal, has not shown a utilization of beaches near net pens, and continues to haulout on the northwestern tip of the island as demonstrated in Figure 16. Out of six seals, five have been positively identified and observed by Blue Ocean Mariculture staff at the net pen array. The sixth seal (RA20) is the mother of one of the pups regularly sighted at the net pens and RA20 is presumed to visit the net pens because she hauls out within 5 km of the mariculture farm. Therefore, at least six seals (five females and one male seal) are likely exposed to the mariculture operations. This number may increase as more pups are reared on the island of Hawaii and the population grows. Based on the abundance estimate by Caretta et al. (2020; 268 seals), 2.2% of seals that reside on the MHIs and 0.42% of the total population (1,428 seals) of Hawaiian monk seals are exposed to the mariculture operations. We are not anticipating lethal takes, merely non-lethal capture of one seal and behavioral changes that could lead to eventual reduction in reproductive success. As discussed, we are continuing to gauge how severe weight gain is to monk seals exposed to the net pens and how it affects their reproduction. We anticipate that the non-lethal effects of up to six seals are not appreciable to the extinction risk of Hawaiian monk seals, and does not reduce the species' ability to survive and recover.

As described in the *Response Analysis*, the haulout area "heat map" analysis which computed the proportion of each sample seal's haulout on beaches near net pens for each year (between 2009-2018) the seal was sighted. The analysis suggests there has been a shift in seal haulout behavior for the six seals described above. As a result of an easily accessible food source at the mariculture net pens, and based on several lines of information, it is our opinion that these seals are abandoning their former haulout areas on the island for beaches within 5 km of mariculture operations. However, given the current available information, we are not reasonably certain this is a net adverse effect to the MHI population.

### Access to atypical food source

Also, as described in the *Response Analysis*, presumed feeding on pen-raised Kampachi is likely to be having effects on the body condition of certain monk seals by causing unnatural weight gain. Monk seals typically swim and dive for each prey item, expending more calories and energy than feeding from the net pen. Monk seals feeding from nets pens likely do not expend as much energy feeding on net pen fish as foraging for them in the wild, resulting in a higher net caloric and nutritional intake. This change in body condition has resulted in health and fitness complications at the individual level.

For example, RW34's first and only successfully weaned pup was in 2013, but unfortunately this seal died as a juvenile from a fish hook ingestion. RW34 gave birth again in 2015 and 2016, however, both of these pups died before being weaned. Necropsy results indicated an accidental death likely due to the mom rolling over the pups. We presume that due to RW34's excessive weight, RW34 inadvertently rolled onto the pups when nursing. RW34's last confirmed pup was in 2017, but that pup also did not survive and died after eight days. She was never observed nursing her pup, and consequently the cause of the pup's death was attributed to malnutrition (Barbieri, M. 2018. Pers. Comm.). RW34 may not have been able to roll to her side to nurse her pup, or she may have been unable to move her body into a nursing position. Consequently, RW34's anomalously large body, likely as a result from feeding on farm fish at the net pens, has prohibited her from successfully weaning a pup since 2013, and possibly from giving birth since 2017.

RW34 was born in 2008, and based on a NMFS' internal report, *Quantifying the population-level cost of a female seal mortality in the MHI* (NMFS 2019), once a female pup matures (at approximately 5 years), she is likely to produce more than 7 pups during her lifetime. When we consider the survival estimates, we would expect 4 ($n$ = 3.08) out of 7 pups to reach maturity (NMFS 2019). If RW34 is unable to successfully wean any pups in the future due to her body condition as a result of feeding at the mariculture net pens, her reproductive potential would be atypically low, representing the loss of 4 - 7 monk seal pups, as well as their future progeny.

However, three females that are reproductively successful that frequent the net pens had pups that nursed longer and did not lose as much body weight as would otherwise be expected. Such pups grow more rapidly post weaning, and have higher average first-year survival rates (Baker and Johanos 2004, Baker et al. 2014, and Robinson et al. 2020). While it is too early to truly understand how much impact the fish at the net pens are having on fecundity, we anticipate as much as a 4% increase in survivorship for each pup of the three mothering females due to larger pup size at weening. We still do not know what percentage of their diet, if any, is from fish at the net pens. As such, it is difficult to know how much the net pens are contributing to their fecundity. Furthermore, we do not know how long the three mothering monk seals will be reproducing with increased nursing (and subsequent increased weaner size). Considering many female monk seals do not reproduce at all from various reasons (i.e., premature death, injuries, or other circumstances), we are optimistic it may at least partially support successful reproducing female monk seals, despite being detrimental to RW34.

Commonly grouped by location (i.e., NWHI and MHI seals), the level of range-wide connectivity demonstrated by tagging and genetic data, as well as historical recolonizations, confirm that this species is properly managed as a single population (Schultz et al. 2011). Based on the data on the expected diminishment of reproductive success in RW34, the loss associated with her reproductive detriment of an estimated 4-7 monk seals accounts for 0.28% to 0.49% of the total Hawaiian monk seal population abundance ($n$ = 1,428). The population has an estimated average growth rate of about 2% per year since 2013 (Caretta et al. 2020, NMFS 2020a). Therefore, a functional loss of one reproductive female seal is less than the population's growth, and not an appreciable loss to the species. However, among the six seals that frequent the net pen, five are female (four adult and one juvenile), and each of those adult females, other than RW34, has successfully weaned a pup over the last few years.

Besides RW34, the three other adult females are: RB00 (weaned 4 pups in 2016, 2017, 2019, and 2020), RA20 (weaned 3 pups in 2017, 2018, and 2019), and R8HE (2 documented pups in 2017, and 2018). However, R8HE may have had undetected pubs born on Niihau; (Mercer, T. 2020. Pers. Comm.). Prior to giving birth, RB00 and RA20 were larger when compared to the average pregnant female, however since nursing their pups for an extended period of 45 days or more, these seals are currently considered to be average sized female seals, as opposed to the size expected of an average seal post-nursing. While the change in body condition has resulted in beneficial effects such as a prolonged nursing period, over the long term, these seals could also be at risk of health and fitness complications. However, while they are at risk of health consequences (like RW34), we are not reasonably certain they will occur.

Further, the amount of time Hawaiian monk seals spend at the net pens may also increase the likelihood of human-seal interactions potentially encouraging monk seals to become habituated to people. This is particularly concerning since two of the monk seals observed in the net pen area are young seals (RK26 and RL50), and juvenile pups are playful and extremely impressionable (Littnan, C. 2018. Pers. Comm.). Seals that regularly feed at the net pens are in close proximity to Blue Ocean employees on a daily basis and may begin to associate humans with food. If a seal associates humans with food, it may become an aggressive "beggar," which could lead to an increase in interactions with humans, and can increase the probability of injury.

### Net Pen Entrapment

As a result of monk seals being attracted to mariculture operations, they are at risk of becoming entrapped in a net pen. As described in the *Consultation History* and *Response Analysis*, there have been two occasions since 2014, that monk seals have entered retired net pens. The seal that was trapped in 2017 died, and due to adaptive management and updated protocols, the seal trapped in 2021 was able to surface for air and was released alive. Open ocean net pen mariculture is an emerging industry; there are many unknowns including the strength and true deterioration rate of the CAM and Kikko net pen materials and their ability to withstand the pressure of a monk seal or any other marine animal pushing up against it. Therefore, we expect that one Hawaiian monk seals to be at risk of net pen entrapment. We are also reasonably certain any seal will be released alive due to the updated protocols outlined in the Blue Ocean Mariculture, Hawaiian monk seal net pen removal protocol in *Appendix B*. We do not expect any mortalities as a result of future net pen entrapment.

While we do not expect any monk seals to die from net entrapment, we do expect sublethal responses that may range from those that are temporary in nature such as elevated stress levels to injuries that may affect feeding, movement, or even breeding success. These effects may decline over time as monk seals heal from any injuries, and we can monitor the extent to which such sublethal injuries persist by observation documentation on the protected species monitoring form, and from haulout sighting data.

## 9. Conclusion

Baseline conditions continue to act on the species, however, the effects of the proposed action, when added to these conditions, do not appreciably contribute to the extinction risk of this species or impede its recovery. We expect the overall population to remain large enough to maintain genetic heterogeneity, broad demographic representation, and successful reproduction. The proposed action will have small positive and negative effects on the overall size of the population, and we do not expect it to affect the Hawaiian monk seals' ability to meet their lifecycle requirements and to retain the potential for recovery.

Based on the evidence available, and after reviewing the current Status of Listed Resources, the Environmental Baseline for the Action Area, the Effects of the Action and the Cumulative Effects, it is NMFS' biological opinion that USACE's authorization of installation of new net pens and ongoing, revised mariculture operations by Blue Ocean Mariculture is not likely to jeopardize the continued existence of the Hawaiian monk seal.

# 10. Incidental take statement

Section 9 of the ESA and protective regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species without a special exemption. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 50 CFR 402.02. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of the Incidental Take Statement (ITS).

The measures described below are nondiscretionary, and must be undertaken by USACE for the exemption in section 7(o)(2) to apply. USACE has a continuing duty to regulate the activity covered by this ITS. If USACE fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, USACE must monitor the progress of the action and its impact on the species as specified in the ITS (50 CFR 402.14(I)(3)). The proposed action results in the anticipated non-lethal take of endangered Hawaiian monk seals.

## 10.1. MMPA Authorization

When an action will result in incidental take of ESA-listed marine mammals, ESA section 7(b)(4) requires that such taking be authorized under the MMPA section 101(a)(5) before the Secretary can issue an ITS for ESA-listed marine mammals. That ITS must specify those measures that are necessary to comply with section 101(a)(5) of the MMPA. Section 7(b)(4) and 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 ITS, including those specified as necessary to comply with the MMPA, Section 101(a)(5).

MMPA 101(a)(5)(E) allows NMFS to issue permits to take ESA-listed species incidental to commercial fishing if certain conditions are met. However, authorizations are not required for commercial fisheries involving a remote likelihood of or no known incidental taking of marine mammals (i.e., fisheries classified as Category III fisheries on the List of Fisheries[1]). According to the 2022 List of Fisheries, the Hawaii offshore pen fishery is a Category III fishery. Therefore, no 101(a)(5)(E) permit is required[2].

## 10.2. Amount or Extent of Take

The following level of incidental take may be expected to result from the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to

[1] The MMPA mandates that all commercial fisheries be classified by the level of incidental marine mammal death and serious injury. The level of marine mammal death and serious injury that occurs incidental to each commercial fishery is reported in the annual Marine Mammal Stock Assessment Reports for each stock. Accordingly, the List of Fisheries puts each commercial fishery into one of three categories: 1) frequent incidental death or serious injury of marine mammals, 2) occasional incidental death or serious injury of marine mammals and 3) remote likelihood of/no known incidental death or serious injury of marine mammals.

[2] See NMFS Procedural Directive 02-204-02 (2020).

minimize the impact of incidental take that might otherwise result from the proposed action. If take is anticipated to occur, then the Services must describe the amount or extent of such anticipated take and the reasonable and prudent measures, and terms and conditions necessary to minimize the impacts of incidental take (FWS and NMFS 1998). If, during the course of the action, this level of incidental take is exceeded for the species as listed, USACE must immediately reinitiate formal consultation with NMFS pursuant to the section 7 regulations (50 CFR 402.16).

In the biological opinion, we determined incidental take is reasonably certain to occur as:

1. Harm that results in the non-lethal take from the disruption of normal feeding patterns of exposed Hawaiian monk seals.
2. Non-lethal entrapment of one additional Hawaiian monk seal over the next 10 years.

In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

### 10.3. Reasonable and Prudent Measures

Reasonable prudent measures are the actions necessary or appropriate to minimize the impacts, i.e., amount or extent, of incidental take (50 CFR 402.02). The associated terms and conditions set out the specific methods by which the reasonable and prudent measures are to be accomplished, e.g., the actions necessary to reduce entrapment and attraction. Reasonable and prudent measures along with the terms and conditions that implement them cannot alter the basic design, location, scope, duration, or timing of the action, and may involve only minor changes. Terms and conditions of an incidental take statement must include reporting and monitoring requirements that assure adequate action agency oversight of any incidental take [50 CFR 402.14(i)(1)(iv) and (i)(3)]. Compliance with the terms and conditions specified in the incidental take statement exempts the Federal agency and any permit or license applicant involved from the taking prohibitions of the ESA up to the level specified in the incidental take statement.

NMFS has determined that the following reasonable and prudent measures, as implemented by the terms and conditions that follow, are necessary and appropriate to minimize the take associated with Blue Ocean Mariculture operations, as described in the proposed action, on the endangered Hawaiian monk seal and to monitor the level and nature of any incidental takes. These measures are non-discretionary—they must be undertaken for the exemption in ESA section 7(o)(2) to apply.

