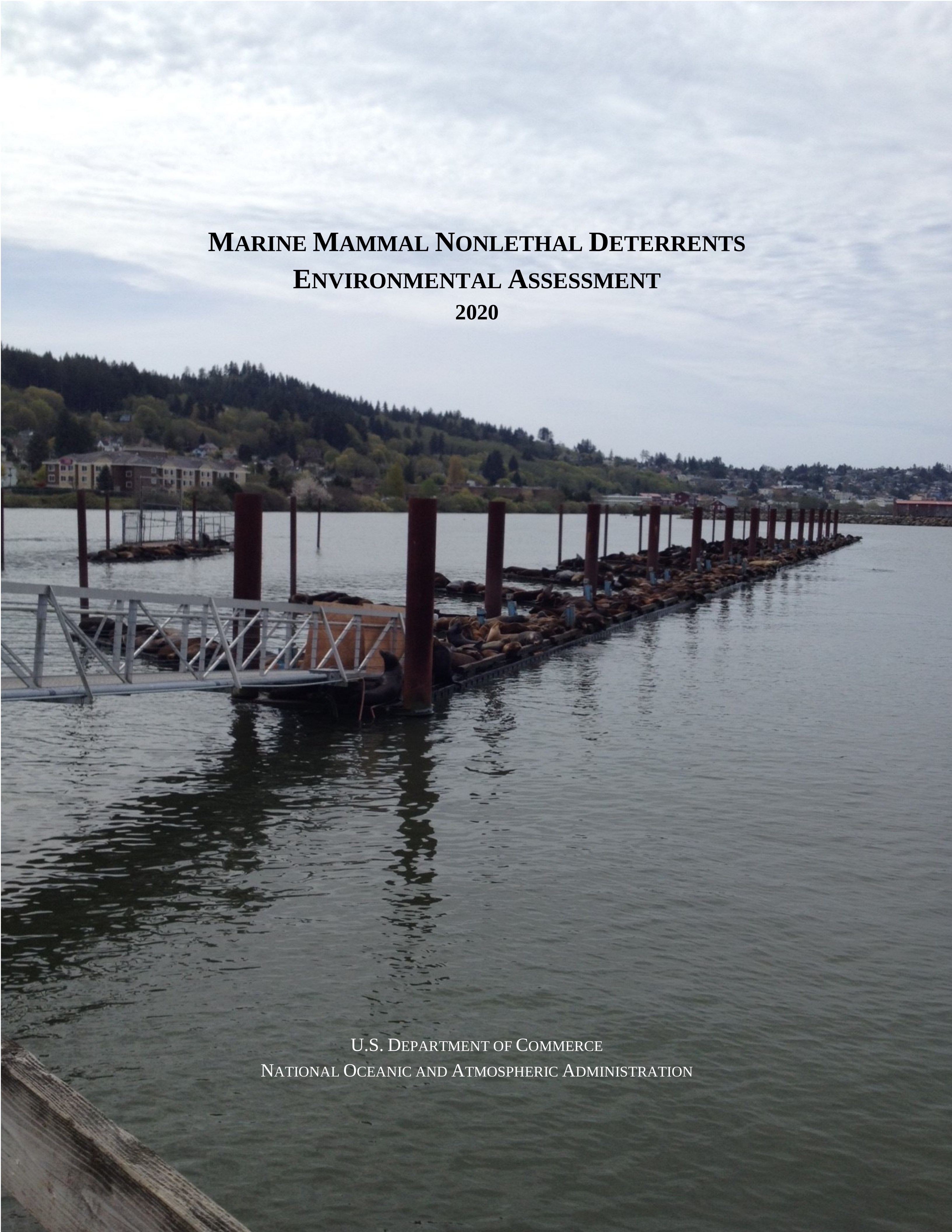

MARINE MAMMAL NONLETHAL DETERRENTS ENVIRONMENTAL ASSESSMENT

2020

U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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NOTICE

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COVER SHEET

Proposed Action:	Issuing Guidelines for Deterring Marine Mammals
Type of Statement:	DRAFT Environmental Assessment
Lead Agency:	U.S. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service
Responsible Official:	Donna S. Wieting, Director Office of Protected Resources National Marine Fisheries Service
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Location:	Nationwide, including the U.S. Exclusive Economic Zone and the High Seas or where any person under U.S. jurisdiction, even if they are outside the geographical jurisdiction of the United States.

Abstract: This assessment analyzes the environmental impacts of the National Marine Fisheries Service's proposal to issue guidelines for deterring marine mammals from interacting with commercial and recreational fishing, aquaculture operations, and property owners. These guidelines include deterrence measures, prohibitions on certain measures, and protocols and procedures for safely implementing the deterrence measures as prescribed in the guidelines.

Date: [add date]

Cover photo provided by the Northern Oregon Southern/Washington Marine Mammal Stranding Network

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ACRONYMS AND ABBREVIATIONS

amp	Ampere
ATF	Bureau of Alcohol, Tobacco, Firearms, and Explosives
CED	Conducted energy devices
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CI	Cook Inlet beluga
D	Animal depth in meters
DC	Direct current
dB	Decibels
DPS	Distinct population segment
EA	Environmental Assessment
EPCD	Explosive Pest Control Devices
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FKW	False killer whale
ft	Feet
g	Grams
GI	Gastrointestinal
h	Hour
HAI	Hydroacoustics, Inc.
HF	High-frequency cetaceans
HMS	Hawaiian monk seal
Hz	Hertz
in	Inch
kg	Kilograms
kHz	Kilohertz
LF	Low-frequency cetaceans
LOF	List of Fisheries
MF	Mid-frequency cetaceans
MMPA	Marine Mammal Protection Act
M	Animal mass in kilograms
m	Meter
mm	Millimeters
ms	Milliseconds
M/SI	Mortality and Serious Injury
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OA	Otariid pinnipeds (in air)

OSHA	Occupational Safety and Health Administration
OW	Otariid pinnipeds (in water)
PA	Phocid pinnipeds (in air)
Pa-s	Pascal-seconds
PBR	Potential Biological Removal
PK	Peak sound pressure level
PPD	Pulsed power device
PPS	Predator Protection System
psi	Pounds per square inch
psi-ms	Pounds per square inch-millisecond (impulse metric)
PTS	Permanent threshold shift
PVC	Polyvinyl chloride
PW	Phocid pinnipeds (in water)
RMS	Root Mean Square sound pressure level
s	Seconds
SAR	Stock Assessment Report
SEL	Sound exposure level
SEL_{cum}	Cumulative sound exposure level
SLDD	Sea lion deterrent device
SRKW	Southern resident killer whale
SPL	Sound Pressure Level
TTS	Temporary threshold shift
µPa	Micropascals
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
U.S.	United States
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
UV	Ultraviolet
WSSL	Western Steller sea lion
XREP	Electro-muscular projectiles

1. INTRODUCTION AND PURPOSE AND NEED

1.1 Introduction

All species of marine mammals are protected under the Marine Mammal Protection Act (MMPA), and some are also protected under the Endangered Species Act (ESA). These animals include whales, dolphins, porpoises, seals, sea lions, walrus, polar bears, sea otters, and manatees. NOAA's National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share responsibilities for the protection, conservation, and management of marine mammals under the MMPA and ESA. NMFS has jurisdiction over whales, dolphins, porpoises, seals, and sea lions, while the USFWS maintains jurisdiction over walrus, manatees, sea otters, and polar bears. This EA pertains specifically to all marine mammals under NMFS' jurisdiction (i.e., all marine mammals except polar bears, walruses, sea otters, and manatees).

The MMPA prohibits take of marine mammals. The MMPA defines "take" as, "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA defines harassment as, "Any act of pursuit, torment, or annoyance, which has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]." The MMPA (16 U.S.C. 1361 *et seq.*) provides exception to these otherwise prohibited acts, such as allowing the use of nonlethal measures to deter a marine mammal from, among other things, damaging private property or endangering personal safety. Specifically, MMPA section 101(a)(4)(A), allows for the owner of fishing gear or catch or private property, or an employee or agent of such owner, to deter marine mammals from damaging fishing gear and catch or damaging personal or public property, respectively, so long as such measures do not result in mortality or serious injury[1] of a marine mammal. Additionally, it allows any person to deter a marine mammal from endangering personal safety and any government employee to deter a marine mammal from damaging public property. Section 101(a)(4)(A) does not afford safe harbor to any other person or for any other purpose than those expressly enumerated, nor does it provide protection from liability under the ESA for the taking of ESA-listed marine mammals.

MMPA Section 101(a)(4)(B) directs the Secretary of Commerce, through NMFS, to publish a list guidelines for use in safely deterring marine mammals and to recommend specific measures which may be used to nonlethally deter marine mammals listed as endangered or threatened under the ESA. While the guidelines and recommended specific measures are not mandatory, section 101(a)(4)(B) provides protection from liability under the MMPA for take resulting from

[1] NMFS has defined "serious injury" in regulation as any injury that will likely result in death (50 CFR 229.2), further interpreted that definition in policy, and developed a process to distinguish serious from non-serious injuries (NMFS 2012a, NMFS 2012b).

such deterrence measures by specifying that any actions taken to deter marine mammals that are consistent with the guidelines or recommendations are not a violation of the act. MMPA Section 101(a)(4)(C) allows NMFS to prohibit certain forms of deterrence if NMFS determines, using the best scientific information available, and subsequent to public comment, that a deterrent has a significant adverse effect on marine mammals.

Separate from the provisions provided in the MMPA Sections 101(a)(4) as indicated above, Section 109(h) allows designated federal, state, and local government officials or employees or persons to take marine mammals in the course of their duties. Specifically, Section 109(h) addresses taking of marine mammals as part of official duties to states that nothing in MMPA Title I or Title IV shall prevent a federal, state, or local government official or employee from taking, in the course of their duties as an official, employee or designee, a marine mammal in a humane manner (including euthanasia) if such taking is for the (1) protection or welfare of the mammal, (2) protection of the public health and welfare, or (3) the nonlethal removal of nuisance animals. The proposed guidelines and the analysis in this EA pertains to members of the public deterring marine mammals for reasons outlined in MMPA Section 101(a)(4) and is not for situations covered under Section 109(h), such as deterring marine mammals from a hazardous area (e.g., an oil spill).

1.2 Background

Many types of deterrents have been used worldwide for years in fisheries to prevent interactions with marine mammals (Perrin et al. 1994, Mate and Harvey 1986, Jefferson and Curry 1996, Reeves et al. 1996). As wild fish stocks decline, aquaculture activities expand, and many marine mammal populations increase, conflicts between humans and marine mammals are likely to become increasingly more common and more severe. The proliferation of the aquaculture industry increases the likelihood for interactions with more marine mammal individuals and taxa (Price et al. 2017). There have been documented cases of interactions between nearshore aquaculture and pinnipeds on both the U.S. east and west coasts. Interactions can result in mortality and serious injury to marine mammals from entanglement as well as economic losses to the aquaculture industry due to damaged gear and/or lost production from marine mammal depredation. Aquaculture operations commonly use marine acoustic deterrents to protect aquaculture assets and much of the relevant research on the effects of acoustic deterrents has been conducted in the context of marine aquaculture (Coram et al. 2014; Lepper et al. 2014).