1. Minimize incidental take from the disruption of normal feeding patterns of exposed Hawaiian monk seals.
2. Minimize incidental take from entrapment of Hawaiian monk seals.
3. Ensure monitoring sufficient to document the proposed action does not exceed the parameters analyzed in the effects section or the extent of take described above, and the terms and conditions are effective in minimizing incidental take.

### 10.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the USACE and Blue Ocean Mariculture must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These include the take minimization, monitoring, and reporting measures required by the section 7 regulations (50 CFR §402.14(i)).

The following terms and conditions implement Reasonable and Prudent Measure 1. USACE shall ensure and Blue Ocean Mariculture shall:

a. Implement the camera operation and coordination protocol in Appendix C to capture Hawaiian monk seal behavior and identify seals at the net pens, and provide biological and operational data to be paired with seal tracking information to NMFS so that the monitoring forms and video data analyzing net pen preference will inform decisions to minimize future incidental take.

    1. Make any necessary re-designs or modifications to the net pens to prevent opportunities for monk seals to obtain fish from the net pens if those opportunities are identified by video observations or other monitoring.

    2. Monitor re-designs or modifications of net pens to ensure that they are effectively reducing farm-raised fish from escaping the net pens, or monk seal foraging on net pen fish. Correct any such issues as soon as practicable.

b. Installs, or allows NMFS to install and maintain a transponder near the net pen array to record acoustically tagged monk seals. The acoustic monitoring data will be used to ground-truth the protected species visual monitoring form and track which individually identified monk seals are frequenting each net pen, the time spent at the net pen, and what net pens the seals prefer. This data will inform decisions to minimize future incidental take.

The following terms and conditions implement Reasonable and Prudent Measure 2. USACE shall ensure and Blue Ocean Mariculture shall:

a. Follow safe release protocols for any seal that enters a net pen as outlined in Appendix B.

b. Within six months of the delivery of this biological opinion, provide NMFS with a revised version of the Hawaiian monk seal removal protocol with technical details of the seine net including the material of the net, the weight, and strength.

c. If the applicant has to execute the Hawaiian monk seal removal protocol, the applicant shall contact and coordinate with NMFS as soon as possible to avoid any possible mortality, and follow up within one week to discuss the effectiveness of the protocol so that changes can be made if needed.

The following terms and conditions implement Reasonable and Prudent Measure 3. USACE shall ensure and Blue Ocean Mariculture shall:

a. Upload video files according to Term and Condition #1 and the protocol in Appendix C.

b. Report all Hawaiian monk seal entrapments to NMFS Protected Resources Division within one week.

c. Use the identification materials provided by NMFS, and obtains training from marine mammal experts on seal identification and behavior to assist Blue Ocean employees in identifying individual seals and documenting seal behavior to facilitate accurate reporting and identification of interactions.

d. Continue to provide monthly observation reports, including number of seals observed at the net pens, status of the net pen, how the seal was observed, and any identifying marks or scars.

### 10.5 Conservation Recommendations

Pursuant to section 7(a)(1) of the ESA, the following conservation recommendation is made to assist the USACE in contributing to the conservation of Hawaiian monk seals by further reducing or eliminating adverse impacts associated with net pens.

- USACE in collaboration with the applicant, Blue Ocean Mariculture, should further encourage dive and snorkel vessels to avoid the net pen array, to reduce the potential for interactions, and to diminish the likelihood for seals to be habituated to the presence of humans.

## 11. Reinitiation Notice

This concludes section 7 consultation for NMFS on the proposed installation of net pens and continued mariculture operation pursuant to Section 7(a)(2) of the ESA . As 50 CFR §402.16 states, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if:

- The amount or extent of taking specified in the incidental take statement is exceeded.
- 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.
- 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.
- A new species is listed or critical habitat designated under the ESA that may be affected by the action.

## 12. LITERATURE CITED

Antonelis, G. A., J. D. Baker, J. J. Polovina. 2003. Improved Body Condition of Weaned Hawaiian Monk Seal Pups Associated with El Nino Events: Potential Benefits to an Endangered Species. Marine Mammal Science 19(3):590-598.

Antonelis, G. A., J. D. Baker, T. C. Johanos, and A. L. Harting. 2006. Abundance of the Hawaiian monk seal (*Monachus schauinslandi)*: status and conservation issues. Atoll Research Bulletin 543:75-101.

Asner, G.P., N.R. Vaughn, J. Heckler, D.E. Knapp, C. Balzotti, E. Shafron, R.E. Martin, B.J. Neilson, and J.M. Gove. 2020. Large-scale mapping of live corals to guide reef conservation. The Proceedings of the National Academy of Sciences 117(52):33711-33718.

Baker, J. D. 2004. Evaluation of Closed Capture-Recapture Methods to Estimate Abundance of Hawaiian Monk Seals. Ecological Applications 14(4):987-998.

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.

Baker, J. D. and T. C. Johanos. 2004. Abundance of the Hawaiian monk seal in the main Hawaiian Islands. Biological Conservation, 116(1):103-110.

Baker, J. D., T. C. Johanos, T. A. Wurth, and C. L. Littnan. 2014. Body growth in Hawaiian monk seals. Marine Mammal Science 30(1):259-271.

Baker, J. D., Harting, A. L., Johanos, T. C., London, J. M., Barbieri, M. M., Littnan, C. L. 2020. Terrestrial habitat loss and the long-term viability of the French Frigate Shoals Hawaiian monk seal subpopulation. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-107, 34 p. https://doi.org/10.25923/76vx-ve75.

Baker, J. D., A. L. Harting, T. A. Wurth, and T. C. Johanos, 2011. Dramatic shifts in Hawaiian monk seal distribution predicted from divergent regional trends. Marine Mammal Science 27(1):78-93.

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.

Baker, J. D., C. L. Littnan, D. W. Johnston. 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.

Baker J. D., E. A. Howell, J. 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..

Baker, J.D., Thompson, P.M., 2007. Temporal and spatial variation in age-specific survival rates of a long-lived mammal, the Hawaiian monk seal. Proc Biol Sci. 2007 Feb 7;274(1608):407-15.

Baker, J. D., Harting, A. L., Barbieri, M. M., Robinson, S. J., Gulland, F. M. D., Littnan, C. L. 2017. Modeling A Morbillivirus Outbreak In Hawaiian Monk Seals (*Neomonachus schauinslandi*) To Aid In The Design Of Mitigation Programs. J Wildl Dis 53 (4): 736–748. https://doi.org/10.7589/2016-10-238

Banish, L. D., and W. G. Gilmartin. 1992. Pathological Findings in the Hawaiian Monk Seal. Journal of Wildlife Diseases 28(3):428-434.

Barbieri, M. M., Kashinsky, L., Rotstein, D. S., Colegrove, K. M., Haman, K. H., Magargal, S. L., Sweeny, A. R., Kaufman, A. C., Grigg, M. E., Littnan, C. L. 2016. Protozoal-related mortalities in endangered Hawaiian monk seals *Neomonachus schauinslandi*. Dis Aquat Organ. 121(2):85-95.

Bjorndal, A. and A.B. Skar. 1992. Tagging of saithe (*Pollachius virens*) at a Norwegian fish farm: preliminary results on migration. Institute of Marine Research, Fish Capture Division. International Council for the Exploration of the Sea. Demersal Fish Committee. C.M. 1992/G:35 Ref. F.

Boland, R. C., and M. J. Donohue. 2003. Marine debris accumulation in the nearshore marine habitat of the endangered Hawaiian monk seal, *Monachus schauinslandi* 1999–2001. Marine Pollution Bulletin 46:1385–1394.

Korte, Tyler. 2021. Blue Ocean Mariculture, *Marine Animal Interactions Standard Operating Procedures*. Transmitted to NMFS via Lesley Hawn on July 28, 2021.

Boness D. J. and W. D. Bowen. 1996. The Evolution of Maternal Care in Pinnipeds: New findings raise questions about the evolution of maternal feeding strategies. BioScience 46(9):645-654.

Burns, J. H. R. and K. L. Kramer (PlanB Consultancy, Inc.). 2018. NELHA Benthic and Biota Monitoring Study, October 2018. Prepared for Natural Energy Laboratory of Hawaii Authority, Kailua-Kona, HI. 50 pp. + Appendices.

Cahoon, 2011. The Foraging Ecology of Monk Seals in the Main Hawaiian Islands. M.S., University of Hawaii, Honolulu, Hawaii.

Carey, J.R. and Roach, D.A. 2020. Biodemography: An Introduction to Concepts and Methods. Princeton University Press. 480 pages, ISBN: 9780691129006

Carretta J. V., K. A. Forney, E. M. Oleson, D. W. Weller, A. R. Lang, J. Baker, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, and R. L. Brownell Jr. 2020. U. S. Pacific Marine Mammal Stock Assessments: 2019. NOAA-TM-NMFS-SWFSC-577. 75 p

Cortés-Hinojosa, G., F.M. Gulland, T. Goldstein, S.Venn-Watson, R. Rivera, T.B. Waltzek, M. Salemi, and J.F. Wellehan. 2015. Phylogenomic characterization of California sea lion adenovirus-1. Infection, genetics and evolution: journal of molecular epidemiology and evolutionary genetics in infectious diseases, 31:270–276.

Craig, M. P. and T. J. Ragen. 1999. Body size, Survival, and Decline of Juvenile Hawaiian Monk Seals, *Monachus Schauinslandi*. Marine Mammal Science 15(3):786-809.

DeMartini, E. E., F. A. Parrish, and J. D. Parrish. 1996. Interdecadal change in reef fish populations at French Frigate Shoals and Midway Atoll, Northwestern Hawaiian Islands: statistical power in retrospect. Bulletin of Marine Science. 58(3):804-825.

Dempster, T., P. Sanchez-Jerez, J. T. Bayle-Sempere, F. Giménez-Casalduero, and C. Valle. 2002. Attraction of wild fish to sea-cage fish farms in the south-western Mediterranean Sea: spatial and short-term temporal variability. Marine Ecology Progress Series. 242: 237-252.

DLNR (Department of Land and Natural Resources). 2003. Final Environmental Assessment for an Offshore Open Ocean Fish Farm off Unualoha Point, Hawaii Island. Office of Environmental Quality Control, Honolulu, HI.

DLNR (Department of Land and Natural Resources). 2014. Final Environmental Assessment for a Production Capacity Increase at the Existing Open Ocean Mariculture Site off Unualoha Point, Hawaii Island. Office of Environmental Quality Control, Honolulu, HI.

Dhurandhar, N.V., L.D. Whigham, D.H. Abbott, N.J. Schultz-Darken, B.A. Israel, S.M. Bradley, J.W. Kemnitz, D.B. Allison, and R.L. Atkinson. Human adenovirus Ad-36 promotes weight gain in male rhesus and marmoset monkeys. Journal of Nutrition. 2002 132(10):3155-60.

Gaitonde, D.Y., Rowley K.D., L.B. Sweeney 2012. Hypothyroidism: an update, South African Family Practice, 54:(5):384-390.

Gerrodette, T. and W. Gilmartin. 1990. Demographic Consequnces of Changed Pupping and Hauling Sites of the Hawaiian Monk Seal. Conservation Biology. 4:423-430.

Gobush, K.S. 2012. Significant covariates of non-invasive measures of glucocorticoids and thyroid hormone in free-ranging Hawaiian monk seals (*Monachus schauinslandi*), 97$^{th}$ Ecological Society of America, Portland, Oregon August 5-10, 2012.

Gobush, K. S., T. A. Wurth, J. R. Henderson, B. L. Becker, C. L. Littnan. 2016. Prevalence of interactions between Hawaiian monk seals (*Nemonachus schauinslandi*) and nearshore fisheries in the main Hawaiian Islands. Pacific Conservation Biology, 23(1):25-31.

Goodman-Lowe, G. D. 1998. Diet of the Hawaiian monk seal (*Monachus schauinslandi*) from the Northwestern Hawaiian Islands during 1991-1994. Marine Biology 132:535-546.

Gulko, D. A., J. E. Maragos, A. M. Friedlander, C. L. Hunter, and R. E. Brainard. 2002. Status of Coral Reefs in the Hawaiian Archipelago. In: Status of Coral Reefs of the World: 2000 by Clive R. Wilkinson.

Harting, A. L. 2010. Shark predation on Hawaiian monk seals workshop, Honolulu, Hawaii, January 8-9, 2008. Pacific Islands Fisheries Science, Center. Administrative report H; 10-02C.

Harting, A. L., M. M. Barbieri, J. D. Baker, T. A. Mercer, T. C. Johanos, S. J. Robinson, C. L. Littnan, K. M. Colegrove, D. S. Rotstein. 2020. Population-level impacts of natural and anthropogenic causes-of-death for Hawaiian monk seals in the main Hawaiian Islands. Marine Mammal Science 2021(37):235-250.

Harting, A. L.; Johanos, T. C., Littnan, C. L. 2014. Benefits derived from opportunistic survival-enhancing interventions for the Hawaiian monk seal: the silver BB paradigm. Endangered Species Research 25: 89-96. Harvell, C. D., C. E. Mitchell, J. R. Ward, S. Altizer, A.P. Dobson, R. S. Ostfeld, and M. D. Samuel. 2002. Climate Warming and Disease Risks for Terrestrial and Marine Biota. Science 296:2158-2162.

Hawley, D. M., K. V., Sydenstricker, G. V., Kollias, and A. A. Dhondt. 2005. Genetic diversity predicts pathogen resistance and cell-mediated immunocompetence in house finches. Biology Letters. 1:326–329.

Henderson, J. R. 1984. Encounters of Hawaiian monk seals with fishing gear at Lisianski Island,1982. Mar. Fish. Rev. 46(3):59-61.

Henderson, J. R. 1985. A review of Hawaiian monk seal entanglements in marine debris. *In* R. Shomura and H. O. Yoshida (Editors), Proceedings of the workshop on the Fate and Impact of Marine Debris, p. 326-335. U.S. Department of Commerce NOAA Technical Memo. NMFSSWFSC-54.

Henderson, J. R. 1990. Recent entanglements of Hawaiian monk seals in marine debris. Pages 540-553 *in* R. S. Shomura and M. L. Godfrey, eds., Proceedings of the Second International Conference on Marine Debris, Honolulu, Hawaii. U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Hildebrand, J. A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series. 395:5-20.

Hiruki, L. M., W. G. Gilmartin, B. L. Becker, and I. Stirling. 1993a. Wounding in Hawaiian monk seals (Monachus schauinslandi). Canadian Journal of Zoology **71**:458-468.

Hiruki, L. M., I. Stirling, W. G. Gilmartin, T. C. Johanos, and B. L. Becker. 1993b. Significance of wounding to female reproductive success in Hawaiian monk seals (Monachus schauinslandi) at Laysan Island. Canadian Journal of Zoology **71**:469-474.

Hoegh-Guldberg, O. P., J. Mumby, A. J. Hooten, R. S. Steneck, P. Greenfield, E. Gomez, C. D. Harvell, P. F. Sale, A. J. Edwards, K. Caldeira, N. Knowlton, C. M. Eakin, R. Iglesias-Prieto, N. Muthiga, R. H. Bardbury A. Dubi, and M. E. Hatziolos. 2007. Coral Reefs Under Rapid Climate Change and Ocean Acidification. Science 318(5857): 1737-1742.

Howland, B. (WHALE Environmental Services, LLC) 2015. NELHA Benthic and Biota Monitoring Study, June 2015. Prepared for Natural Energy Laboratory of Hawaii Authority, Kailua-Kona, HI. 37 pp. + Appendices.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland. 151 p.

IPCC (Intergovernmental Panel on Climate Change). 2018. Summary for Policymakers. In: Masson-Delmotte, V., P. Zhai, H.-O. Portner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Pean, R. Pidcock et al., editors. 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. World Meteorological Organization, Geneva, Switzerland: 32.

Isaac, J.L. 2008. Effects of climate change on life history: Implications for extinction risk in mammals. Endangered Species Research 7:115-123.

Iverson, S., J. Piche, and W. Blanchard. 2006. Hawaiian monk seals and their prey in the Northwestern Hawaiian Islands: Assessing characteristics of prey species fatty acid signatures and consequences for estimating monk seal diets using quantitative fatty acid signature analysis. Unpublished report. Pacific Islands Fisheries Science Center, Honolulu, HI, 134 p.

Johanos, T. C., B. L. Becker, and T. J. Ragen. 1994. Annual Reproductive Cycle of the Female Hawaiian Monk Seal (*Monachus Schauinslandi*). Marine Mammal Science 10(1):13-30.

Johanos, T. C., L. H. Harting, T. A. Wurth, and J. D. Baker. 2014. Range-wide movement patterns of Hawaiian monk seals. Marine Mammal Science 30(3):1165-1174.

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**:123-132Kelly, I.K. 2020. A Review of Vessel Collision Threat to Sea Turtles in Hawaii. NOAA PIRO Unpublished Technical Memo (white pater) to File. Final draft: October 29, 2020.

Kenyon, K. W. and D. W. Rice. Life History of the Hawaiian Monk Seal. 1959. Pacific Science XIII: 215-252.

King B. S. and Gibbins J. D. 2011. Health hazard evaluation of Deepwater Horizon response workers. Health Hazard Evaluation Report HETA 2010–0115 & 2010–0129–3138.

Lammers, M. O., Pack, A. A., & Davis, L. (2003). Historical evidence of whale/vessel collisions in Hawaiian waters (1975–present). Hawaiian Islands Humpback Whale National Marine Sanctuary, National Oceania and Atmospheric Administration. Richardson, J. W., Green Jr. , C. R., Malme, C. I., & Thomson, D. H. 1995. *Marine mammals and noise*. 576 pp. Academic Press, San Diego, CA.

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 3:232–244.

Longenecker, K.R., R.A. Dollar, and M.K. Cahoon. Increasing Taxonomic Resolution in Dietary Analysis of the Hawaiian Monk Seal. Hawaii Biological Survey No. 2005-004. 10pp.

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 (2012):2588-2598.

Lubell System 3300. Diver Recall System. http://www.lubell.com/3300P.html. Accessed 02 October 2018.

Madge, L. 2016. Preliminary assessment of monk seal-fishery interactions in the main Hawaiian Islands. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96818-5007. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-16-08, 23 p.

McKenna, M. F., D. Ross, S. M. Wiggins, and J. A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. Acoustical Society of America. 131(1):92-103.

Mercer, T.A. 2020. Hawaiian Monk Seal Research Program Hawaiian monk seal fisheries interaction data collected in the main Hawaiian Islands, 1976 - 2019. US National Oceanographic Data Center.

Meyer C.G., T.B. Clark, Y.P. Papastamatiou, N.M Whitney, K.N. Holland (2009) Long-term movements of tiger sharks (*Galeocerdo cuvier*) in Hawaii. Mar Ecol Prog Ser 381:223–235.

Morishige, C., M. J. Donohue, E. Flint, C. Swenson, C. Woolaway. 2007. Factors affecting marine debris deposition at French Frigate Shoals, Northwestern Hawaiian Islands Marine National Monument, 1990–2006. Marine Pollution Bulletin 54:1162–1169.

MMC (Marine Mammal Commission). 2007. Marine Mammals and Noise: A Sound Approach to Research and Management. A Report to Congress from the Marine Mammal Commission. 370 p.

NOAA (National Oceanographic Atmospheric Administration) 2016. Pacific Reef Assessment and Monitoring Program Data Report. Ecological monitoring 2016-reef fishes and benthic habitats of the main Hawaiian Islands, Northwestern Hawaiian Islands, Pacific Remote Island Areas, and American Samoa. Pacific Islands Fishery Science Center Data Report DR-17-001. doi:10.7289/V5/DR-PIFSC-17-001.

NOAA (National Oceanographic Atmospheric Administration) 2019. Pacific Reef Assessment and Monitoring Program Data Report. Ecological monitoring 2019-reef fishes and benthic habitats of the main Hawaiian Islands, Northwestern Hawaiian Islands, Pacific Remote Island Areas, and American Samoa. Pacific Islands Fishery Science Center Data Report DR-19-039.

NOAA (National Oceanographic Atmospheric Administration) 2018. US Coral Reef Monitoring Data Summary 2018. NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 31, 224 pp.

NMFS (National Marine Fisheries Service). 2007. Recovery Plan for the Hawaiian Monk Seal. National Marine Fisheries Service, Pacific Islands Region, Honolulu, HI.

NMFS (National Marine Fisheries Service). 2009. Endangered Species Act Section 7 Consultation Biological Opinion and Incidental Take Statement: Continued authorization of pelagic troll and handline fisheries, as managed under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region. NMFS, Pacific Islands Region, Protected Resources Division. 31 p.

NMFS (National Marine Fisheries Service). 2014. Hawaiian Monk Seal Critical Habitat Final Biological Report. National Marine Fisheries Service, Pacific Islands Region, Honolulu, HI.

NMFS (National Marine Fisheries Service). 2015. Main Hawaiian Islands Monk Seal Management Plan. National Marine Fisheries Service, Pacific Islands Region, Honolulu, HI.

NMFS (National Marine Fisheries Service). 2016a. Main Hawaiian Islands Monk Seal Management Plan. National Marine Fisheries Service, Pacific Islands Region, Honolulu, HI.

NMFS (National Marine Fisheries Service). 2016b. Revised guidance for treatment of climate change in NMFS Endangered Species Act decisions. United States Department of Commerce. 1-8 p.

NMFS (National Marine Fisheries Service). 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. NOAA Technical Memorandum NMFS-OPR-59. 167 p.

NMFS (National Marine Fisheries Service). 2019. Population Summary for Hawaiian Monk Seals in 2018. Hawaiian Monk Seal Research Program, Pacific Islands Fisheries Science Center. PIFSC Internal Report IR-19-003.

NMFS (National Marine Fisheries Service). 2020a. Population Summary for Hawaiian Monk Seals in 2019. Hawaiian Monk Seal Research Program, Pacific Islands Fisheries Science Center. PIFSC Internal Report IR-20-001.

NMFS (National Marine Fisheries Service).. 2020b. "The Toll of Toxoplasmosis: Protozoal Disease Has Now Claimed the Lives of 12 Monk Seals and Left Another Fighting to Survive". https://www.fisheries.noaa.gov/feature-story/toll-toxoplasmosis-protozoal-disease-has-now-claimed-lives-12-monk-seals-and-left. Accessed 12 March, 2020.

NRC (National Research Council). 2003. Ocean Noise and Marine Mammals. Washington (DC): The National Academies Press.

Opp, K. R., T. M. O'Hara, J. M. Castellini, M. Barbieri, C. L. Littnan, and L. D. Rea. 2015. Total Mercury Concentration and Stable Isotopes of Carbon and Nitrogen in Hawaiian Monk Seal Hair. Poster presented at: Bridging the Past Toward the Future. SSM 2015.. 21st Biennial Conference on the Biology of Marine Mammals; San Francisco.

Otis, D. L., K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed animal populations. Wildlife Monographs 62:1-135.

Parmesan, C. (2006). Ecological and evolutionary responses to recent climate change. Annual Review of Ecology, Evolution, and Systematics 37(1):637-669.

Parrish, F. A. 2004. Foraging landscape of the Hawaiian monk seal. Ph.D., University of Hawaii, Honolulu, Hawaii.

Parrish, F. A. and C. L., Littnan. 2007. Changing perspectives in Hawaiian monk seal research using animal-borne imaging. Marine Technology Society Journal 41(4):30-34.

Parrish, F. A. and K. Abernathy. 2006. Movements of monk seals relative to ecological depth zones in the lower Northwestern Hawaiian Islands. Atoll Research Bulletin, 543:115-130.

Parrish, F. A., K. Abernathy, G.J. Marshall, and B.M. Buhleier. 2002. Hawaiian monk seals (*Monachus schauinslandi*) foraging in deep-water coral beds. Marine Mammal Science 18(1):244-258.

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. Marine Mammal Science, 16(2):392-412.

Parrish, F. A., G. J. Marshall, B. M. Buhleier, and G.A. Antonelis. 2008. Foraging interaction between monk seals and large predatory fish in the Northwestern Hawaiian Islands. Endangered Species Research 4:299-308.

Parrish, F. A., G. J. Marshall, C. L. Littnan, M. Heithaus, S. Canja, B. Becker, R. Braun, and G. A. Antonelis. 2005. Foraging of juvenile monk seals at French Frigate Shoals, Hawaii. Marine Mammal Science 21(1):93-107.

Peterson, M.E. (2021). "Hypothyroidism in Animals - Endocrine System." *Merck Veterinary Manual*, Merck Veterinary Manual, www.merckvetmanual.com/endocrine-system/the-thyroid-gland/hypothyroidism-in-animals. Accessed 20 March, 2021.

Randall, A. 2010. NEPA, National Security, and Ocean Noise: The Past, Present, and Future of Regulating the Impact of Navy Sonar on Marine Mammals. Journal of International Wildlife Law & Policy. 13(4):326-356.

Reidarson, T. H., J. McBain, C. House, D. P. King, J. L. Stott, A. Krafft, J. K. Taubenberger, J. Heying, and T.P. Lipscomb. 1998. Morbillivirus Infection in Stranded Common Dolphins from the Pacific Ocean. Journal of Wildlife Disease 34(4):771-776.