In recent years, frustration by fishermen and property owners has increased as some populations of marine mammals have increased in certain areas. Human-induced death and intentional harm of marine mammals has also increased in multiple areas (Warlick et al. 2018). Deterrence guidelines would provide an alternative mechanism for these members of the public to deter marine mammals without purposely killing or seriously injuring the animal involved. Without deterrence guidelines and recommended specific measures, unlawful intentional killing of marine mammals will likely continue as a result of unwanted marine mammal damage to fishing gear/catch or property. Multiple illegal marine mammal mortalities have occurred in situations where lawful nonlethal deterrence could likely have been attempted. These well-documented examples span both pinnipeds and cetaceans, occur broadly in different U.S. geographical regions, and involve a range of affected parties.

In January 2013, a female Hawaiian monk seal was found alive on a beach with a three-pronged spear (commonly used for spear fishing) embedded in the middle of her forehead immediately above her eyes. Federal veterinary staff and rescue personnel responded to the incident and successfully removed the spear from the animal's head. While this is a single incident, the impact on this species, especially given the sex of the animal, could have been disproportionally substantial if a response effort was not successful. The Hawaiian monk seal is the most critically endangered seal species in the U.S. The survival of each individual is paramount to the conservation and ultimate survival of the species.

Since 2006, NOAA prosecuted at least four federal cases involving illegal take or harassment of bottlenose dolphins in commercial and recreational fisheries. These cases include recreational hook and line fishing, commercial longline fishing, commercial trawl fishing, and the charter boat and headboat industry. These cases represent very different areas of the commercial and recreational fishery sectors and span a wide range of the southeastern U.S., demonstrating that these are not minor, isolated cases but rather part of a larger, more systemic issue. From 2002 to 2013, an additional 17 bottlenose dolphins were recovered and determined to have died as a result of gunshot wounds.

Along the northern Oregon and southern Washington coastlines, human-caused California sea lion mortalities significantly increased during two of the primary commercial fishing seasons (Lee 2016). The majority of these mortalities were from gunshot wounds. The Northern Oregon-Southern Washington Marine Mammal Stranding Network reported that over 84% of dead California sea lions examined in this region from 2012-2016 were found to have confirmed gunshot wounds or injuries indicative of gunshots.

In December 2014, NMFS issued a notice of intent to issue guidelines on the nonlethal use of marine mammal deterrents (79 FR 74710). In this notice, NMFS requested public input on which deterrents to consider for approval under MMPA Section 101(a)(4). Comments from representatives of the commercial and recreational fishing industry asked NMFS to consider and include acoustic deterrent devices and a range of other deterrents currently in use so that their constituents had multiple options available for deterring different species under the full array of conditions presented within their industries.

In addition to comments received during the public comment period for the notice of intent, NMFS identified and compiled deterrent types through a literature review and additionally considered input from participants of a NMFS-hosted workshop (Long et al. 2015) and preparers of this document. There is a paucity of research evaluating the potential impacts of deterrents on marine mammals. Most research to date has centered on better understanding the efficacy and efficiency of deterrents. A summary of the literature review that formed the foundation of this assessment is provided in Long et al. (2015).

Prior to the development of proposed guidelines and this EA, a comprehensive assessment of the impacts of deterrents currently used for marine mammals had not been conducted, thereby limiting the ability to make informed management decisions regarding the appropriate use of nonlethal deterrence measures. This EA does not evaluate the effectiveness of deterrents. Instead, it focuses on the impacts of the deterrents on the environment, particularly marine mammals. This EA pertains specifically to deterring marine mammals under NMFS's jurisdiction by members of the public without the need for additional authorizations.

1.3 Description of Deterrence Methods and Technologies

In general, deterrents fall within two categories, "non-acoustic" or "acoustic". Non-acoustic deterrents include those that do not emit sound. Non-acoustic deterrents could be visual, a physical barrier, electrical, chemosensory, or tactile. Acoustic devices generate sound and are divided into two groups based on their potential to affect marine mammal hearing: impulsive (e.g., firecrackers, seal bombs, pipe banging) and non-impulsive (e.g., acoustic alarms, predator sounds, in-air noisemakers). A summary of the deterrents assessed in this EA is provided in Table 1. Types of deterrents are further discussed below and detailed in Appendices A and B.

Table 1 Types of non-acoustic and acoustic deterrents evaluated for this EA.

NON-ACOUSTIC DETERRENTS	
Visual	• Air dancers, flags, pinwheels, streamers • Bubble curtains* • Flashing or strobe lights • Human attendants • Lasers • Patrol animals • Predator shapes • Vessel chasing * • Vessel patrolling* • Unmanned aircraft systems (UASs)
Physical barriers	• Anti-predator netting* • Containment booms/waterway barriers* • Gates/closely spaced bars • Horizontal bars • Rigid fencing in air • Swim step protectors
Chemosensory	• Chemical irritants • Corrosive chemicals

	• Taste deterrents
Tactile: Electrical	• Cattle prods • Electric fencing in air • Electric fencing in water* • Electrical mats • Electrical nets • Electroshock weapon technology • Underwater electric barriers*
Tactile: Projectiles used with firearms	• Bullets, plastic bullets, rubber bullets • Shotgun shells with rubber shot or balls, • BBs • Shot pellets • Beanbag rounds • Sponge grenades
Tactile: Projectiles used with compressed air/gas	• BBs • Shot pellets • Paintballs • Sponge grenades • Nails • Spears
Tactile: Other projectiles	• Arrows • Darts • Spears • Foam missiles/rounds • Rocks
Tactile: Fixed sharp objects	• Nails • Barbed wire
Tactile: Manual – sharp	• Gaffs • Hooks • Sharp-ended poles, etc.
Tactile: Manual – blunt	• Crowder boards • Blunt-tipped poles, brooms, mop handles, etc.
Tactile: Water	• Hose • Sprinkler • Water gun
ACOUSTIC DETERRENTS	
Impulsive: Explosive	• Fireworks • Bird bangers • Bird whistler/screamers • Pencil launchers/bear bangers • Propane cannons

	• Explosive pest control devices (EPCDs) (i.e., seal bombs*, cracker shells (both air & water), bird bombs, underwater firecrackers*)
Impulsive: Non-Explosive	• Banging objects*/passive acoustic in-air deterrents • Low-frequency, broadband devices* • Pulsed power devices*
Non-impulsive	• Acoustic alarms* (i.e., pingers, transducers) • In-air noisemakers • Predator sounds/alarm vocalizations using underwater speakers*

* indicates devices that function underwater (opposed to functioning in air)

1.3.1 Non-acoustic Deterrents

Non-acoustic deterrents are methods or technologies that target senses other than hearing to deter a marine mammal. The types of non-acoustic deterrents analyzed in this EA include: visual deterrents, physical barriers, chemosensory deterrents, tactile deterrents, electrical deterrents, and projectiles. This section describes and gives examples of each category of non-acoustic deterrent.

1.3.1.1 Visual Deterrents

Visual deterrent methods rely on a marine mammal's visual acuity and perception of a change in their immediate environment to elicit a flight behavior. Visual deterrents can be either active or passive. Examples of active visual deterrents include, but are not limited to, vessel chasing, lasers, and unmanned aerial systems. Examples of passive visual deterrents include, but are not limited to, air dancers, flags, pinwheels, streamers, flashing lights, human attendants, predator shapes, colored fishing line or ropes, and vessel patrolling. For this EA, specific visual deterrents are described below.

<u>Air dancers, flags, pinwheels, and streamers</u>

Air dancers (examples of brand names include AirDancers®, SkyDancers®, and FlyGuys®) are inflatable moving devices that are composed of a long fabric tube (with two or more outlets) that is attached to and powered by an electric fan (typically ¼ to 1 horsepower). Air blowing through the fabric tube causes it to move in a dynamic motion. Flags, pennants, pinwheels, streamers, or other similar products are typically constructed of brightly colored, weather resistant material such as polyethylene plastic.

<u>Bubble curtains</u>

Bubble curtains are barriers of air bubbles produced from submerged perforated hoses that attempt to create a visual and sound barrier to exclude marine mammals in a way similar to physical barriers. Bubble curtains are also known as air barriers, air curtains, air bubble curtains, pneumatic barriers, barriers of air bubbles, curtains of air bubbles, bubble walls, and bubble screens. Design specifications, such as range of air pressure, for bubble curtains vary.

Flashing lights or strobe lights

Flashing lights emit alternating periods of light and dark on regular and repeating intervals. Strobe lights, or stroboscopic lamps, are devices used to produce regularly intermittent, very short, intense flashes of light by means of an electric discharge in a gas. Flashing and strobe lights can range in intensity from benign levels as low as flashing traffic lights to high intensity strobing flashlights designed as less than lethal weaponry capable of disorienting and debilitating by eliciting a dizzying effect.

Human attendants

Physical presence of humans on docks or onshore near fishing gear may be used. Human attendants may try to maintain a safe distance from a marine mammal by using a manual blunt object, such as a pole or crowding boards, or enhance their deterrence presence through the use of patrol animals.

Lasers

A laser is a device that generates an intense beam of coherent monochromatic light or electromagnetic radiation by stimulated emission of photons from excited atoms or molecules. The energy density of a laser beam in air can extend great distances, dependent upon the source level (energy emitted as photons); however, the energy density decreases rapidly once it enters the water column as attenuation of light energy in water is high. Under U.S. Federal law it is legal to own a laser of any power so long as it complies with U.S.C. 21 CFR 1040.10 and 1040.11; devices marketed as laser pointers and demonstration lasers are limited to power below 5 milliwatts. Stronger lasers are legal to be manufactured, sold, and possessed as long as they are not marketed or labelled specifically as laser pointers or demonstration lasers. Additional state and local laws regulate laser equipment or use.

Patrol Animals

Patrol animals, such as guard dogs, are used as sentries to guard against unwanted or unexpected people or animals. Such animals are specifically trained to perform duties in a discriminating manner and as desired by handlers and animal trainers. In the case of dogs, vocalizations or barking is used to either alert of a target’s presence or to scare away the target. Livestock guardian dogs have been used for thousands of years to protect livestock from predators through vocal intimidation, barking, and displaying aggressive behavior.

Predator shapes

Predator shapes are any physical model, or decoy, designed to have the visual appearance of an animal or object that would elicit a flight response in a target marine mammal. Such deterrent methods are analogous to scarecrows used in agricultural applications. Marine predator shapes, including killer whales and sharks, have been used to deter marine mammals.

Vessel chasing

Vessel chasing is the use of any motorized watercraft or terrestrial vehicle, such as an ATV (all-terrain vehicle) to directly pursue a marine mammal at any speed, whether consistent or variant, and any direction, whether direct or variable, and includes the use of rapidly increasing and decreasing throttle speed to elicit a response in a marine mammal using engine noise or water disturbance.

Vessel patrolling

Vessel patrolling refers to the use of a motorized vessel or vehicle to patrol fishing gear either in-water or from land, which is different from vessel or vehicle chasing, where a motorized vessel is used to pursue a marine mammal. Vessel patrolling uses a motorized watercraft or other vehicle on land at safe speeds in controlled and predictable directions in the immediate vicinity of actively fished gear.