Reif, J. S., A. Bachand, A. A. Aguirre, D. L. Borgesson, L. Kashinsky, R. Braun, and G. Antonelis. 2004. Morphometry, Hematology, and Serum Chemistry in the Hawaiian Monk Seal (*Monachus Schauinslandi*). Marine Mammal Science 20(4):851-860.

Rexstad, E. A. and K. P. Burnham. 1991. User's manual for interactive Program CAPTURE. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, CO. 29 pp.

Robinson, S., Hauser, S., Latch, E. 2021. Preliminary Report on Genomics Research Collaboration between the NOAA/NMFS/PIFSC/Hawaiian Monk Seal Research Program and the University of Wisconsin-Milwaukee for the Study of Hawaiian Monk Seal Conservation Genomics. PIFSC Administrative Report, H-21-06, 34 p. doi:10.25923/ttx8-9n02

Robinson, S., A. L. Harting, T. Mercer, T. C. Johanos, J.D. Baker, and C.L. Littnan. 2020. Sightings patterns reveal unobserved pupping events to revise reproductive rate estimates for Hawaiian monk seals in the Main Hawaiian Islands. Marine Mammal Science 2020:1-13.

Robinson, S. J., Barbieri, M. M., Murphy, S., Baker, J. D., Harting, AL, Craft, M. E., Littnan, C. L. 2018. Model recommendations meet management reality: implementation and evaluation of a network-informed vaccination effort for endangered Hawaiian monk seals. Proc Biol Sci. 285(1870):20171899. doi: 10.1098/rspb.2017.1899.

Sanchez-Jerez P., D. Fernandez-Jover, I. Uglem, P. Arechavala-Lopez, T. Dempster, J. T. Bayle-Sempere, C.V. Perez, D. Izquierdo, P. Bjorn, and R. Nilsen. 2011. Coastal Fish Farms as Fish Aggregation Devices (FADS). Artificial Reefs in fisheries Management. CRC Press. Taylor and Francis Group. Florida, USA.

Schoeman, R. P., Patterson-Abrolat, C., & Plön, S. (2020). A global review of vessel collisions with marine animals. *Frontiers in Marine Science*, *7*, 292.

Schultz, J. K, J.D. Baker, R.J., Toonen, and B. W. Bowen. 2009. Extremely Low Genetic Diversity in the Endangered Hawaiian Monk Seal (*Monochus schauinslandi*). Journal of Heredity, 100(1):25-33.

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.

Speed, C. W., Meekan, M. G., Rowat, D., Pierce, S. J., Marshall, A. D., & Bradshaw, C. J. (2008). Scarring patterns and relative mortality rates of Indian Ocean whale sharks. *Journal of Fish Biology*, *72*(6), 1488-1503.

Stewart, B. S., G.A., Antonelis, J.D., Baker, and P. K. Yochem. 2006. Foraging biogeography of Hawaiian monk seals in the Northwestern Hawaiian Islands. Atoll Research Bulletin, 543:131-146.

USACE (U.S. Army Corp of Engineers) 2018. Biological Evaluation on the Installation of New Net Pens and Ongoing Mariculture Operations by Blue Ocean Mariculture LLC. Department of the Army, File POH-2007-00201.

USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook. Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act. http://www.nmfs.noaa.gov/pr/pdfs/laws/esa_section7_handbook.pdf

Wellehan, J. and G. Cortes-Hinojosa. 2019. Marine Mammal Viruses. Fowler's Zoo and Wild Animal Medicine Current Therapy, (9):597–602.

West, K. L., Silva-Krott, I., Landrau-Giovannetti, N., *et al*. Novel cetacean morbillivirus in a rare Fraser's dolphin (*Lagenodelphis hosei*) stranding from Maui, Hawai'i. *Sci Rep* **11,** 15986 (2021). https://doi.org/10.1038/s41598-021-94460-6

White, G.C., D.R. Anderson, K.P. Burnham, and L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, Los Alamos, New Mexico.

Wilson, K., Littnan C., Patrick, H., Read, A. 2017. Integrating multiple technologies to understand the foraging behaviour of Hawaiian monk seals. R. Soc. open sci. 4160703160703 http://doi.org/10.1098/rsos.160703

Wilson, K., Littnan, C., Read, A.J. 2017b. Movements and home ranges of monk seals in the main Hawaiian Islands. Mar Mam Sci, 33: 1080-1096. https://doi.org/10.1111/mms.12429

Ylitalo, G. M., M. Myers, B.S. Stewart, P.K. Yochem, R. Braun, L. Kashinsky, D. Boyd, G.A., Antonelis, S. Atkinson, A.A. Aguirre, and M.M. Krahn. 2008. Organochlorine contaminants in endangered Hawaiian monk seals from four subpopulations in the Northwestern Hawaiian Islands. Marine pollution bulletin, 56(2):231–244.

# APPENDIX A: LISTED RESOURCES AND STRESSORS NOT CONSIDERED FURTHER

Below we briefly describe stressors that are not likely to adversely affect (NLAA) listed species or their designated critical habitat, and our reasoning for this conclusion. Based on our evaluation, the following resources are not likely to be adversely affected by the proposed action: hawksbill sea turtle, Central North Pacific green sea turtle, Main Hawaiian Islands (MHI) insular false killer whale (IFKW), oceanic whitetip shark, giant manta ray, Hawaiian monk seal critical habitat and MHI insular false killer whale critical habitat. The following stressors (except shift in feeding behavior and entrapment in net pens) are also NLAA Hawaiian monk seals.

In order to determine that a proposed action is NLAA listed species, NMFS must find that the effects of the proposed action are expected to be insignificant, discountable, or beneficial as defined in the joint USFWS-NMFS Endangered Species Consultation Handbook: (1) insignificant effects relate to the size of the impact and should never reach the scale where take occurs; (2) discountable effects are those that are extremely unlikely to occur; and (3) beneficial effects are positive effects without any adverse effects (USFWS and NMFS, 1998). This standard, as well as consideration of the probable duration, frequency, and severity of potential interactions, was applied during the analysis of effects of the proposed action on ESA-listed marine species to determine if and which species are NLAA.

## 1. Wastes, discharges, or decreased water quality

Local and Federal regulations prohibit the intentional discharge of toxic wastes and plastics into the marine environment. The potential for fuel or oil leakages from the mariculture support vessels that transit to the net pen array and, the support vessel regularly stationed at the array, is extremely unlikely. An oil or fuel leak would likely pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately to the extent possible. Additionally, the proposed action outlines BMPs to include a chemical spill contingency plan, pre-work equipment inspections for cleanliness and appropriate materials to contain and clean potential spills and be readily available.

In the event that a leak should occur, the amount of fuel and oil onboard the 74-ft steel landing craft and the 17-ft skiff is unlikely to cause widespread, high dose contamination that would affect ESA-listed species directly or pose hazards to their food sources. The vessels are small, and are not expected to carry any fuel or other pollutants that would be expected to cause any significant impacts to ESA-listed species or designated critical habitat in the unlikely event that they would enter the marine environment. Further, the applicant will implement measures to minimize the risk of an oil or fuel spill and prevent contamination should one occur. Fuel transfer will be carried out by trained personnel and all personnel will follow all regulations set forth to prevent pollution from the ship. While we understand that discharges and spills could occur, they are expected to be infrequent, small, and quickly cleaned. Therefore, we are reasonably certain the effects of such spills will not rise to the scale of harm or harassment and are insignificant, as highly mobile animals such as marine mammals, sea turtles, and fish will also likely move away from potential effects of such spills.

Mariculture pollutants are primarily from effluent discharge comprised of nitrogen, phosphorous and carbon produced by the production biomass and any uneaten feed falling to the benthos. In addition, the discharge of a hydrogen peroxide solution is used to remove ectoparasites from production fish. However, the biomass levels are designed to minimize the negative impacts of effluent discharges on water quality. Factors in this analysis include the chemistry and carrying capacity of the surrounding waters and benthos, state and federal water quality standards, the expected discharge rates for excess feed and fish waste, and the characteristics of the dispersion field (e.g., water depths, current speeds, and directions).

Blue Ocean is also permitted to discharge hydrogen peroxide and certain medications under permits issued by U.S. Fish and Wildlife Service. These discharges are monitored for water quality impacts under the NPDES permit. Peroxide treatments are administered under an FDA-approved protocol managed by U.S. Fish and Wildlife Service. Every treatment is reported to USFWS. According to the 2018 USACE BE, to-date, hydrogen peroxide discharges in the farm site area have a 100% compliance rate under an effluent toxicity protocol, indicating no changes to the quality of the surrounding waters. Blue Ocean has not discharged medications in the farm site area since 2011.

Impacts on water quality and benthic health in the action area are closely monitored by a third party. As noted in the BE, to-date, the water quality monitoring program has not identified any significant changes to water quality due to discharges under the permitted action. In addition to monitoring water quality and benthic parameters, Blue Ocean requires its feed suppliers to monitor their feed products for PCBs, mercury, melamine and other adulterants. As noted in USACE's 2018 BE, Blue Ocean's feed supplier is certified to be free of these contaminants under the global aquaculture alliance best aquaculture practices and global good aquaculture practices programs.

Based on continued monitoring, adherence to discharge permits, and infrequency of medical treatments, we are reasonably certain mariculture effluent and discharges will not rise to the level of harm or harassment on any ESA-listed resources and are therefore insignificant.

2. **Direct Physical Impacts**

Objects are deployed and recovered in the action area, including anchors, new net pens, and small nets used for harvesting, fish crowding or cage enclosure. It is probable ESA-listed marine mammals, sea turtles, and elasmobranchs could be physically struck and injured by moving objects during these operations. A direct physical impact from a moving object could lead to adverse effects such as injury or death. Potential injuries and their severity will depend on the mass and velocity of the object, where and how the animal is struck, and the body part affected. Injuries may include cuts, bruises, broken bones, cracked or crushed carapaces, and amputations, any of which could result in the animal's death. In the case of being struck by an anchor or ballast block, an animal could also be pinned to the bottom and drowned.

As described in USCE's 2018 BE, the net pen array is secured by 24 anchors. Anchors are installed or repositioned during grid system installation/replacement projects, which occur once every 10 years and take approximately one month to complete. Each year, 1 to 2 anchors are tensioned or repositioned during a 3 to 4-hour exercise in which the anchor is rarely lifted from the bottom. Net pens are installed or removed from the farm site 1-2 times per year. The installation and removal processes include towing the two large components of the cage into and out of the action area. These tows are conducted at minimum speed for forward propulsion and attended by divers.

All objects over 10 kg are deployed and recovered from waters in the action area with the assistance of boat cranes, lift bags and divers in the water. The cranes place and retrieve objects at a slow (6 cm/sec), controlled pace. Objects under 10 kg are moved by divers underwater, occasionally with the assistance of small lift bags. These objects include mortality hand bags, shackles, and hand tools. These objects move at the speed of a swimming diver and are always attended by a diver.

Due to the low frequency of large object movements, the low mass and soft nature of the materials placed into the water, and the slow deliberate speeds in which objects are moved, we are reasonably certain the probability of an ESA-listed marine mammal, sea turtle, or elasmobranch being exposed to a physical direct impact with objects deployed and recovered in the action area is extremely unlikely. In addition, most operations involving moving objects take place inside a closed net pen, inaccessible to ESA-listed species. All factors considered, exposure to this stressor will be extremely unlikely and therefore discountable for all of the ESA-listed resources.

### 3. Vessel Strikes

As described in USCE's 2018 BE, the 4.5-nautical mile daily transits from Honokohau Harbor to the net pen site are made with two mariculture support vessels; a 74-ft. steel landing craft with a top speed of 8-kts and 17-ft skiff with a top speed of 20-kts. The steel landing craft vessel is stationary about 90% of the time and operates in the net pen area about 5-6 hours per day, mid-morning to early afternoon. The skiff is primarily used for crew transport and is stationary with engine off approximately 95% of the time while in the net pen area. BMPs incorporated into the action include operating vessels at reduced speeds when marine mammals are observed, watching for and avoiding all wildlife while operating vessels, and operating vessels at minimum speed for forward propulsion on the farm site. A collision with a vessel can lead to adverse effects such as injury or death. With regular trips to the net pen site, vessels have the potential to strike and injure ESA-listed species . The severity of the injury will depend on the speed and size of the vessel, the part of the vessel that strikes the animal, and the body part impacted.

Sea turtles, monk seals, and whales surface to breathe. Although sharks and giant manta rays do not breathe air, individuals occasionally swim near the surface. Therefore, it is possible that project vessels could strike ESA-listed sea turtles, monk seals, whales, sharks, and giant manta rays.