Unmanned aircraft systems

As defined by the Federal Aviation Administration (FAA), an unmanned aircraft system (UAS) is the unmanned aircraft and all of the associated support equipment, control station, data links, telemetry, communications and navigation equipment, etc., necessary to operate the unmanned aircraft. The unmanned aircraft (UA) is the flying portion of the system, flown by a pilot via a ground control system, or autonomously through an on-board computer, communication links, and any additional equipment that is necessary for the UA to operate safely. They range in size from wingspans of six inches to 246 feet and can weigh from approximately four ounces to over 25,600 pounds. The FAA issues an experimental airworthiness certificate for the entire system, not just the flying portion of the system. The Aircraft Certification Service AIR-113 at FAA headquarters is responsible for issuing experimental airworthiness certificates for flying civil UASs. All uses of UASs for work or business are regulated by FAA Small UAS Rule (14 CFR 107, 28 June 2016). UAS can be used to fly over and patrol fishing gear or property, such that a marine mammal would be deterred from the area. UAS have been documented as causing hauled out pinnipeds to flush back into the water.

1.3.1.2 Physical Barriers

Examples of physical barriers include rigid fencing in air, gates or closely spaced vertical poles, mounted horizontal bars (also known as bull rails), electric fencing, anti-predator netting (typically used around aquaculture operations), and swim step protectors (used to block access to swim steps at the back of boats). Physical barriers are defined below.

<u>Anti-predator netting</u>

Anti-predator nets are high strength nets with mesh sizes 3-5 inches that are deployed to maintain tension on the net and an approximate space of 3 to 4 feet from the primary containment of an aquaculture or other structure. Anti-predator nets are typically weighted on the bottom with a large diameter ring filled with sand or other substrate. Anti-predator netting can range from coated galvanized steel wire like those used as shark barriers off beaches and for retaining rockslides to monofilament nets. Popular lightweight, flexible netting made of polyethylene, preferred for its water and ultraviolet resistance, is essentially a gillnet employed for deterrence rather than catching fish.

<u>Containment booms and waterway barriers</u>

Booms, also referred to as debris barriers, consist of floating barriers that are designed to contain logs, floating debris, hazardous waste and oil spills, and to obstruct passage along a waterway. Log booms are barriers typically placed in a river or waterway to contain floating logs and are constructed by anchoring in place logs chained together to retain logs floating downstream. Additionally, a full range of floating barriers have been developed as demarcation lines and physical barriers to block boater and debris access from underwater components of dams and hydroelectric plants.

<u>Gates or closely spaced vertical poles</u>

Closely spaced poles can be installed vertically as barriers to prevent marine mammals from hauling out of the water onto a structure, such as a dock.

<u>Horizontal bars, also known as bull rails</u>

Horizontally mounted poles, or bull rails, are barriers constructed and installed in such a manner as to increase the vertical height of the edge of a structure thereby limiting access from the water. Bull rails can be permanently mounted to docks or removable and can be constructed of a variety of materials, including wood and galvanized steel.

Rigid fencing in air

Fences are structures that enclose an area and are typically constructed from posts that are connected by boards, wires, rails, or netting. Examples of fencing include construction, snow, or chain-link fencing.

Swim step protectors

Access to vessels through the swim step or swim platform can be prevented through the use of a rope, chain, or other physical barrier, such as a box or cooler. Manufactured flip-up style swim platforms can alternatively be installed to prevent access to vessels. For this EA, swim step protectors refer to any obstruction used to prevent intentional entry to a vessel.

1.3.1.3 Chemosensory Deterrents

Chemosensory deterrent mechanisms for marine mammals often focus on taste to induce an aversion response rather than smell, due to the lack of or poor olfactory capacity in marine mammals. Conditioned taste aversion methods have historically been used in human/wildlife conflicts. Nonlethal animal control methods have been developed based on the role of learning in behavioral development. Conditioned taste aversions were first used to prevent coyote depredation on lambs (Gustavson et al. 1974) and subsequently to protect livestock, chickens, and sunflowers (Gustavson et al. 1982). In addition to chemical repellents applied through consumption mechanisms, chemicals used for animal control can also be aerosolized or applied through an inhalation route of entry. Finally, chemicals can be used to deter marine mammals by acting as an irritant or due to their corrosiveness.

Chemical irritants

The Occupational Safety and Health Administration (OSHA) defines a chemical irritant as a chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. Examples of chemical irritants include pepper spray, capsaicin extract, tear gas, and other aerosol self-defense sprays.

Corrosive chemicals

OSHA defines a corrosive chemical as a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. Examples of readily available (i.e., household) corrosive chemicals include ammonia, bleach, hydrogen peroxide, lye, hydrochloric acid, sodium hypochloritem and pest control products.

Taste deterrents

Taste deterrents are non-regulated substances designed to have an undesirable taste or olfactory stimulus. Often used as a behavioral modification tool in domestic animals, taste deterrents are available in liquid, spray, and gel forms. Examples of deterrents used for behavioral modification in domestic terrestrial mammals include solutions of capsaicin extract, vinegar, citronella, garlic juice, lemon juice, and other plant extracts. Learned aversion/emetics is a consummatory chemical aversion treatment that pairs ingestion of a substance that causes nausea or some other discomfort to induce a taste aversion. This deterrent approach specifically incorporates a chemical substance with a prey or food item and involves direct or indirect feeding or provisioning of a target animal.

1.3.1.4 Tactile Deterrents

Tactile deterrent methods typically involve physically creating pain or discomfort to induce aversion with the goal of eliciting flight behaviors (Scordino 2010). Examples of tactile deterrents include, but are not limited to, fixed sharp objects on a structure, propelled objects, sharp projectiles, manual sharp objects, manual blunt objects, and water deterrents. Tactile deterrents can be propelled through the use of a multitude of devices to extend the deterrent potential beyond what would be possible with manual use (e.g., throwing or striking by hand).

For this EA, the term manual refers to the use of a deterrent by hand without the additional use of a propelling or firing mechanism. Examples of such propelling and firing mechanisms include archery bows, crossbows, slingshots, pistols, and shotguns.

1.3.1.5 Electrical Deterrent Devices

Devices that use electricity can be either stationary such as electric mats or fencing, or manually deployed devices, such as cattle prods and tasers. Electric barriers are common in agricultural and livestock applications as well as areas of high security concern, such as military facilities.

Cattle Prods

A cattle prod, also called a stock prod, is a handheld device commonly used to encourage livestock to move by striking or poking them. Cattle prods can be either simply tactile or can also be charged with electrodes on the end that disperse a relatively high-voltage, low-current electric shock. Some products include a noisy visible arc between the electrodes to warn potential targets and may allow for a conditioned response without requiring direct contact of the electrified end of the prod.

Electric fencing (in air)

Electric fencing is an enclosure of wires carrying a high voltage, low amperage (amp) charge typically delivered in short pulses to cause pain and elicit avoidance but not cause injury. Electric fence systems are composed of three main components: an electrical charger or energizer, fencing wires, and a grounding rod. Electric fencing can be portable and installed temporarily or permanently.

Electric fencing (in-water)

Like on land, underwater physical barriers can also carry a voltage and function as an electric fence. For this EA, in-water electric fencing refers to any enclosure installed partially or completely underwater that carries a voltage through the structure.

Electrodes and Electric mats

Engineered electronic pulses deployed via cable electrodes in non-conductive walkway mats, such as Pinniped Deterrence Systems™, supply a low voltage (e.g., 24 volts nominal) direct current (DC) pulse. The maximum current is 5 amps; anything over 5 amps and protective circuitry should interrupt the electrical output as a safety/protection measure. Two mat deterrent systems exist: the first is a permanent installation of the mat deterrent system to the walkway, dock or deck and the second is a temporary, mobile system that uses a similar mat that it is not attached permanently and can be moved from one location to another. Both mat-based systems incorporate UV-resistant PVC mats with stainless steel electrodes. The mobile system has been used on tidal surfaces to deter pinnipeds from oil platforms.

Electric nets

Ace Aquatec patented a system of electric nets that can be deployed as a deterrent. The electrical field is designed to create an uncomfortable sensation when the pinniped attempts to feed directly from aquaculture facilities. Electric nets can be operated in either a continuous mode or triggered by a sonar detection device and are designed to be used either in isolation or in conjunction with other deterrent systems.

Electroshock Weapon Technology

Electroshock weapon technology uses a temporary high-voltage low-current (i.e., amps) electrical discharge to override the body's muscle-triggering mechanisms. These products are commonly referred to as conducted energy devices, or CEDs. The relatively low electric current must be pushed by high voltage to overcome the electrical resistance of the target's body. Such weapons are designed to be nonlethal or less than lethal and include, but are not limited to: electric shock prods, stun guns, tasers, wireless long-range electric shock weapons, and prototype designs including weapons that administer electric shock through other media.

Stun Guns

Stun guns are handheld devices similar to tasers; however the user must make direct contact with the target to deliver the electric stimulus rather than utilizing projected barbs. These devices can be configured in a handheld device the size of a small handgun or as part of a baton or short rod.

Tasers

Tasers, or conducted electrical weapons, fire two small dart-like electrodes, which stay connected to the main unit by conductors, to deliver electric current to disrupt voluntary control of muscles resulting in neuromuscular incapacitation. Standard tasers can deliver an electric stimulus to a target from up to 15 ft (5 m) away; law enforcement personnel use taser devices with a range of up to 21 ft (7 m). Newer, more advanced tasers, do not require the dart-like electrodes to embed in the skin; they use a shaped pulse/arc of electricity that disrupts nerve impulses on impact. The average peak voltage of a taser is between 10,000 and 50,000 volts.

Underwater electric barriers

Underwater electrical barrier coupled with sonar array detection systems to deter seals and sea lions are currently in a developmental phase and, as such, are not analyzed further in this EA. The concept is to combine a sonar array, which can enumerate and identify specific targets in the water column, with an electrical barrier to deter marine mammals from areas where fish congregate. The system would deliver brief, nonlethal electric pulses that deter seals or sea lions without harming either the marine mammals or fish. The electric barrier would use a gradient of low-voltage, direct current with pulses less than or equal to 3.0 milliseconds. The sonar used to cue operation of the electric barrier would distinguish marine mammals from humans and fish based on body anatomy and swimming patterns. The system would be designed to allow fish to pass unimpeded.

Wireless Long-Range Electric-Shock Weapons

Wireless long-range electro-shock projectiles, also called extended range electro-muscular projectiles (XREP), can be fired from any 12-gauge shotgun. The general term shockround is used for the class of piezo-electric projectiles that generate and release electric charge on impact. The projectile contains a small high-voltage battery that powers the discharge of electricity upon contact from 98 ft (30 m) away. Other variants of such devices are in development that use needles rather than barbed darts to administer a single jolt from a high-voltage capacitor.

1.3.1.6 Projectiles

Projectiles are objects that are either propelled from a device such as a firearm or similar product using compressed air, carbon dioxide, or other gas or a propellant such as gunpowder, or propelled by hand or in manually controlled products such as slingshots, compound and simple bows, and crossbows. Some objects are designed to cause physical trauma (blunt or sharp) to a body part, either by impact or injury. The section below describes both the object that is propelled (e.g., paint balls, rubber bullets, arrows) as well as the method of propulsion.

<u>Projectiles Used with Firearms</u>

Traditional, modern firearms, such as rifles, shotguns, and handguns (i.e., pistol or revolver), fire projectiles by way of a combined cartridge containing a percussion cap (i.e., primer), gunpowder, and a projectile. During the firing, a hammer or firing pin strikes the cartridge primer, igniting the gunpowder and expelling the projectile from the firearm.

The Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) defines a rifle as a weapon designed or redesigned, made or remade, and intended to be fired from the shoulder and designed or redesigned and made or remade to use the energy of an explosive to fire only a single projectile through a rifled bore for each single pull of the trigger.

ATF defines a shotgun as a weapon designed or redesigned, made or remade, and intended to be fired from the shoulder and designed or redesigned and made or remade to use the energy of an explosive to fire through a smooth bore either a number of ball shot or a single projectile for each single pull of the trigger.

ATF defines a handgun as any firearm, including a pistol or revolver, which has a short stock and is designed to be held and fired by the use of a single hand.

Bullets

Bullets are projectiles fired from a rifle, revolver, or other small firearm, and are typically made of metal, cylindrical and pointed, and sometimes contain an explosive.

Plastic bullets

Plastic bullets, or plastic baton rounds, are nonlethal projectiles fired from a specialized gun. Plastic bullets were designed to replace rubber bullets in an effort to reduce risks by limiting ricochets and decrease strike force by slowing muzzle velocity. Typical plastic bullets weigh approximately 130 g, are designed to be effective from 33 to 64 m (108 to 210 ft), and are available in a variety of calibers. The bullets are designed for use in revolver handguns and propelled with a primer, a thin metal cap containing a small quantity of pressure-sensitive explosive. When struck during firing, the explosive detonates and discharges the round.

Rubber bullets

Rubber bullets, also called rubber baton rounds, are kinetic impact munitions designed to cause pain but not lethal impact. Specifications and composition vary widely from bullets composed entirely of rubber to metal projectiles coated in as little as 1 millimeters (mm) to 2 mm of rubber. Such coated projectiles may also be known as rubber-coated bullets. Rubber bullets are fired from traditional firearms (e.g., pistols, rifles, shotguns) or dedicated riot guns.

Shotgun shells with rubber shot or rubber balls

Shotgun shells, or cartridges, are self-contained cartridges composed of a plastic case with a base covered in a thin layer of brass, a gunpowder propellant, and one of a wide variety of projectiles. While typically designed as a sharp, penetrating projectile, nonlethal versions have been designed with a wide range of rubber ball projectiles ranging from single ball to multiple rubber pellets in a single cartridge. Commercially available shells are designed for use in 12- and 20-gauge shotguns.

BBs

BBs are spherical projectiles made of a standard size of lead pellet used in shotguns or air guns. For more information on air guns, see description below.

Projectiles Used with Compressed Air/Gas.

Shot pellet

Shot pellet is a collective term for small balls or pellets, often made of lead, fired primarily from shotguns or air guns. Shot is available in many sizes for different applications; buckshot is a larger diameter shot pellet. The size of numbered shot decreases as the number increases.

Beanbag rounds

A bean bag round, or flexible baton round, is a non-lethal projectile fired in a shotgun shell. Commercially available baton rounds are small fabric pillows filled with approximately 40 g (1.4 ounces) of lead shot packaged into a standard 12-gauge shotgun shell. When fired, the bag is propelled at 70 to 90 m/s (230 to 300 ft/s) and expands during flight to a strike area of approximately 6 cm^2 (1 in^2). Beanbag rounds are designed as a non-penetrating projectile, and design modifications have reduced the velocity of the round and altered the shape of the pillow to a round projectile.

Spears

Spears are sharp, pointed, or barbed instrument on a shaft. Spears can be operated manually or shot from a gun, such as a powerhead, or a sling.

A powerhead is a specialized firearm used underwater that is fired when in direct contact with a target. It consists of a long length of tubing that serves as a chamber for a cartridge, a firing pin, and usually a safety pin or latch to prevent firing when engaged; some powerheads use the cartridge to propel a spear. A powerhead is also referred to as a bang stick or a shark stick.

Sponge grenades

Sponge grenades are used for riot control and intended to be nonlethal. Sponge grenades can be either low velocity (40x46mm) rounds deployed using a hand held grenade launcher or high velocity (40x53mm) rounds used in mounted and crew-served weapons.

The bullet-shaped 40x46mm projectile, designed as a single blunt force object, weighs approximately 28 g (1 ounce) and is composed of a foam rubber nose and a high-density plastic projectile body. Hand held grenade launchers deploy a single shot, using shoulder fired break-action. The M79 can fire a wide variety of 40 mm rounds including explosive, anti-personnel, smoke, buckshot, flechette (pointed steel projectiles), and illumination rounds. The M203 is a single shot grenade launcher designed to attach to a rifle, utilizing the same propulsion system as the M79.

Projectiles Used with Compressed Air/Gas

Air guns, often called BB or pellet guns, are pneumatic weapons[2] that propel projectiles by means of compressed air or other gas, in contrast to firearms, which use combustible propellants. Air guns can be either rifles or pistols, which typically propel metallic projectiles, either spherical BBs or non-spherical air gun pellets. Certain types of air guns may also propel darts or arrows. Air guns in this context do not refer to seismic air guns used for marine reflection and refraction surveys in ocean exploration applications. In addition to being a tactile deterrent, these air guns or air rifles also produce an acoustic signature when used with higher projectile velocities resulting in more (i.e., louder) sound (Lankford et al. 2016).

BBs

BBs, as described above, can also be propelled by air guns.

[2] A pneumatic weapon fires a projectile by using air pressure rather than a propellant. In such devices, the entire firing round is the projectile as there is no need for a blasting cap or casing to enclose the propellant onto the projectile. The simplest pneumatic weapons are single-stroke pneumatics that are manually pumped for each shot. Multi-pump pneumatics allow the user to fill the gun with compressed air through subsequent manual pump actions. More advanced pneumatics rely on a compressed air reservoir or tank that is built into the gun or attached as an external accessory. Electropneumatic firing mechanisms use one or more electromechanically operated components to increase firing speed over comparable manual devices. These devices simultaneously chamber a projectile and release the propulsion gases to fire a projectile, thereby drastically increasing the firing sequence.

Shot pellet

Shot pellet, as described above can also be propelled by air guns.

Paintballs

Paintballs are spherical, breakable projectiles containing non-toxic, water-soluble substances and dye. Paintballs come in a variety of sizes including 0.50” (.50 caliber, “low impact”) and 0.68” (.68 caliber, higher impact). Paintball manufacturers have been transitioning to biodegradable, food-grade quality ingredients and reducing production of oil-based paint products. Paintballs are propelled using a paintball gun.

A paintball gun, also known as a paintball marker, uses an expanding gas such as carbon dioxide or compressed air to propel paintballs. Muzzle velocity of standard paintball markers range from 75 m/s (low velocity markers) to approximately 90 m/s (300 ft/s) through either mechanical or electropneumatic propulsion mechanisms with an average air pressure in the barrel at the time of firing of 25 psi. Paintball markers are designed to ensure the projectile is travelling fast enough to break upon impact and not to cause more than mild bruising, and firing speed can be calibrated with a paintball chronograph, a device that records the velocity of a projectile. Paint ball speed decreases as pressure in the compressed air tank decreases with subsequent firings. Force on contact or force of impact can vary widely based on paintball weight, air pressure, distance from target, and ambient environmental factors such as wind speed, wind direction, temperature, and humidity.

Sponge grenades

Lower muzzle velocity versions of the sponge grenades described above are designed for use in hand held launcher. Hand held launchers are replica firearms, or a special type of air guns, that fire spherical projectiles composed of different materials, including but not limited to plastics and biodegradable materials such as corn starch. Propulsion of the projectile is achieved using compressed gas, spring-driven piston, electrical piston, a combination of electrical and spring-driven pistons, or hydraulics. A hand held launcher can operate either manually or on a cyclic basis. Hand held launchers are designed to be nonlethal and non-penetrating.

Spears

Spears, as described above can also be propelled by pneumatic air guns. Pneumatic spear guns rely on a small quantity of compressed air to send the projectile forward and use a trigger to fire the spear.

Other Projectiles

Archery arrows

Archery arrows are designed to penetrate an animal's skin and strike through bone, hide, and muscle.

Archery bows and slingshots have variable forces inherent in their design as they rely on energy generated by the user. Draw weight (the amount of force required to pull back in preparation of firing) and draw length (the distance between the device's position at rest and its position when drawn immediately before firing) are the two factors that determine the amount of energy in such a device. In other words, a slingshot or bow's overall strength depends on how hard it is for the user to pull the string and how far back the user is able to pull it prior to release. Bow manufacturers express device strength in terms of the bow's energy (measured in foot-pounds or joules) and the arrow or propelled object's velocity (measured in feet or meters per second).

Crossbows differ from archery bows and slingshots in that the design maintains a more consistent and predictable strength as the arrow or propelled object is cocked in a consistently fixed position.

A compound bow is a bow that uses a levering system, usually of cables and pulleys, to bend the limbs. The pulley system gives a mechanical advantage to the user because its rigidity is more energy efficient. Compound bows have draw weights less than one half of a crossbow.

Blow darts

Blow darts are projectiles that are propelled through a tube using the force of breath and travel at a low velocity. Blow darts can also be delivered from a gun and propelled by compressed air, carbon dioxide, or an explosive charge.

Blunt-tip arrows

Blunt tip arrows are either screw-on points that replace penetrating, sharp arrow tips or push-on style points that slide over existing arrow tips. The striking surface of standard, commercially available blunt-tips range in diameter from ¼ in to 11/32 in, and some have enhanced projections for increased contact power. Arrows are propelled using archery bows, crossbows, compound bows, or air guns.

Foam missiles/rounds

Foam missiles or rounds are toy projectiles propelled through plastic toy guns, such as "Nerf rocket launchers" or other foam blasters.

Spears

Spears, as described above, can also be operated manually. Under the Magnuson Fishery Conservation and Management Act regulations at 50 CFR 635.2, speargun fishing means a muscle-powered speargun equipped with a trigger mechanism, a spear with a tip designed to penetrate and retain fish, and terminal gear. Terminal gear may include, but is not limited to, trailing lines, reels, and floats. The term “muscle-powered speargun” means a speargun that stores potential energy provided from the operator's muscles, and that releases only the amount of energy that the operator has provided to it from their own muscles. A common energy storing method for muscle-powered spearguns includes the stretching of rubber bands.

Types of spears manually deployed include pole spears (also called a three-prong because of the type of tip commonly used) and Hawaiian slings (Stoffle and Allen 2012). The pole spear has a heavy-duty sling or band attached at the end for launching and interchangeable tips; the spear is usually composed of fiberglass and comes in varying lengths. The Hawaiian sling makes use of a shooter, which is traditionally composed of wood and a high-powered rubber strap to fling the spear shaft forward, similar to a bow and arrow. Both are referred to as rubber powered spear guns. Additionally, a banded speargun is designed for small reef species or built much bigger and more powerful for targeting larger pelagic species (Stoffle and Allen 2012). Banded spear guns have a trigger mechanism to fire the harpoon.

Rocks

Rocks or other blunt material can be thrown by hand or propelled by a slingshot.

<u>Fixed Sharp Objects</u>

Barbed wire

Barbed wire is wire with clusters of short, sharp spikes set at intervals along the wire.

Nails

A nail is a long, thin piece of metal that is sharp at one end and flat at the other end. Nails can be propelled with a nail gun, a device for driving nails into an object by the force of compressed air, though various devices can be used to propel fasteners (nails, pins, etc.) into wood, steel, concrete, or masonry.

Manual Deterrents

Sharp objects

Manual, sharp objects are any object used to make contact with an animal without releasing or projecting the object and which is sharp enough on the contact end to potentially penetrate an animal's skin. Examples of such objects include, but are not limited to, hooks and sharp-ended poles, such as gaffs and nail-studded bats or poles.

Blunt objects

Manual, blunt objects are any object used to make contact with an animal without releasing or projecting the object and which is dull or blunt enough on the contact end so as to prevent the potential to penetrate an animal's skin. Examples of such objects include, but are not limited to, crowder boards (e.g., plywood), blunt tip poles, brooms, and mop handles.

Water deterrents

Water deterrents involve the use of propelled water at any speed or direction intended to deter a marine mammal through contact or the threat of contact. Examples include, but are not limited to, water hoses, sprinklers, and water guns.

1.3.2 Acoustic Deterrents

Acoustic deterrents have been used to deter marine mammals for decades, with reports of attempts to use killer whale calls to keep beluga whales away from salmon nets (Fish and Vania 1971). Anderson and Hawkins (1978) reported the first attempts to deter pinnipeds acoustically, from salmon net fishery operations, using pure tones, killer whale calls, and recorded loud noises within the hearing range of target marine mammals. To provide context and background relevant for understanding acoustic deterrents, a brief technical understanding of acoustics, including underwater acoustics, is provided below.

Sound travels in waves, the basic components of which are frequency and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second and can be described as the "tone" of a sound. Amplitude is the height of the sound pressure wave or the "loudness" of a sound, and is typically described using the relative unit of the decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure[3] (underwater this is one micropascal (μPa)

[3] Sound levels produced in air are not equivalent to those produced in water due to air and water having different densities and reference pressures. (Chapman and Ellis 1998; see tutorial: Link to DOSITS website).

and in air this is 20 μPa), and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure.

Sounds are often considered to fall into one of two general types: impulsive and non-impulsive, which differ in the potential to cause physical effects to animals (see Southall et al. (2007) for in-depth discussion). Impulsive sound sources (e.g., seal bombs, firecrackers, banging pipes, bird bangers) produce brief, broadband signals that are atonal transients and occur as isolated events or repeated in some succession. They are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury. Non-impulsive sounds (e.g., pingers, predator sounds, and air horns) can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous. Some can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time). Additionally, some implusive acoustic deterrents involve the use of explosives, and these have the potential to cause physiological injury to other organs, such as the lungs and gastrointestinal (GI) tract (DoN 2017). For our analysis, we evaluated over 100 different acoustic deterrents (refer to Appendix B) in terms of five marine mammal hearing groups (NMFS 2018): high-frequency (HF) cetaceans (i.e., Dall's porpoise, harbor porpoise, pygmy sperm whale, and dwarf sperm whale); mid-frequency (MF) cetaceans (all other odontocetes not categorized as HF cetaceans); LF cetaceans (mysticetes); phocid pinnipeds (true seals); and otariid pinnipeds (sea lions and fur seals).

1.3.2.1 Impulsive Acoustic Deterrents - Explosives

Impulsive sound sources produce sounds that are typically transient, brief (less than 1 second), broadband (produce sound over a wide frequency range), and consist of high peak sound pressure with rapid rise time and rapid decay (peak sound increases and dissipates quickly) (NOAA 2016). There are two types of impulsive deterrents: those that involve explosives and those that do not.

The ATF defines explosive materials to include explosives, blasting agents, and detonators. Explosives are defined as any chemical compound mixture, or device, the primary or common purpose of which is to function by explosion; the term includes, but is not limited to, dynamite and other high explosives, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, and igniters (18 U.S.C. § 1102).

Underwater explosives can result in acoustic impact to hearing as well as a physical impact to various air-filled organs, including lungs or the gastrointestinal tract due to the formation of a pressure wave (or shock wave). Below we describe different impulsive acoustic deterrents. For specifications (e.g., frequency, source level) of each device, see Appendix B.

Aerial Pyrotechnics

Aerial pyrotechnic units (screamer rockets, poppers, banger rockets, bottle rockets, etc.) have been used to scare birds away from crops, pinnipeds off docks, and birds and sea lions from aggregating at the base of fish ladders. The units are ignited using a hand held launcher (similar to a 0.22 short caliber starter pistol) and projected through the air, emitting a loud whistling sound (screamers) that end with a percussive detonation similar to a firecracker. Aerial pyrotechnics, or fireworks, can also be launched from traditional hand held or free-standing constructed packaging.

Bear Bangers used with Pencil Launchers

These devices are pencil-sized devices that are used to launch pyrotechnic cartridges via a spring and a firing pin. They are lightweight and considered simple to load and operate. They can be loaded with "bangers" that fire a fused projectile a distance of approximately 125 ft in 0.8 to 1.0 seconds before exploding and making a loud bang (USFWS 2015).

Bird Bangers

Bird bangers, a lower intensity version of bird bombs (see below), are pyrotechnic devices that are discharged from a handheld pistol, similar to a starter pistol, and travel 50 to 75 ft (15 to 22 m) before detonating in air. Actual flight range varies depending on firing angle and variables such as wind speed and direction. Handheld launchers use 6 mm 0.22 caliber firing caps to propel the cartridges from a single-shot launcher.

Bird Whistlers/Screamers

Bird Whistlers®, also known as "screamers" or "screechers", are fired from a hand held launcher and emit a screeching sound for 250 to 300 ft (75 to 90 m). Actual flight range varies depending on firing angle and variables such as wind speed and direction. Handheld launchers use 6 mm 0.22 caliber firing caps to propel the cartridges from either a single-shot or double-shot launcher.

Propane Cannons

A propane-powered gas gun produces a periodic explosion typically with a sound pressure less than 150 dB root mean square sound (RMS) sound pressure level in air. Some propane cannons are programmable with blast intervals between 5 and 30 minutes and/or in-air RMS sound pressure levels between 80 and 120 dB (re 20 μPa) (Good Life, Inc. 2020). Others can be motion detectors, remotely controlled, and/or multiblast (i.e., more than one blast every time the cannon fires).

Explosive Pest Control Devices

ATF describes Explosive Pest Control Devices (EPCDs), commonly referred to as “seal bombs,” “cracker shells,” “shell crackers,” “bird bombs,” or other similar terms, as used to maintain adequate levels of agricultural and aquacultural production and aviation by minimizing crop damage and interference from pests, birds, and seals at airports, landfills, farm land, golf courses, and fishing areas (ATF 2016). EPCDs are regulated explosives that fall under the jurisdiction of the ATF and require an ATF permit to purchase and use.

Cracker Shells

Cracker shells, or shell crackers, are pyrotechnic devices discharged from a 12-gauge shotgun and designed to detonate in air or at or just below the surface in water. The shells contain a flash explosive charge (similar to a firecracker) that is designed to explode in air at a distance of over 200 ft (60 m) from the point of discharge. Cracker shells emit two impulsive sounds, one associated with firing the shell and a second sound when the shell detonates.

Bird Bombs

Bird bombs are pyrotechnic devices similar to a cracker shell in that they are designed to detonate in air; however, they are discharged from a handheld launcher similar to a starter pistol rather than a 12-gauge shotgun. Hand held launchers use 6 mm 0.22 caliber firing caps to propel the cartridges from a single-shot launcher. Actual flight range varies depending on firing angle and variables such as wind speed and direction; however, bird bombs are designed to travel 75 to 100 ft (20 to 30 m). The ATF classifies bird bombs as an explosive, and a Federal Explosives License is required to purchase, possess, or use them.

Seal Bombs

Explosives commonly referred to as “seal bombs” are similar to cracker shells and underwater firecrackers in their explosive criteria; however, they are launched by hand (i.e., thrown manually), rather than being propelled from a gun or other device. The concussive property of a seal bomb is limited to the moment at which it detonates, unlike cracker shells and underwater firecrackers where there is a concussive property when the shell is fired and a subsequent concussive property at detonation. The ATF limits all EPCDs to 40 grains of explosive material; however, standard seal bombs are composed of up to 36 grains (2.332 g) explosive composition. Seal bombs’ explosive charge is contained in a sealed cardboard tube, fitted with a waterproof fuse and are weighted to sink below the surface of the water (i.e., 1 to 4 meters) before detonation (Myrick et al. 1990). The time delay between when the fuse is lit and when the unit enters the water allows regulation of detonation depth.

Underwater Firecrackers

Underwater firecrackers are pyrotechnic devices designed with a fuse and casing that is water resistant enough to hold off water infiltration long enough to permit detonation in or under water. These devices have historically been used to deter pinnipeds and disperse fish in a number of situations. Underwater firecrackers used by state and federal wildlife managers were commonly called “Seal Control Devices” prior to the development of EPCDs marketed today as “seal bombs”. A key difference in the two devices is that underwater firecrackers have a much shorter fuse than seal bombs.

1.3.2.2 Impulsive Acoustic Deterrents – Non-Explosive

Low Frequency, Broadband Device

The Aquaculture Predator Protection System (PPS) by Hydroacoustics, Inc. (HAI) is an example of a deterrent system that uses compressed air to generate a low frequency, broadband, impulsive acoustic signal rather than the higher frequency, single tone signal of acoustic alarms (see below) or the higher frequency impulsive signal of a pulsed power devices (see below). The acoustic effect can be scaled by changing the air pressure supplied to the system by SCUBA tanks or changing the chamber volume of the system. Such pneumatic systems are capable of rapid, repeatable firing, approximately once per second. HAI PPSs can be either portable, for single deployment from a small watercraft, or permanently fixed to docks or other structures, as either a single unit or a multi-unit array. In an array configuration, air guns can be fired simultaneously, sequentially to produce a wave train of individual pulses, or fired in combination to produce pulse wave trains. The air gun utilized in such a device is based on the air gun technology used in the marine seismic industry. However, this air gun is different from the seismic air guns used for marine reflection and refraction surveys in ocean exploration applications. Unlike previously described deterrent devices that rely on producing a sound in the peak sensitivity range of the target animal, the primary effect from the PPS is a full body impulsive force from a pressure wave with only a secondary effect on hearing.

Pulsed Power Devices

Pulsed power devices (PPDs) are arc-gap transducers, or sparkers, used to generate underwater shock waves. In these devices, a large amount of electrical energy is stored at high voltage and is then released across the space (or gap) between paired electrodes immersed in seawater. The resulting discharge creates an arc of ionized gas, which lasts a few micro-seconds and momentarily vaporizes the sea water between the terminals, producing an underwater shock wave. The high pressure, high temperature water vapor produces a gas bubble that quickly expands and collapses producing a high frequency, broadband acoustic pulse that travels in all directions from the initiating arc. The magnitude of the resulting acoustic pulse is a product of the amount of stored energy. An arc-gap transducer can be pulsed or cycled at a rate determined by the ability of the system to replenish the stored electrical energy. One example of a PPD is the Sea Lion Deterrent Device (SLDD) developed by ACTIX. The SLDD uses a high amplitude pressure pulse of short duration meant to cause low impact to an animal's body.