Kelly (2020) documented vessel collisions with sea turtles resulting in lethal and sub-lethal injuries. Sea turtles may be in the action area and could potentially be struck by transiting vessels during the proposed activities. NMFS (2008) estimated 37.5 vessel strikes of sea turtles per year from an estimated 577,872 trips per year from vessels of all sizes in Hawaii. More recently, we estimated as many as 200 green sea turtle strikes annually in Hawaii (Kelly 2020). If these turtle strikes are evenly distributed around the islands, the probability of a green sea turtle strike from any one vessel trip is extremely low (on average 0.035%, calculated by dividing the most recent strike estimate of 200 per year by the best estimate of all vessel transits of 577,872 per year). However, green sea turtle strikes are not evenly distributed throughout the islands. They are concentrated in areas with high sea turtle density and high small vessel activity (e.g., near small boat harbors and boat launches), such as Kaneohe Bay and Pearl Harbor on O'ahu (Kelly 2020). The action area is not in a location identified by Kelly (2020) as a hot spot for green sea turtle strikes, nor is it an area with significant overlap of high density boating activity and sea turtle habitat.

Green sea turtles are most vulnerable to small vessels (<15 m), traveling at fast rates (>10 knots) (Kelly 2020). Increased vessel speed decreases the ability of sea turtles to recognize a moving vessel in time to dive and escape being hit, as well as the vessel operator's ability to recognize the turtle in time to avoid it. However, as USACE notes in their BE, USACE will require Blue Ocean to operate two steel landing crafts with a top speed of 8 knots, and one 17' aluminum skiff with a top speed of 20 knots. The landing craft vessels are stationary about 90% of the time while in the action area. One landing craft makes one transit to and from the farm site each day, with transit time approximately 30 minutes each way at 8 knots. The skiff typically makes one transit to and from the farm site each day, at 20 knots. All vessels operate at minimum speed for forward propulsion when moving around the farm site. There are no observations of ESA-listed species approaching a Blue Ocean vessel during the history of the farm site.

On Hawaii Island, between 2008 and 2018, there were a total of 21 green turtles (no hawksbills) stranded with boat strike injuries (Kelly 2020). The majority of strandings were near boat harbors and boat launches including the Honokohau harbor inside the *action area*. Even in higher density areas such as Honokohau harbor, collisions between sea turtles and vessels are relatively rare events based on the number of sea turtles that have stranded on Hawaii Island ($n$ = 21; Kelly 2020). Therefore, the probability of a green sea turtle strike is likely much less than the overall rate calculated above.

The other sea turtle species have a lower rate of vessel strikes than green sea turtles. This is likely due to their lower abundance numbers. Therefore, the low vessel speeds are expected to minimize the effects of vessel strikes to green sea turtles and will also minimize the risk to the other sea turtle species. Thus, we are reasonably certain that the probability of exposure of ESA-listed sea turtles to vessel strikes is extremely unlikely, and therefore discountable.

Pinnipeds are generally less responsive to vessels while in water than when hauled out. However, pinnipeds are highly agile, and vessel strikes with monk seals are infrequent (Carretta et al. 2019). According to the Pacific Islands Fisheries Science Center's database there have been only four verified vessel strikes of Hawaiian monk seals between 1981 and 2016 (John Henderson, PIFSC 5/4/17). These factors in addition to the low speeds employed by the vessels associated with this proposed action provide reasonable certainty that the likelihood of exposure of any monk seal is extremely unlikely, and therefore discountable.

Whales surface to breathe, with calves surfacing more regularly than adults. While at the surface, a whale is at risk of being struck by a vessel. In a study by Lammers et al. (2003), 22 whale/vessel incidents were recorded between 1975-2003, with 14 of those occurring during the years from 1994-2003. The vast majority (17) of the vessel strikes were from vessels traveling at speeds in excess of 15 knots, and nearly all of them occurred in close proximity to the coastline of the main four Hawaiian Islands (Lammers et al. 2003). Based on expected slow vessel speeds, the collision risks from the references cited above, and the low abundance and widely scattered nature of whales in the action area, the likelihood of an individual from the whale species being struck during the proposed action is extremely unlikely, and therefore discountable.

The risk of exposure to vessel strikes is low for sharks and giant manta rays. These species are not routinely on the surface and do not breathe air. Giant mantas are known to congregate at the surface and breach on occasion. However, few vessel strikes on this species have ever been recorded. Vessel collisions have been documented on other elasmobranchs but have been most commonly documented with larger shark species (e.g., whale sharks and basking sharks) with evidence of blunt trauma and laceration scars (Schoeman et al. 2020; Speed et al. 2008). The risk of a vessel collision depends on the amount of time that an animal spends at the surface of the water, and their behaviors at the surface of the water. Behaviors such as foraging, resting, socializing with other animals, and taking care of their young may distract an animal from detecting approaching vessels. For sharks and giant manta rays, these behaviors do not occur at the surface of the water, thereby reducing the likelihood of collisions with vessels during these critical behaviors. Based on this evidence we are reasonably certain the likelihood of a vessel strike on ESA-listed shark or giant manta ray is extremely unlikely, and therefore discountable.

### 4. Entanglement with Lines or Netting

Entanglement with loose lines or netting could lead to adverse effects such as injury, reduced forage efficiency, interference with reproduction, or death. Potential injuries and their severity will depend on the complexity and duration of the entanglement. Injuries may include cuts, bruises, broken bones, slow amputation or drowning if the marine mammal is prevented from accessing the surface. Any of these injuries could result in the animal's death.

As described in USCE's 2018 BE, all anchor and grid lines radiating from the net pen array are in a constant, fixed position and kept in a tensioned, taut state. Anchor lines are made of negatively buoyant, 3-4 in diameter nylon lines which are too heavy for medium and small-size animals to move. Cages are secured in net pen array via four bridle lines radiating from the cage to the four corners of a grid cell. There is not enough slack in the line for marine species to become entangled. Net pen spoke lines are integrated with tensioned netting. The netting materials include smooth, semi-rigid polyester monofilament or semi-rigid chain link copper alloy mesh. Taut lines reduce the likelihood of entanglement with lines. Netting is rigid and no entanglement is expected. These measures will reduce the probability for entanglement. Because of these factors, we are reasonably certain exposure to this stressor for all ESA-listed species is extremely unlikely, and therefore discountable.

### 5. Shift in Feeding Habits

The continued operation of the mariculture pens may attract ESA-listed species to the area near and around the net pens based on the following factors: 1) the high frequency or volume of fish escapes from the production biomass, 2) pelleted food intended for the farm fish drifts outside the net pens, and 3) the aggregate effect of mariculture net pens analogous to the effect of fish aggregation devices (FADs).

Green and hawksbill sea turtles forage on seagrass, algae, sponges, and invertebrates, not fish such as *S. rivoliana*. Likewise, *S. rivoliana* are also not the preferred prey of giant manta rays, which primarily forage on plankton and sometimes small fish. Consequently, green and hawksbill sea turtles and giant manta ray will not be attracted to forage near or around the net pens. In contrast, the oceanic whitetip shark feeds on a variety of marine species including fish species similar to *S. rivoliana*. However, the literature suggests that these sharks are more common in the pelagic environment; therefore, we expect very few oceanic whitetip sharks to be exposed to the submerged net pens.

Alternatively, satellite tag data suggest that the likelihood of MHI IFKW's being in the vicinity (defined as within 5 km) of the submerged net pens is relatively high (Baird, R. 2018. Pers. Comm). MHI IFKW's are known to consume a large variety of large, widely migratory fish species which may include *S. rivoliana*. However, since 2003 there have been no recorded observations of MHI IFKW's on the Protected Species Reporting and Monitoring Reports submitted by Blue Ocean Mariculture. While MHI IFKWs are present in the vicinity of the action area, despite over 18 years of monitoring, none have been observed at the net pen array, and are therefore extremely unlikely to interact with the net pens. Because of these factors, we are reasonably certain exposure to this stressor is extremely unlikely for all ESA-listed species in Table 4, and therefore discountable.

### 6. Attraction of Predators to the Area

The continued operation of the mariculture net pens may attract predators, to the area near and around the net pens based on the following factors: 1) the frequency or volume of fish escapes from the production biomass, 2) pelleted food intended for the farm fish drifts outside the net pens, and 3) the aggregate effect of mariculture net pens analogous to the effect of fish aggregation devices (FADs). An increase in predators of ESA-listed species could lead to adverse effects such as injury or death. Potential injuries and their severity will depend on the aggressiveness of the predator, the duration of the attack, and the body part impacted. Injuries may include cuts, bruises, broken bones, and cracked or crushed carapaces, any of which could result in the animal's death.

As described in USACE's 2018 BE, to reduce the frequency of escapes, older, nylon Dyneema netting has been removed and eliminated from its net pens as part of the most recently permitted action and a combination of Kikkonet (polyester monofilament) and CAM (metal copper alloy mesh) is currently being used. Since 2011, there have been 12 escapes , four of which were concentrated in a single, older net pen during a two- month period in 2016. As described in USACE's BE, the primary mechanism for fish escapes is a break or tear in the cage netting caused by a failure in the netting material, improper rigging, or predators breaking or tearing the netting in pursuit of production fish inside the net pen. Escaped fish typically remain near their net pen for 2-3 days after the escape event. During this period, Blue Ocean divers attempt to recover as many of the escaped fish as possible. The recovery rate of escaped fish in 2016 and 2017 was approximately 40%.

Until the recent net pen breach by a Hawaiian monk seal on March 24, 2021, there had been no instances of a break in the CAM netting in 61 cage- months of deployment. Oceanic blacktip sharks, and tiger sharks regularly visit the net pen site and may attempt to break the netting in pursuit of a production fish. To discourage predators attracted to weak or distressed fish, a healthy production biomass is maintained. Natural mortality biomass is removed from each net pen on a daily basis. To limit the amount of pelleted food exiting the net pen, feeding operations are monitored by divers or via camera. Divers communicate with feeders on the boat to adjust feed rates based on the feeding intensity of the fish ball. This process ensures that the contained fish are satiated, and pelleted food is not pumped into the nets in excess.

At least one tiger shark has been observed in the action area on eight days in 2017. The University of Hawaii shark program tracks the presence of tagged tiger sharks passing within 600-800 m of the net pen area through an acoustic receiver mounted on the net pen array. From January through September 2017, a total of eight different tiger sharks passed near the net pen area, and at least one tiger shark was in the net pen area on 49 days during this period. This total is not greater than will be expected elsewhere outside of the action area (Meyer et al. 2009). Further, just because there are documented sharks in the area, doesn't necessarily mean there is more predation on ESA-listed species, as the sharks may be attracted to escaped fish, or other marine species using the nets as a FAD. Therefore, we are not reasonably certain the number of sharks known to predate on ESA-listed species will increase, nor will the frequency at which ESA-listed species encounter these sharks as a consequence of the proposed action. Therefore, we are reasonably certain exposure to this stressor is extremely unlikely, and therefore discountable for all ESA-listed species.

### 7. Disturbance from Human Activity or Equipment Operation

As described in USACE's 2018 BE, Blue Ocean divers, swimmers, vessels, and associated mechanical equipment operate inside and around the net pens on a daily basis. It is possible that all of the ESA-listed sea turtles elasmobranchs, and marine mammals may be exposed to sounds, vibrations or sudden movements caused by human activity or equipment when installing new net cages and ongoing operations in the action area. These ESA-listed species may exhibit a wide range of reactions to a disturbance by human activity or equipment operation, including a calm curious investigation of the disturbance, avoidance of the area, or a startle and flee reaction. It is possible that a panicked flight reaction could lead to stress or injury.

The process to install a net pen begins with a two-week onshore period during which the spar and netting are assembled, and the netting is bundled closely to the spar. The spar/net assembly is towed into the designated grid cell, where the spar is righted and secured to the grid system. The net pen rim is then towed into position over the spar/net bundle, connected to the spar with 24 spokelines and tensioned to specific loads. Finally, the net is unbundled and secured to the net pen frame. The offshore portion of the installation typically takes 3-5 working days with further minor tensioning occurring over the following 2-3 weeks. All human activity is conducted within the 5.76 ha area of the net pen array at depths between 0 and 90-ft. All dive operations are conducted in SCUBA mode, and at least one diver pair or swimmer operates "in-the-water" approximately two hours each day. The majority of human activity in the water is related to observation and inspection dives.

No hammering, drilling, or loud noises are created during normal mariculture operations except for an occasional power washer and a diver recall system used periodically. The 4,200 PSI gas pressure washer is secured on a vessel and connected to a wand which is used underwater. According to a Health Hazard Evaluation of Deepwater Horizon Response Workers (King 2011), the sound levels for a gas pressure washer range from 92 A-weighted decibels to 98 dBA. The diver recall system (Lubell System 3300) has a frequency range of 725 Hz-1800 Hz and an output level of 180 dB (re: 1 µPa, Lubell 2019). It has been used to recall divers to a vessel 4 times during the past 3 years and is tested once each calendar quarter for 3 seconds.

Man-made sounds can affect animals exposed to them in several ways such as: non-auditory damage to gas-filled organs, hearing loss expressed in permanent threshold shift or temporary threshold shift (TTS) hearing loss, and behavioral responses. They may also experience reduced hearing by masking (i.e. the presence of one sound affecting the perception of another sound). Of these physical effects, the one measurable effect that is most likely to occur at the lowest noise intensity, will be TTS hearing loss. Therefore, we used TTS as a surrogate for all physical effects from noise from the proposed activities in order to assess the likelihood or extent of adverse effects from vessel noise. When analyzing the auditory effects of noise exposure, noise is generally categorized as either impulse or non-impulsive noise. Acoustic thresholds for impulsive sounds use dual metrics: cumulative sound exposure level ($SEL_{cum}$) and peak sound pressure (PK). For non-impulsive sounds, acoustic thresholds are presented using the $SEL_{cum}$

metric (NMFS 2022). The TTS level for 8-hours of exposure to non-impulsive noise for mid-frequency cetaceans (i.e. MHI IFKW) is 178 dB $SEL_{cum}$, for phocid pinnipeds is 181 dB $SEL_{cum}$ and for sea turtles is 180 dB $SEL_{cum}$ (NMFS 2018). There have been no specific studies on impulse or non-impulsive noise on the oceanic whitetip shark or giant manta ray, however, it is highly unlikely that they will be exposed long enough and continuously enough to experience TTS. The output level from the diver recall (180 dB) is greater than the TTS and behavioral thresholds for MHI IFKW, however, we expect these sound levels to dissipate further from the source and attenuate into the water column and we do not expect MHI IFKW or any of the ESA-listed species in Table 4 to be exposed to this level of sound continuously for the entire 8-hour workday. All noises could potentially elicit a behavior response from exposed ESA-listed animals in all hearing groups. Although the NOAA acoustic threshold exists for behavioral responses, it is less understood or studied than hearing loss and non-acoustic injury. Behavior responses can range from a head turn to flight or abandonment. Considering how commonly monk seals are observed at the net pen site despite vessels sounds being louder than the behavior thresholds, the monk seals in the action area do not appear to be disturbed to the point of harm or harassment. These common responses to human activity are not expected to reduce the animals' fitness or prevent them from foraging or resting activities in any meaningful way. Thus, we are reasonably certain this stressor will not rise to the level of harm or harassment on any of the ESA-listed resources. It is therefore insignificant.

### 8. Entrapment in Nets

The net pens are fully enclosed and routinely positioned in a submerged state. It is probable that an ESA-listed sea turtle, fish or marine mammal could be stressed, injured or may drown if it becomes trapped in a submerged net pen and is not able to surface for air. As noted in the *Consultation History* section of this opinion, a dead Hawaiian monk seal was found in an empty, recently retired, net pen in 2017.

Although the net pens are fully enclosed and routinely positioned in a submerged state, to avoid another potential animal drowning, cage installation procedures require that no partially assembled or disassembled cage be left unattended in a submerged state. Procedures also require that top netting is removed first during net pen removal. As noted in the USACE's BE, these procedures will ensure that any marine mammal or sea turtle entering a cage during the installation or removal period will always have direct access to the surface.

To prevent a marine mammals or elasmobranchs from breaching a net pen and becoming entrapped, Blue Ocean has updated their offshore protocol following a recent monk seal interaction on March 24, 2021. The net pens will continue to be measured daily, and when any netting is measured to be 2.5 mm (or less) the contained fish will be removed and the net pen will be retired. The net measurement where the monk seal entered the pen in the 2021 incident was 1.5 mm. Therefore, the threshold for the net width has increased to 2.5 mm. When any netting is measured to be 2.5 mm, the contained fish will be removed and the net pen will be retired. Since Blue Ocean Mariculture expects a range of values within 0.5 mm of each measurement, as a precaution, they have agreed to raise the net pen to create a 15 ft. air gap whenever a mesh net measurement reaches 2.8 mm. Every month the mesh on every panel is measured with calipers including panels at the waterline, and the upper and bottom trapezoids. Due to these protocols, entrapment in a retired net pen or an additional breach of the netting is extremely unlikely to occur. Therefore, we are reasonably certain exposure of ESA-listed species in Table 4 to this stressor is discountable.

### 1. Addition of Man-made Structure in the Action Area

The applicant has increased the amount of man-made structures in the action area. The array is arranged in a 3x3 grid with eight pens around the perimeter and a vacant space in the middle. Each net array is 124.75 meters in diameter, covering a 392 square meter area. The arrays are arranged conically from top and bottom as shown in Figure 1. The total height of the two conical nets is estimated as 31.4 meters. The bottom anchoring systems that cover the sandy bottom at the site were already in place prior to this consultation, and have already been rearranged for the new configuration and additional net pens. The proposed action does not increase the number of bottom anchorings at the site. The net pens will be spaced far enough apart and arranged in a manner so that they do not touch each other, physically interact with each other, and will not impede flow through, which properly flushes nutrients and ensures oxygen flow and exchange. Data presented in the BE suggests that the net pens do not disrupt drift cells, sediment transfer, oceanographic patterns, or pollutant loading, and we do not expect the addition of three net pens to measurably change the physical and chemical properties at the existing site. The site is generally unused by sea turtles and heavily used by Hawaiian monk seals. We do not anticipate that changing as a result of increasing the number of net pens in the action area.

### 2. Critical Habitat

#### MHI IFKW

On July 24, 2018, NMFS published a final rule (83 FR 35062) to designate critical habitat in waters from 45 m to 3,200 m (49 to 3,500 yards) in depth surrounding the main Hawaiian Islands (from Niihau to Hawaii Island). Physical and biological features for the proposed critical habitat are: 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 MHI IFKWs.; and 4) Sound levels that will not significantly impair MHI IFKW's use or occupancy.

The action area is designated critical habitat for MHI IFKW, including the transit route from the 4.5 nautical mile transit route for vessels supporting the mariculture farm from Honokohau Harbor. All of the physical and biological features for the MHI IFKW critical habitat may potentially be affected by the proposed activities.

Mariculture operations may affect prey species abundance, but the opinion found an increase in availability of prey for Hawaiian monk seal. We also concluded a shift in feeding habits for MHI IFKW is discountable (Section 1.9 above). As described below, the proposed activities are not expected to affect the water quality in the action area, which is expected to remain free of pollutants of a type and amount harmful to MHI IFKWs, and thus is unlikely to alter the quantity, quality, and availability of their prey. Lastly, the mariculture operations will not be removing any fish from the action area. The contained biomass in the net pens are grown from fertilized eggs from local broodstock. The fish are reared in tanks at the land facility before being transferred to ocean net pens. Therefore, we are reasonably certain the proposed action will not affect prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth.

Mariculture operations may affect the essential feature of space for movement and use within shelf and slope habitat, by obstructing such space. However, all net pens, rigging and anchors associated with the array are contained within the 90-acre boundaries of the facility's submerged lands lease and currently, the net pen array coverers 5.76 ha. There remains adequate space below and around the net pens for movement including along slope and shelf habitat. Therefore, we are reasonably certain the size and location of the mariculture net pen array will not significantly alter the amount or adequacy of the space available for movement and use of shelf and slope habitat.

Mariculture operations may discharge pollutants primarily from effluent discharge comprised of nitrogen, phosphorous, and carbon produced by the production biomass and any uneaten feed falling to the benthos. In addition, the discharge of the hydrogen peroxide solution used to remove ectoparasites from production fish and the fuels and lubricants from mariculture support vessels have the potential to be harmful to MHI IFKWs and their designated critical habitat.

Biomass levels are designed to minimize the negative impacts of these discharges on water quality and benthic health, based on an analysis of the chemistry and carrying capacity of the surrounding waters and benthos, State and Federal water quality standards, the expected discharge rates for feed and waste, and the water depths, current speeds and directions of currents.

Impacts on water quality and benthic health in the action area are closely monitored by a third party. As noted in the BE, to-date, the water quality monitoring program has not identified any significant changes to water quality due to discharges under the permitted action. In addition to monitoring water quality and benthic parameters, Blue Ocean requires its feed suppliers to monitor their feed products for PCBs, mercury, melamine and other adulterants. As noted in USACE’s 2018 BE, Blue Ocean’s feed supplier is certified to be free of these contaminants under the global aquaculture alliance best aquaculture practices and global good aquaculture practices programs.

Blue Ocean is also permitted to discharge hydrogen peroxide and certain medications under permits issued by USFWS. These discharges are monitored for water quality impacts under the NPDES permit. As noted in the BE, the benthic health monitoring program has not identified any significant changes to the benthic health in the action area due to discharges under the proposed action. These tests include compliance/control comparisons for total organic carbon, redox potential, and copper/zinc concentrations. Annual surveys are also conducted to assess potential changes in benthic sand characteristics and micromollusc populations.

To-date, hydrogen peroxide discharges in the farm site area have a 100% compliance rate under a whole effluent toxicity protocol, indicating no changes to the quality of the surrounding waters (DLNR 2003, 2014). Blue Ocean maintains a healthy production biomass and has not discharged medications in the farm site area since 2011. According to Blue Ocean, they maintain a healthy production biomass and have not discharged medications in the farm site area since 2011 (ACOE 2018). Based on continued monitoring and adherence to conservation measures, waters in the action area are likely to remain free of pollutants of a type and amount harmful to essential features of MHI IFKW critical habitat. We also concluded wastes, discharges, and decreased water quality were discountable for the species (Section 1.1 above). Therefore, we are reasonably certain the proposed action will not discharge pollutants of a type and amount harmful to essential features of MHI IFKW critical habitat

Underwater noise generated from mariculture operations will occur within designated critical habitat and could potentially produce sound levels that significantly impair MHI FKWs use or occupancy. However, as described above in the *Disturbance from Human Activity or Equipment Operation* section, there are no proposed activities that are expected to generate appreciable acoustic output that will be expected to significantly affect these features. We do expect that the mariculture operations including the support vessels, will add to the local noise environment. However, this contribution is likely small, and undetectable when compared to the overall regional ambient sound levels. These sounds are short in duration, intermittent (or infrequent) and occur at predictable times during the day, and never at night. The noises are not long-lasting and will not significantly change the quantity or quality of the essential features. Therefore, we are reasonably certain sound levels emanating from mariculture operations would not impair MHI IFKW's use or occupancy in any significant way.

### Hawaiian Monk Seal Critical Habitat

The action area contains designated critical habitat for Hawaiian monk seals, which is defined as areas around the Hawaiian Islands extending from the 200-m depth contour line (relative to mean lower low water), including the seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, 5 m (in length) inland from the shoreline (80 FR 50925, 2015). The physical and biological features of monk seal critical habitat are: (1) Terrestrial areas and adjacent shallow, sheltered aquatic areas with characteristics preferred by monk seals for pupping and nursing; (2) marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging; and (3) significant areas used by monk seals for hauling out, resting, or molting.

The proposed action may affect the second physical and biological feature, marine areas from 0-200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging. Habitat conditions, such as water quality, substrate composition, and available habitat, should support growth and recruitment of bottom-associated prey species to the extent that monk seal populations are able to successfully forage. However, strong ocean currents are effective in flushing concentrated nutrients and waste from the mariculture farm site. These currents cause a high seawater replenishment rate of about 30 minutes, or roughly 47 daily turnovers (DLNR 2003; DLNR 2014). Consequently, the quality of the water is able to support growth and recruitment of bottom-associated prey. Further, the bottom anchoring elements that secure the net pens are unlikely to cause significant physical modifications to the substrate, and when submerged, the net is positioned well above the substrate (approximately 31 m from net bottom to substrate), therefore no scouring is expected.

Lastly, the benthos in the action area is a course sand, scouring bottom-type. As described in USACE's 2018 BE, the primary benthic forage species for Hawaiian monk seals (e.g. eels, octopus, and large crustaceans) are not typically present in the action area. The opinion found an increase in availability of prey for Hawaiian monk seal. Therefore, the proposed action is extremely unlikely to decrease prey quality and quantity for juvenile and adult monk seal foraging.

## APPENDIX B: BLUE OCEAN MARICULTURE, HAWAIIAN MONK SEAL NET PEN REMOVAL PROTOCOL

If a seal enters one of the cages:

- **The cage must be air gapped immediately**. The cage must remain with an air gap until the unwanted animal procedure has been concluded and the net has been inspected to ensure complete closure.
- Lead hand must notify the Farm Manager immediately if a seal is found inside of a pen.

Notification will include: Cage number, species of animal, cage break size, escape numbers.