Banging Objects/In-Air Passive Acoustic Deterrents

Banging refers to the active use of any combination of objects to create sound either in-air or underwater. Examples include, but are not limited to, striking metal poles with hammers, banging metal pipes or wooden poles together, striking the metal hull of a vessel with a hammer, Oikomi pipes, and bells. Oikomi pipes are reverberant metal devices, typically a metal pipe suspended and submerged into water with an above water extension that is struck to create a reverberating sound wave. Oikomi pipes can be used singly or in arrays of multiple pipes deployed from coordinated vessels to create a wall of sound. Bells are another form of device that consists of banging, specifically where a clapper strikes the side of the bell. Cowbells have often been used for sporting events and as general in-air noise-making devices.

Passive acoustic deterrents are typically objects suspended, mounted, or otherwise hung in such a manner, in air, to make noise when naturally disturbed by the wind or other passive force resulting in an impact sound from two materials hitting one another. Examples of passive acoustic deterrents include, but are not limited to, aluminum cans strung together, chains, and other makeshift wind chimes. This term should not be confused with passive acoustic monitoring, which refers to underwater microphones (i.e., hydrophones) to detect, monitor, and locate vocalizing marine animals. Passive acoustic deterrents typically have lower source levels than other devices in this category.

1.3.2.3 Non-impulsive Acoustic Deterrents

Non-impulsive sound sources produce sounds that can be broadband (produce sound over a wide frequency range), narrowband (produce sound over a limited frequency range) or tonal, brief or prolonged, continuous or intermittent, and typically do not have a high peak sound pressure with rapid rise time (peak sound does not increases and dissipates quickly) that impulsive sounds do (NOAA 2016). In this section, we describe several types of non-impulsive deterrents, including acoustic alarms, in-air noisemakers, and predator sounds or alarm vocalizations using underwater speakers.

Acoustic Alarms

Acoustic alarms are a generic category of non-impulsive devices[4]. These devices have a wide range of applications by various industries and often target different species. Deployment and operations can vary (McGarry et al. 2020).

Pingers

Pingers are small, self-contained, battery operated devices that emit regular or randomized acoustic signals at a range of frequencies. The devices are typically ultrasonic, low-intensity (source level: < 150 dB RMS re 1 μPa at 1 m) underwater acoustic transponders that emit pulsed signals ranging from 2.5 to 12 kilohertz (kHz) with higher harmonic frequencies (up to 160 – 180 kHz). The intent of these devices is typically to alert and deter animals (e.g., to prevent entanglement in nets), and as such, they have relatively low source levels (Kraus 1999; Reeves et al. 2001; Nowacek et al. 2007). Pulse duration varies, but typically ranges from 4-30 second randomized interpulse intervals. While pingers were typically designed to have a low source levels and frequency, recently developed devices produce higher frequencies.

Transducers

Transducers typically generate sound at higher amplitudes than traditional pingers to elicit a startle response in the targeted marine mammals. They can also consist of customized array systems that pair an acoustic output signal with another stimulus, such as an electrical shock or pressure wave. These devices are connected to a power supply/control unit typically via a cable and use an on/off power switch (i.e., thus, the entire device is not capable of being fully submerged because of surface control and power units; MMO 2018). They are typically deployed singly over the side of a boat or more permanently on an aquaculture cage (Nowacek et al. 2007). Because they have their own power supply, these devices are capable of producing higher source levels and often have the intent of harassing animals (e.g., causing physical discomfort/pain or annoyance, Kraus 1999) and have often been used specifically to reduce depredation, in particular from pinnipeds (Reeves et al. 2001). The GenusWave and OrcaSaver are examples of transducers.

In-air Noisemakers

In-air noisemakers are devices that are actively initiated to emit sound and can be either mounted in a permanent manner or handheld and mobile. The most common example of an in-air handheld noisemaker is an air horn, a pneumatic device composed of a pressurized air source

[4] Some may be more familiar with these devices as acoustic deterrent devices or acoustic harassment devices, but formal definitions do not exist for these devices; therefore, this EA more generally describes the effects of acoustic alarms.

coupled with a horn, typically used for signaling purposes. The stream of air released from the compressed air canister passes over a reed or diaphragm to create sound waves and the attached horn amplifies the sound. Other in-air noisemakers include, but are not limited to, aerodynamic whistles, vuvuzelas, and sirens. Vuvuzelas, or stadium horns, are plastic horns, approximately 2 ft in length. Sirens maximize power output and direct sound using a horn, which transforms high-pressure sound waves into lower-pressure sound waves in the open air.

Predator Sounds or Alarm Vocalizations using Underwater Speakers

Predator sounds or alarm vocalizations refer to recorded acoustic transmissions of animals meant to elicit an evasive flight response in target animals. For example, projected recordings of killer whales have been used to deter harbor porpoises from an area (Deecke et al. 2002). Vocalizations are emitted from underwater speakers and can also include acoustic recordings of members of the same species, rather than predators of the target animals.

A full product line of underwater speakers that may be used to play predator sounds or alarm vocalizations is available from multiple companies. In this EA, we analyzed products made by Lubell Labs, Inc. as they are one of the more widely distributed product lines in the marine industry with a production history dating back to the first broadband underwater speaker. In general, the term underwater speaker refers to piezoelectric underwater acoustic transducers.

1.4 Primary Parties, Activities, or Areas Affected

The primary parties or activities affected by marine mammal damage include commercial and recreational fishermen and fishing, aquaculture operators and operations, and property owners and private property (e.g., harbormasters, piers, marina owners, marinas, docks). The primary area is nationwide, within coastal, estuarine, and offshore waters of the U.S., including the U.S. Exclusive Economic Zone and the High Seas.

1.5 Purpose and Need

The purpose of issuing guidelines is to prescribe methods and technologies to safely deter marine mammals, including recommended specific measures for endangered or threatened species, in a manner that will allow fishermen and private property owners to protect their catch and property without killing or seriously injuring marine mammals. These guidelines include prohibitions[5] of certain methods and technologies and provide commercial and recreational fishermen, aquaculture operators, and private property owners with protocols and procedures for properly implementing deterrence methods and technologies. Deterring marine mammals through nonlethal methods and technologies consistent with such guidelines would not be a violation of

[5] Section 101(a)(4)(C) of the MMPA allows allows the prohibition of certain deterrence methods if NMFS determines, using the best scientific information available, and subsequent to public comment, that the deterrence measure has a significant adverse effect on marine mammals.

the MMPA. Without guidelines for nonlethally deterring marine mammals, parties affected by marine mammal damage to fishing gear, catch, or private property will likely continue intentionally killing or seriously injuring marine mammals (e.g., gunshots), which is counter to the MMPA's primary purpose.

1.6 Environmental Review Process

1.6.1 National Environmental Policy Act

NEPA requires federal agencies to examine the environmental impacts of their proposed actions within the U.S. and its territories. A NEPA analysis is a public document that provides an assessment of the potential effects a major federal action may have on the human environment, which includes the natural and physical environment. Major federal actions include activities that federal agencies fully or partially fund, regulate, conduct, or approve. Because the issuance of guidelines would provide an exception to otherwise prohibited interactions with marine mammals, we consider this a major federal action subject to NEPA. Therefore, NMFS is assessing the environmental effects associated with nonlethal deterrence methods and technologies to prepare the appropriate NEPA documentation.

1.6.2 Scoping and Public Involvement

The intent of the NEPA process is to enable NMFS to make decisions based on an understanding of the environmental consequences and to take actions to protect, restore, and enhance the environment. An integral part of the NEPA process is public involvement. Public involvement facilitates the development of an EA and informs the scope of issues addressed in the EA. Although agency procedures do not require public involvement prior to finalizing an EA, NMFS determined that the publication of the draft EA along with the proposed guidelines was the appropriate step to involve the public. Through public involvement, NMFS seeks to understand the public's concerns for the proposed action, identify significant issues related to the proposed action, and obtain the necessary information to complete the analysis.

To inform development of proposed guidelines, NMFS initially solicited the public's input on which deterrents to evaluate and consider for approval. NMFS requested information on: the specifications (e.g., source and frequency levels, pulse rate, type of fencing, size of flags, etc.) for each deterrent or technique, which marine mammal species or species group (large cetaceans, small cetaceans, pinnipeds) would be deterred, how a deterrent would be employed (e.g., attached to fishing gear, launched some distance from a marine mammal), any evidence that the deterrent would not result in mortality or serious injury, and any other implementation considerations. NMFS issued a notice of intent on December 16, 2014 (79 FR 74710) and received a range of comments and requests from non-governmental organizations, private sector companies and product developers, fishery management councils, commercial and recreational fishermen, and representatives of the merchant shipping and maritime trade industry. For example, multiple respondents urged NMFS to ensure any prohibitions and guidelines were not too specific as to limit the ability to develop new technologies or products and to consider geographical and species variation inherent in the deterrent process. There were also general requests for NMFS to consider including acoustic devices along with the range of deterrents currently in use so commercial and recreational fishermen would have advice on and multiple options available to deter different species under a variety of conditions presented within their industries. NMFS considered information from this public comment period to assist with determining which methods and technologies are appropriate for inclusion in the guidelines. The selection criterions are further explained in Section 2.2.

1.7 Other Environmental Laws or Consultations

There are no other environmental laws, regulations, Executive Orders, consultations, federal permits or licenses needed to implement these guidelines beyond those identified in the publication of the proposed guidelines.

1.8 Scope of Environmental Analysis

This EA was prepared in accordance with NEPA (42 USC 4321, et seq.), CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508) and the 2017 NOAA NEPA Companion Manual. We analyze direct, indirect, and cumulative impacts related to deterrence methods and technologies to allow the public and NMFS to understand the impacts and to distinguish between the alternatives. The analysis in this EA addresses potential impacts to marine mammals resulting from NMFS's proposed action to issue guidelines for safely deterring marine mammals. The intent of this EA is to provide focused information on the primary issues and impacts of environmental concern. For these reasons, this EA does not provide a detailed evaluation of the effects to the elements of the human environment because the proposed action would not impact these elements or there is no difference between the alternatives.

The proposed action has no effect or negligible effects on some elements of the human environment (e.g., water quality and air quality) given the range and effects of the deterrents. Fishermen and property owners may choose to deter marine mammals using these guidelines, but they are not required to undertake deterrence; we cannot predict who will use deterrents in a given area or how often deterrents will be used. Therefore, NMFS cannot determine the effects on other elements (e.g., economics or cultural resources) because there is no available data that indicate the scale of the effects under the no-action alternative, nor can NMFS determine specifically what deterrents will be used, where, by whom, and at what purchase costs. For this NEPA analysis, NMFS believes that there is no difference between the alternatives for these resources in that individuals would continue to buy and use deterrents wherever they are needed to protect property, fishing gear or catch.

1.8.1 Best Available Information

In accordance with NEPA and the Administrative Procedure Act of 1946 (5 U.S.C. §§ 551–559) and MMPA Section 101(a)(4)(C), NMFS used the best scientific information available accepted by the appropriate regulatory and scientific communities to compile and assess the environmental baseline and impacts evaluated in this document.

For evaluating the potential effects associated with the use of acoustic deterrent devices on marine mammals (i.e., acoustic criteria), NMFS relied heavily upon NOAA 2016, DoN 2017, NMFS 2018, and Southall et al. 2019, which are the best representation of the current state of science on this topic. Additionally, the measurements provided in Wiggins et al. 2019 are considered the best available science on characterizing the sound produced by seal bombs.