- Notify NMFS within 24 hours

If a seal enters a **retired, inactive pen** (without fish):

1) If seal is discovered in net pen late in the afternoon (~3 pm), four panels will be removed as shown below in Figure 2423, and the pen will be raised with a 15ft. air gap. The length of each panel (from the top of the pen to the net rim) is 50 feet.

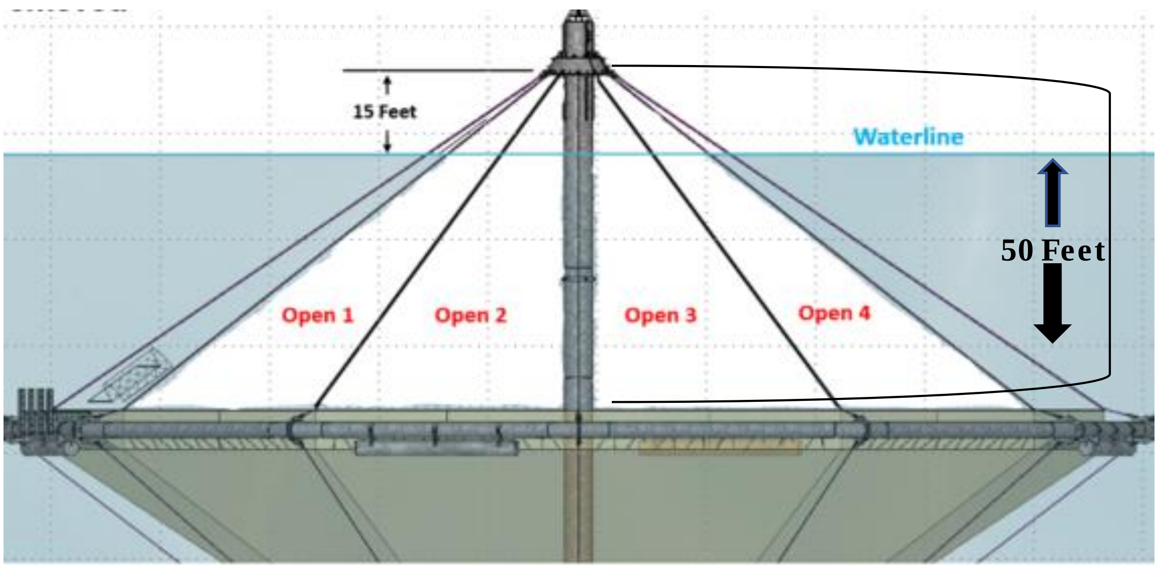


Figure 24. An inactive net pen with four (out of 12 total) panels removed (Korte 2021).

2) If seal is discovered in net pen early in the day (before 3 pm), remove the entire top of pen (all 12 panels).
3) If for some reason, no panels are able to be removed immediately, lift the cage to the rim to provide ample surface area for seal to access.

If a seal enters an **active pen** (fish inside) follow steps below for **Action 1:**

1) Raise cage until the water line is at the bottom of the portal as shown below in Figure 2524.
2) Open the 6 x 10-foot portal and lower cage to allow the bottom of the portal to submerge just under the surface. Monitor the seal and give 30 minutes to allow the animal to find and leave through the lowered portal.

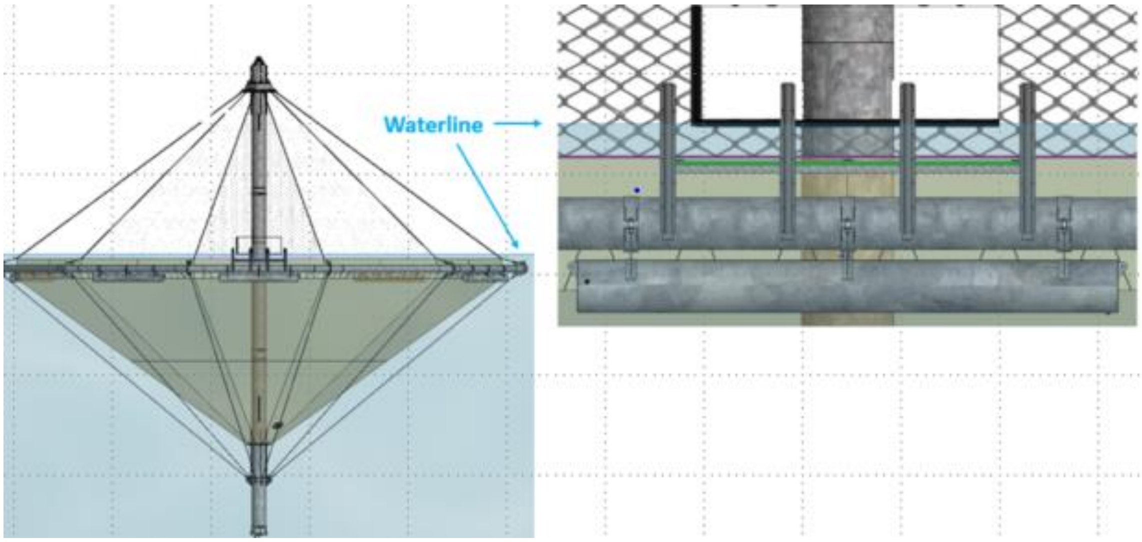

Figure 25. Pen with open portal entrance at the waterline (Korte 2021).

If seal does not exit through the portal after 30 minutes, follow steps below for **Action 2:**

1) Remove the top 15 feet of 4 upper panels to create a 32 x 15-foot exit at the top of the cage as depicted in Figure 26 and Figure 27 below.
2) The pen will then be lowered to a 15 ft. air gap with the bottom of the opening below the waterline. This partial submersion of the cage will confine the space that the animal has for surface breathing increasing the likelihood of the animal leaving the cage.
3) If the animal is unable to leave the pen before 4pm, the pen will be lifted all the way up with the rim at the surface allowing for the animal to have access to the surface from anywhere in the pen. The pen will be left in this configuration overnight and this option will be attempted again early the next morning.

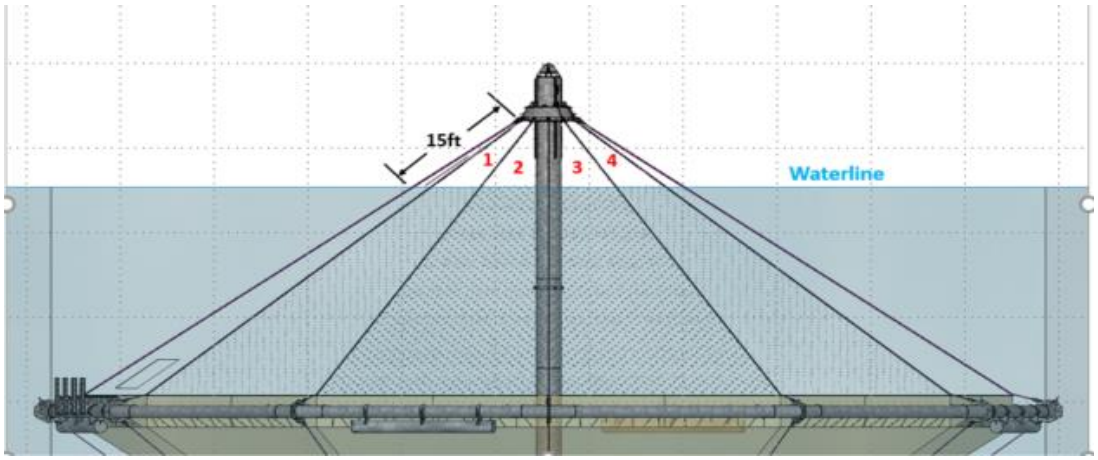

Figure 26. Pen with four top panel sections removed. Removing the panels will provide 15 feet of depth for a seal to exit (Korte 2021).

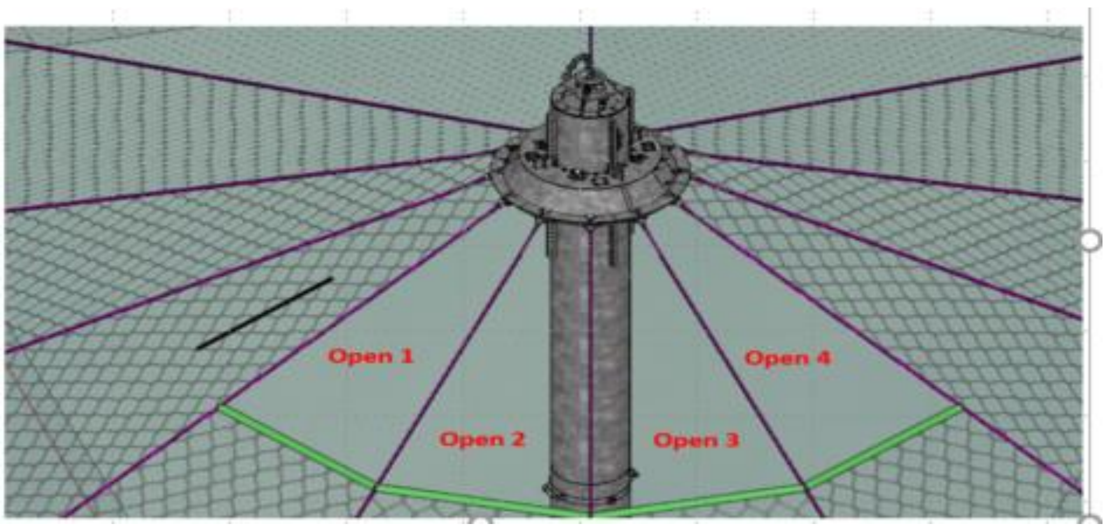

Figure 27. Isometric view of the net pen with four panels removed (Korte 2021).

If by noon of the second day, the animal has not left on its own then Blue Ocean Mariculture staff will notify farm management and speak with NOAA officials before proceeding to **Action 3**.

Follow steps below for **Action 3** if the animal needs help leaving the cage.

1) Raise the cage and deploy the large seine net to be used as a standing wall (Figure 2827.
2) Divers will deploy standing wall from the north side of the portal to the spar. A midpoint line will be run around the spar to control the net once fully deployed. A second line will be run from the net at the spar to the opposite side of the cage. Once the seal is within the standing wall pull the closing wall across the cage to create a false wall barrier.
3) Once false wall is in place lower the cage again until the bottom of the portal is just underwater and start closing the false wall to minimize space forcing the animal out of the portal.

4) A full cage inspection must be completed post release and all openings secured before the cage can be submerged.

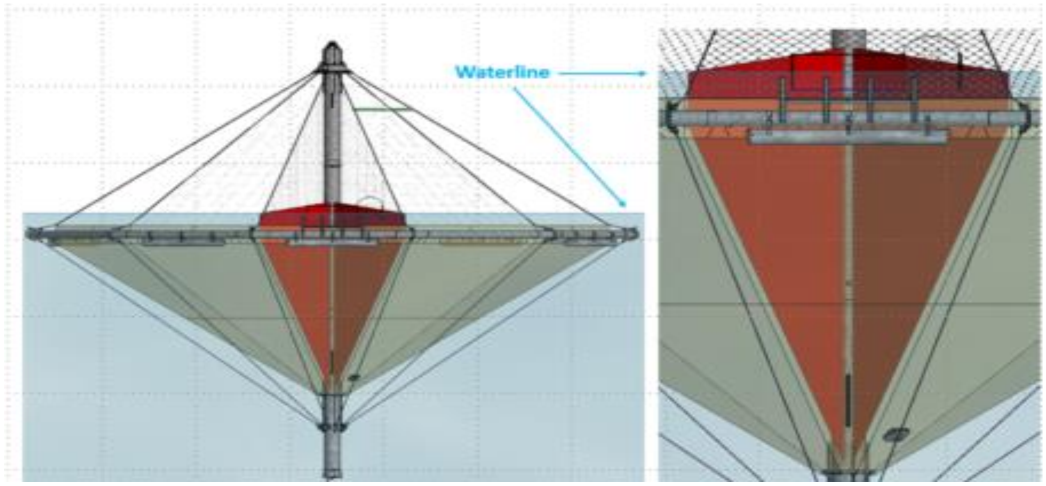


Figure 28. Pen with waterline at ½ open portal and sweep nets installed (Korte 2021).

## APPENDIX C: CAMERA OPERATION AND COORDINATION PROTOCOL

A. Purpose

The following operation and coordination protocol describes the necessary steps to meet reasonable and prudent measure 2 the biological opinion. This monitoring effort will provide data to help increase our understanding of interactions between ESA-listed species and aquaculture net pens. It is an integral component of implementing reasonable and prudent measures designed to minimize take by ensuring their design is adequate to reduce interactions with ESA-listed species. It is also integral to implementing the other monitoring and reporting requirements, which report the progress of the action and its impact on the species as specified in the incidental take statement (50 CFR 402.14(i)(3)).

B. The Project

Deploying, retrieving, downloading, and saving video data from four (4) SOLO X Autonomous Recording Cameras (Figure 29) attached to Blue Ocean Mariculture (BOM) aquaculture pens in support of the research conducted under NMFS FY21 Internal Competitive Aquaculture Funding award, "Monitoring of Hawaiian monk seal behavior at aquaculture net pens." This Project aims to develop a multi-faceted technology-enabled monitoring approach to understand the interactions of ESA-listed species and the aquaculture net pens and their associated behavior.

Camera specifications and configuration settings are in the attached Autonomous Recording Camera (SOLO X ARC) Operations Manual.

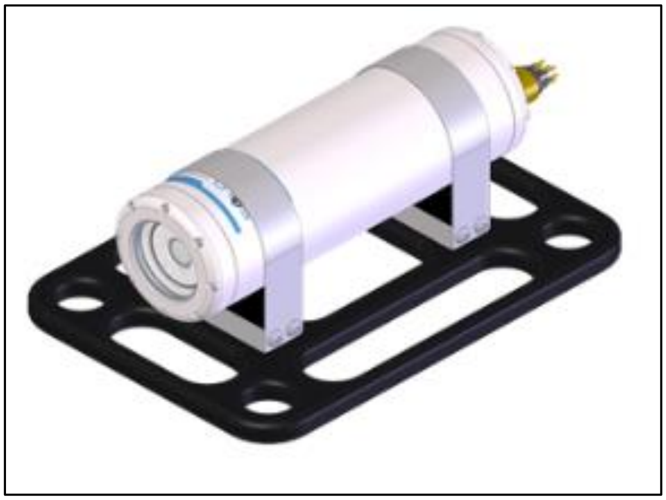

Figure 29. SOLO X Autonomous Recording Camera by Williamson and Associates.

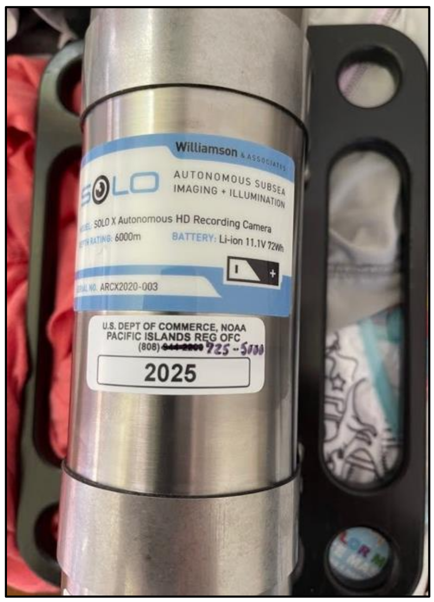


Figure 30. Example of NMFS identification numbers on each camera. The following numbers are assigned for the four cameras used in this study: 2025, 2026, 2027, 2028.

C. The Parties

| Role | Organization | Name, Title | Phone, email |
| --- | --- | --- | --- |
| Action Agency | Corps of Engineers (Corps) | Vera Koskelo, Project Manager | 808-835-4310, Vera.B.Koskelo@usace.army.mil |
| Applicant | Blue Ocean Mariculture (BOM) | Tyler Korte, Vice President, Marine Operations | 808-430-5181, tyler.korte@bofish.com |

| | | | |
|---|---|---|---|
| Aquaculture Coordinator | NMFS Sustainable Fisheries Division (SFD) | Tori Spence McConnell, Fishery Policy Analyst-Aquaculture | 808-725-5186, tori.spence@noaa.gov |
| ESA Contact | NMFS Protected Resources Division (PRD) | Ron Dean, Branch Chief | 808-725-5140, ron.dean@noaa.gov |
| Research Coordinator | Pacific Islands Fisheries Science Center (PIFSC) | Stacie Robinson, Research Ecologist, Hawaiian Monk Seal Program | 808-725-5740, stacie.robinson@noaa.gov |

D. Camera Operation and Activities Overview

BOM will deploy cameras for 5 days at a time over the course of at least one year. When cameras are on land, BOM will download and save their data, wipe SIM cards, and charge camera batteries in preparation for the next round of deployment.

| Activity | Responsible Party | Timeframe |
|---|---|---|
| 1. Deploy cameras on cages<br>- Configuration – see E.1.b. below<br>- Email NMFS with camera locations (which net, where on net) | BOM | Day 1 |
| 2. Retrieve cameras from cages | BOM | Day 5 |
| 3. Download and save video files and save to shared Google Drive<br>- Notify NMFS when video files are uploaded | BOM | Day 6 |
| 4. Run camera maintenance<br>- Charge batteries<br>- Erase all data from camera | BOM | Day 6-7 |
| 5. Redeploy cameras | BOM | Day 8 (Start over as day 1) |

E. Camera Operation and Activities

1. Camera Deployment, BOM will:
    a. Camera configuration

i. To access the camera configuration interface, with the charging hub attached, search available wifi networks and locate SOLO-XXXX. Join the network by entering the network key “williamson”.
ii. Follow camera configuration settings in Figure 3 below
iii. Pre-program cameras to turn on at 6:00am and turn off at 6:00pm. BOM will not need to turn the cameras on or off.

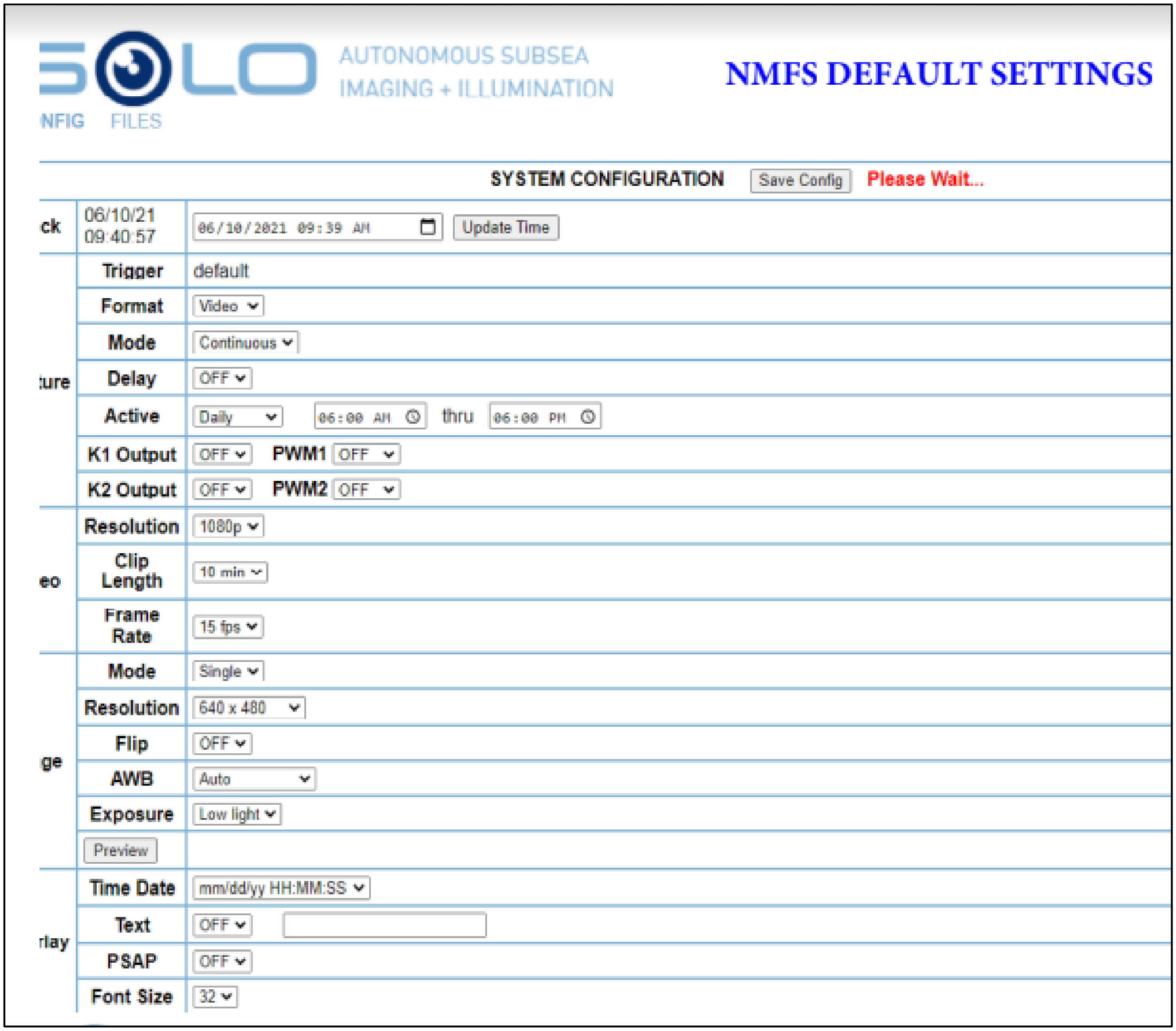


Figure 31. Configuration settings for SOLO cameras. Note: these and other settings are in the Autonomous Recording Camera Operations Manual.

b. Camera deployment
i. Transport cameras in the pelican cases.
ii. Attach cameras on the pens where fish mortalities collect and other areas where ESA-listed species frequently visit. BOM will coordinate with PIFSC

and NMFS to determine initial camera locations and any time a location changes due to video results during the course of the Project.

iii. Attach each camera to the net pens using at least four (4) zip ties (one in each corner) and then secure them with two stainless steel carabiners.

iv. Within 24 hours of placement, email NMFS with camera identification numbers, BOM net pen identification information, and the general location of the cameras on the pens.

2. Camera Retrieval, BOM will:
    a. After 5 days, remove cameras from the net pens and place them inside the pelican cases for transport to the BOM shore facility.
    b. Rinse with fresh water and let dry.
    c. Inspect for any obvious maintenance issues and report to NMFS.
3. Video Retrieval, BOM will:
    a. Ensure that cameras have been rinsed with fresh water and completely dry before charging or retrieving data.
    b. Charge cameras.
        i. See detailed charging directions in the Autonomous Recording Camera Operations Manual. **CAUTION:** Always mate the charge hub to the 8-pin connector on the camera before connecting the charger.
        ii. After mating the charge hub to the 8-pin connector, plug the smart charger into the wall socket and connect the barrel connector to the charge hub. The charger will display a red light while charging and a green light when the charge is complete.
        iii. The camera program may change when the battery is depleted, so ensure the settings match the default settings found in Figure 31 above. Full instructions for configuration, if needed, are in the Autonomous Recording Camera Operations Manual.
        iv. Once the cameras are fully charged and configured and if waiting for more than one day before redeployment, insert the dummy plug into the camera.
    c. Video download and upload.
        i. Download the video from the cameras and save with the following naming convention: "YYYY-MM-DD CameraID NetpenID"
            Where "YYYY-MM-DD"= first date of recording.
            Where "CameraID"= NMFS camera identification number assigned to the camera that produced the recording.
            Where "NetpenID"= Net pen number where the camera was recording.
        ii. Upload video to Google shared drive folder.[3]

[3] https://drive.google.com/drive/folders/1Y6QIULSEqMYtXRfuHmsO6dHsaKk8fnae

iii. Detailed downloading and file deletion instructions are in the Autonomous Recording Camera Operations Manual.
iv. Notify NMFS when all video is uploaded

d. Configuring cameras for redeployment.
   i. Lubricate the 8-pin connector with di-electric grease applied with the nylon brush (a light coating to where you see the connectors glisten) and mate the activation plug.

4. Camera Ownership
   a. The cameras will remain property of NMFS Pacific Islands Regional Office
   b. BOM will return the cameras upon completion of the project
   c. Replacement of lost cameras is the responsibility of BOM

F. Reporting Activities

1. Quarterly – Every 3 months
   a. BOM and PIFSC will collaborate on a status email to the Corps, NMFS SFD, and NMFS PRD that includes:
      i. The success at maintaining the schedule in D. above
      ii. The general success of observing ESA-listed animals
      iii. Any general observations about the data, such as
         1. Are ESA-listed species being observed
         2. The ability to determine behavior from the videos
      iv. Any proposed changes necessary to complete the monitoring as intended
   b. NMFS SFD and NMFS PRD will collaborate with PIFSC to provide feedback to BOM if modifications to the activities are warranted
2. Annually – After 12 months
   a. BOM and PIFSC will collaborate on a report that includes:
      i. All information in 1a
      ii. The species of observed ESA-listed animals
      iii. The behavior of the animals
      iv. Any analysis helpful to 2b. below
   b. After receiving the report, NMFS PRD will determine if current measures adequately minimize take in conformance with the incidental take statement
   c. The Corps will convene a meeting with the other parties
      i. The respective parties will present the results of 2a and 2b
      ii. All parties will collaborate to determine if changes to further reduce interactions are possible