2 PROPOSED ACTION AND ALTERNATIVES

2.1 Description of the Proposed Action

NMFS's Proposed Action is to develop and promulgate guidelines, pursuant to MMPA Section 101(a)(4)(B), for safely deterring marine mammals from interacting with commercial fisheries, recreational fishing activities, aquaculture operations, and the public. The proposed guidelines will include methods and technologies for safely deterring marine mammals, including recommended specific measures for endangered or threatened species listed under the ESA, and prohibitions on certain methods or technologies that have been determined to have a high adverse effect on marine mammals. These guidelines will also provide implementation procedures deterrence technologies and monitoring and reporting requirements.

2.2 Alternatives Development and Screening

In accordance with NEPA and CEQ Regulations, NMFS is required to consider alternatives to the Proposed Action. This includes the no action and other reasonable course of action associated with issuance of guidelines to deter marine mammals. The evaluation of alternatives under NEPA assists NMFS with ensuring that any unnecessary impacts are avoided through an assessment of alternative ways to achieve the purpose and need for our Proposed Action that may result in less environmental harm. To warrant evaluation under NEPA, an alternative must be reasonable along with meeting the stated purpose and need for the proposed action. For the purposes of this EA, an alternative will only meet the purpose and need if it satisfies the requirements under Sections 101(a)(4)(A) of the MMPA. Therefore, NMFS applied the following screening criteria to the alternatives to identify which alternatives to carry forward for analysis. Accordingly, an alternative must meet the following criteria to be considered "reasonable".

- The alternative action must not violate any Federal laws or regulations.
- The alternative action must be consistent with the requirements and goals of NMFS Regulatory Programs, including the collection of information necessary to facilitate

the conservation and recovery of protected species and their habitat. It would not be practical to issue guidelines that conflict with these program efforts.

- The alternative action must be administratively feasible. The costs associated with implementing an alternative cannot be prohibitively exorbitant or require unattainable infrastructure, such as databases or additional staffing.

2.3 Description of the Alternatives

2.3.1 Alternative 1 (No Action): NMFS Does Not Issue Guidelines or Recommended Specific Measures for Safely Deterring Marine Mammals

CEQ Regulations (40 CFR Section 1502.14[d]) require a no action alternative be included and analyzed to provide a clear basis for choice among options by the decision maker and the public. Under Alternative 1 (No Action), there are several potential outcome scenarios. One is that commercial and recreational fishermen and the public use commercially-available deterrents on non-ESA listed marine mammals. In this case, 1) person(s) deterring marine mammals would be in violation of the MMPA if mortality or serious injury of a marine mammal occurs incidental to the deterrence; 2) prohibitions for certain methods and technologies known to result in death or serious injury would not be prescribed by NMFS; 3) guidance on best practices for minimizing risk of killing or seriously injuring marine mammals would not be prescribed by NMFS; and 4) all person(s) will continue to be precluded from deterring any ESA-listed marine mammals because no recommended specific measures currently exist. Without issuing guidelines, fishermen or private property owners might take lethal action against marine mammals in situations where deterrents could be employed instead. Over the past several years, the number of interactions between marine mammals and humans has increased, particularly gunshots (Warlick et al. 2018). As these interactions become more common without deterrence methods or technologies and the implementing guidelines, the risk of mortality, through lethal action and misuse of available deterrence devices, also increases.

Although Alternative 1 (No Action) would not meet the purpose and need to issue guidelines prescribing deterrence methods and technologies under certain conditions, CEQ Regulations require consideration and analysis of a no action alternative for the purposes of presenting a comparative analysis to the action alternatives.

2.3.2 Alternative 2 (*Preferred Alternative*): NMFS Issues Guidelines and Recommended Specific Measures for Safely Deterring Marine Mammals and Prohibitions

Under Alternative 2 (*Preferred Alternative*), NMFS would issue guidelines prescribing nonlethal deterrents or prohibited for use with non-ESA marine mammals and best practices for implementing such methods or technologies as well as recommended specific measures for ESA-listed marine mammals. By issuing guidelines and recommended specific measures and prohibited methods and technologies and associated best practices, NMFS can potentially lessen the impacts on the marine mammal species and stocks associated with improper use of deterrents and minimize or prevent intentional, lethal take.

NMFS considered species-specific responses in determining which deterrents to include under the guidelines, recommended specific measures, or prohibitions. The criteria for evaluating acoustic deterrents and the associated analysis may be used for research and the development of new methods or technologies that would not likely result in the death or serious injury of marine mammals. The preferred alternative was selected because it best meets the purpose and need for taking the regulatory action to implement the MMPA and in achieving NMFS's mission of recovering and protecting marine mammals.

Some deterrents may be subject to prohibition under federal, state, or local ordinances and also may come with additional legal regulation. Any person considering the use of any deterrent method or technology would be responsible for consulting the appropriate authorities to determine whether additional regulations (e.g., permitting requirements) apply.

2.3.2.1 Guidelines for non-ESA Listed Marine Mammals

These "guidelines" apply to marine mammals that are not listed under the ESA. As noted in Table 2, we have developed several overarching guidelines that apply any time a deterrent is used to protect both the user and the marine mammals. For using deterrents to target each of the three taxa, mysticetes (baleen whales), odontocetes (toothed whales and dolphins), and pinnipeds (seals and sea lions), NMFS has developed guidelines for allowable types of deterrents within a particular category of deterrents. For most deterrents, we have specified practices that must also be followed to use the deterrent lawfully; this is particularly noteworthy for acoustic deterrents where a there is a specified minimum distance from a target marine mammal.

Table 2 General guideline devices for deterring non-ESA marine mammals under the Preferred Alternative; best practices for using each deterrent are included in the text in the following section.

<table>
<tr><th colspan="3">GENERAL GUIDELINES</th></tr>
<tr><td colspan="3">• Human safety is paramount. However, also consider the safety of the marine mammal.
  o If operating from a vessel, captains should use extreme caution when maneuvering around marine mammals.
  o When animals dive, they may surface in unexpected places.
• Place engine in neutral if animal approaches the vessel.
• Cease using deterrent if an animal demonstrates any sign of aggression (e.g., charging, lunging).
• If a deterrent is unsuccessful, NMFS strongly encourages you to temporarily suspend your activity and allow the animal(s) to leave the area before resuming your activity.</td></tr>
<tr><th colspan="3">DETERRENTS INCLUDED IN GUIDELINES</th></tr>
<tr><th>MYSTICETES</th><th>ODONTOCETES</th><th>PINNIPEDS</th></tr>
<tr><th colspan="3">Non-Acoustic Deterrents</th></tr>
<tr><td>Visual
• Bubble curtains
• Flashing or strobe lights
• Predator shapes
• Vessel patrolling
• Unmanned Aircraft System
Physical Barriers
  • Containment booms, waterway barriers, and log booms
Tactile – Projectiles
  • Foam projectiles with toy guns
Tactile - Manual
  • Blunt objects - blunt tip poles, brooms, mop handles, etc.
Tactile - Water</td><td>Visual
• Bubble curtains
• Flashing or strobe lights
• Predator shapes
• Vessel patrolling
• Unmanned Aircraft System
Physical Barriers
  • Containment booms, waterway barriers, and log booms
Tactile – Projectiles
  • Foam projectiles with toy guns
Tactile - Manual
  • Blunt objects - blunt tip poles, brooms, mop handles, etc.
Tactile - Water</td><td>Visual
• Air dancers, flags, pinwheels, and streamers
• Bubble curtains
• Flashing or strobe lights
• Human attendants
• Predator shapes
• Vessel patrolling
• Unmanned Aircraft System
Physical Barriers
  • Rigid fencing in air
  • Horizontal bars/bull rails
  • Gates or closely spaced poles
  • Containment booms, waterway barriers, and log booms
  • Swim step protectors
Tactile - Electrical
  • Electric fencing (in air)</td></tr>
</table>

• Water hoses, sprinklers, water guns	• Water hoses, sprinklers, water guns	• Low voltage electric mats Tactile – Projectiles • Foam projectiles with toy guns • Paintballs with paintball guns • Sponge grenades with hand held launcher • Blunt objects with slingshot Tactile - Manual • Blunt objects - blunt tip poles, brooms, mop handles, etc. Tactile - Water • Water hoses, sprinklers, water guns
Acoustic Deterrents		
Impulsive – Non-Explosives • Banging objects (e.g., Oikomi pipes) underwater Non-Impulsive (<170 dB RMS**) • Acoustic alarm (i.e., pingers/transducers) • Predator sounds/alarm vocalizations using underwater speakers	Impulsive – Non-Explosives • Banging objects (e.g., Oikomi pipes) underwater Non-Impulsive (<170 dB RMS**) • Acoustic alarms (i.e., pingers/transducers) • Predator sounds/alarm vocalizations using underwater speakers	Impulsive - Explosives* • Aerial pyrotechnics/fireworks • Bird bangers, bird whistlers/screamers, bear bangers using pencil launchers/propane cannons • Cracker shells, bird bombs, seal bombs, underwater firecrackers Impulsive – Non-Explosives • Low frequency, broadband devices • Pulsed power devices • Banging objects (e.g., Oikomi pipes)/in-air passive acoustic devices (e.g., hanging chains, cans) Non-Impulsive (<170 dB RMS**) • Acoustic alarms (i.e., pingers/transducers) • Air horns, in-air noisemakers, sirens, whistles • Predator sounds/alarm vocalizations using underwater speakers

*Guidelines include minimum distances and silent intervals, see below.

**Any underwater non-impulsive acoustic device capable of producing underwater sound levels ≥ 170 dB RMS must be evaluated via the NMFS Acoustic Deterrent Web Tool.

Programmable Devices and the NMFS Acoustic Deterrent Web Tool

Many devices allow the user to manipulate various settings or characteristics of the device. For all such non-impulsive devices, a user must visit the online NMFS Acoustic Deterrent Web Tool, enter the settings they intend to use for a particular device, and obtain a certificate that authorizes the use of the device as specified and analyzed. Additionally, any underwater non-impulsive devices capable of producing sound ≥ 170 dB RMS must first be evaluated via the Acoustic Deterrent Web Tool before using the device. NMFS evaluated various source levels to determine the maximum source level that would not exceed our 100-m, 1-h criterion, and devices with a source level of 170 dB, with a maximum 54% duty cycle (i.e., producing sound for less than 32 minutes within an hour), met this criterion. If the specifications do not meet NMFS's criteria for approval (see Chapter 4.1), the user would not obtain a certificate and would not be authorized to use the device. If specifications do meet NMFS's criteria for approval, the user would obtain a certificate that must be onsite and produced for inspection at any time.

Practices and Minimum Distances

For each type of deterrents included in the guidelines, we specify practices that will further minimize the risk of injury to marine mammals. Additionally, for acoustic deterrents, to reduce potentially harmful impacts to the target marine mammals and other sensitive marine mammals in the vicinity, minimum deployment distances as well as silent intervals (for use of a single device) are specified (Table 3. to Table 6). When deploying acoustic deterrents, users in close proximity to each other and/or on the same vessel must coordinate deploying any acoustic deterrents that have a minimum silent interval to ensure compliance with the specifications. The following section details practices and minimum distances for using the deterrents noted above in Table 2. Note that for several types of deterrents (e.g., explosives), there are additional municipal, state, and/or federal requirements for using and possessing such deterrents; users are responsible for complying with each of those requirements regardless of the deterrents included in these MMPA guidelines. If a deterrent is not specifically mentioned, there are no associated required practices.

Visual

Flashing lights or strobe lights

All marine mammals: flashing lights and strobe lights used to deter marine mammals must conform to any standards established by Federal law.

Flags, pinwheels, and streamers

Pinnipeds: When using flags, pinwheels, and streamers to deter pinnipeds, products should be selected to ensure, to the best ability of the user, that the materials will stay intact and securely fastened; all such products should be installed and maintained in such a manner as to ensure they do not pose an entanglement or ingestion risk.

Vessel patrolling

All marine mammals: When patrolling fishing gear or property with a vessel, the user must maintain a consistent and safe speed in compliance with any and all applicable speed limitations (pursuant to 33 U.S.C. 1602), and fixed direction to avoid coming into contact with a marine mammal.

Unmanned Aircraft System (UAS)

All marine mammals: Only vertical takeoff and landing aircraft are allowed for use to deter marine mammals. Devices should be in good working order and operated consistent with the manufacturer's specifications. Users should fly UASs no closer than 5 m from an animal. UAS altitude adjustments should be made away from animals or conducted slowly when above animals. A UAS should hover over a target animal only long enough to deter the animal and should not come in direct contact with the animal.

Physical barriers

Containment booms, waterway barriers, and log booms

All marine mammals: Containment booms, waterway barriers, and log booms used to deter marine mammals must be constructed, installed, secured and maintained to reduce the risk of entanglement or entrapment. In-water lines should be kept stiff, taut, and non-looping. Booms/barriers should not block major egress points in channels, rivers, passes, and bays.

Rigid fencing in air, horizontal bars/bull rails, and gates or closely spaced poles

Pinnipeds: Rigid fencing in air, horizontal bars/bull rails, and gates or closely spaced poles used to deter pinnipeds must be constructed, installed, and maintained in such a manner as to ensure spacing, height, and/or width would not result in the entrapment or entanglement.

Tactical - Electrical

Electric fencing (in air)

Pinnipeds: Electric fencing used to deter pinnipeds shall be no more than 3,000V and maintained properly to ensure required voltage and reduce the risk of entrapment or entanglement.

Electric mats

Pinnipeds: Electric mats used to deter pinnipeds shall not exceed 24V nominal.

Tactile - Projectiles

Foam projectiles with toy guns

All marine mammals: When using foam projectiles with toy guns to deter marine mammals, the deterrent must strike the posterior end of an animal's body, taking care to avoid the animal's head and/or blowhole.

Paintballs using paintball gun

Pinnipeds: When using paintballs to deter pinnipeds, paintballs must be fired at a minimum of 14 meters from phocid and 3 meters from an otariid. The paintball must strike at the posterior end of an animal's body, taking care to avoid the animal's head

Sponge grenades using hand held launcher

Pinnipeds: Low velocity sponge grenades to deter pinnipeds must be deployed at a minimum distance of 14 m from a phocid and 10 m from an otariid and the sponge grenade must strike the posterior end of an animal's body, taking care to avoid the animal's head.

Tactile - Manual

Blunt objects

All marine mammals: Blunt objects (e.g., poles, broom and mop handles) used to deter marine mammals must be deployed using a prodding motion rather than a swinging or side-to-side motion. Such deterrents are only appropriate in situations where an animal is directly pursuing a person, dock, vessel, or fishing gear, or attempting to haul out on a dock or vessel. The deterrent must strike the posterior end of an animal's body, taking care to avoid the animal's head and/or blowhole. For pinnipeds, the user may also impact the animal's chest.

Tactile – Water

Water deterrents

All marine mammals: When using water deterrents, users must first aim at strike an area near the animal before targeting striking the animal; then the user must strike the posterior end of an animal's body, taking care to avoid the animal's head and/or blowhole.

Acoustic

For acoustic deterrents, minimum distances as well as other practices (Table 3 -Table 6) are provided below. When deploying acoustic deterrents, users in close proximity to each other and/or on the same vessel must coordinate deploying any acoustic deterrents that have a minimum silent interval to ensure compliance.

Table 3 Minimum distances and silent intervals when deploying underwater impulsive explosive deterrents for deterring pinnipeds.

Deterrent	Minimum Silent Interval	Phocids Minimum Distance	Otariids Minimum Distance*
Cracker shell	320 seconds	3 meters	2 meters**
Seal Bombs	180 seconds	20 meters	2 meters
Underwater firecracker	1 second	1 meter	2 meters**

* If both phocid and otariid pinnipeds are observed in the area, then the minimum distance for phocids becomes the default minimum distance.

**Distance is based on physical proximity instead of acoustic effects.

Table 4 Minimum distances and silent intervals when deploying underwater impulsive non-explosive deterrents for pinnipeds.

Deterrent	Source Level (RMS SPL)	Minimum Silent Interval	Phocid Minimum Distance	Otariid Minimum Distance
Pulsed Power Device	220 dB	1200 seconds (20 minutes)	1 meter	1 meter
Low frequency, broadband device	219 dB	300 seconds	5 meters	1 meter
Low frequency, broadband device	215 dB	120 seconds	5 meters	1 meter
Low frequency, broadband device	208 dB	30 seconds	4 meters	1 meter

Table 5 Minimum distances and silent interval when using banging objects underwater as deterrents for each hearing group. LF – low frequency, MF – mid frequency, HF – high frequeny.

Deterrent	Minimum Silent Interval	LF Cetacean Minimum Distance	MF Cetacean Minimum Distance	HF Cetacean Minimum Distance	Phocid Pinniped Minimum Distance	Otariid Pinniped Minimum Distance
Banging objects (e.g., metal pipes)	18 seconds	11 meters	3 meters	100 meters	8 meters	2 meters**

**Distance is based on physical proximity instead of acoustic effects.

Table 6 Minimum distances when deploying airborne acoustic deterrents for deterring pinnipeds.

Deterrent	Phocid Pinniped Minimum Distance	Otariid Pinniped Minimum Distance*
IMPULSIVE		
Aerial pyrotechnics/ fireworks	23 meters	2 meters
Paintballs used with paintball gun	14 meters	3 meters**
Sponge grenades used with air guns	14 meters	10 meters**
Bear bangers using pencil launcher	2 meters	2 meters**
Bird Banger	23 meters	2 meters
Bird Bomb	8 meters	2 meters**
Bird Whistler/Screamer	5 meters	2 meters**
Banging objects/Passive acoustic deterrent (e.g., aluminum cans strung together, chains)	24 meters	2 meters
Cracker Shells	24 meters	2 meters
Propane cannon	2 meters	2 meters**
NON-IMPULSIVE		
Air horn	4 meters	2 meters**
In-air noise maker (e.g., vuvuzela)	5 meters	2 meters**
Sirens	2 meters	2 meters**
Whistles	3 meters	2 meters**

* If both phocid and otariid pinnipeds are observed in the area, then the minimum distance for phocids becomes the default minimum distance.
**Distance is based on physical proximity instead of acoustic effects.

Impulsive explosives

General

- Users must obtain necessary permits or authorizations from local, state, and/or federal authorities and produce for inspection at any time.
- Devices should be in good working order and used via manufacturer's specifications.
- Explosives should be aimed behind the target animal to deter the animal from the rear rather than head-on and should never be deployed or attempted to be deployed in the middle of a group of animals.
- When multiple animals are present, smaller individuals should not be targeted.
- Users should ensure there are no additional animals, including non-target marine mammals and other protected species (e.g., sea turtles, seabirds), in the immediate vicinity of the detonation other than the target marine mammal(s).
- Users should confirm that there are no humans in the water or in a location on a boat where they could be injured by use of the deterrent.

Bear bangers using pencil launchers, bird whistler/screamer, bird bombs:

Devices should be aimed between the user and the target marine mammal, while abiding by the minimum distance from the animal.

Cracker shells (underwater):

When using cracker shells to deter pinnipeds underwater, the user must first conduct a visual scan in all directions for cetaceans within 100 m; if Dall's porpoise, harbor porpoise, dwarf sperm whales, or pygmy sperm whales are sighted within 100 m of the user, cracker shells shall not be deployed underwater. If no Dall's porpoise, harbor porpoise, dwarf sperm whales, or pygmy sperm whales are sighted within 100 m of the user, underwater cracker shells must be deployed according to the minimum distances in Table 3 and only once every 5 minutes. When deploying acoustic deterrents, users in close proximity to each other and/or on the same vessel must coordinate deploying any acoustic deterrents that have a minimum silent interval to ensure compliance. Cracker shells must be aimed behind the target animal to deter from the rear and not in the path of or toward the head of the animal. Users must obtain all necessary permits or authorizations from local, state, and/or federal authorities and produce for inspection at any time.

Seal bombs:

When using seal bombs to deter pinnipeds, the user must first conduct a visual scan in all directions for cetaceans within 100 m; if cetaceans are sighted within 100 m of the user, seal bombs shall not be deployed. If no cetaceans are sighted within 100 m of the user, seal bombs must be deployed according to the minimum distances in Table 3 and only once every 3 minutes. Users must take care to avoid throwing the seal bomb in front of the animal or in the direction the animal is traveling.

Impulsive non-explosives

Pulsed Power Devices

When using pulsed power to deter marine mammals, the user must first conduct a visual scan in all directions for all marine mammals within 100 m; if a cetacean is sighted within 100 m of the user, pulsed power devices shall not be used.

Low Frequency, Broadband Devices

When using low frequency, broadband devices to deter marine mammals, the user must first conduct a visual scan in all directions for all marine mammals within 100 m; if a cetacean is sighted within 100 m of the user, low frequency, broadband devices shall not be used.

Banging objects (underwater):

When using banging objects to deter marine mammals, the user must first conduct a visual scan in all directions for all marine mammals within 100 m; if Dall's porpoise, harbor porpoise, pygmy sperm whales, or dwarf sperm whales are sighted within 100 m of the user, banging pipes shall not be used underwater.

2.3.2.2 Recommended Specific Measures for ESA-listed Marine Mammals

Pinnipeds

The preferred alternative includes recommended specific measures for the western Distinct Population Segement (DPS) of Steller sea lions and the Hawaiian monk seal; for all other species of ESA-listed pinnipeds (i.e., Arctic ringed seals and Guadalupe fur seals), all of the above guidelines for deterring non-ESA pinnipeds are considered recommended" specific measures" (see Table 7). The western DPS of Steller sea lions is defined as Steller sea lions born west of 144° W longitude. In recent years, western DPS Steller sea lions have also been documented east of 144° W longitude. Western DPS Steller sea lions east of 144° W longitude commonly occur from Cape Suckling through Yakutat and northern southeast Alaska to 55°49'22.00" N latitude, but are rarely found south of 55°49'22.00" N latitude (north of the southern tip of Coronation Island) (Jemison et al. 2018, Hastings et al. 2020). Therefore, NMFS proposes recommended specific measures for all areas occupied by western DPS animals, both east and west of 144° W, except for airborne acoustic impulsive explosives, which are proposed only for deterring Steller sea lions east of 144° W longitude and north of 55°49'22.00" N latitude.

Mysticetes

In general, all deterrents included in the guidelines for non-ESA-listed mysticetes are considered recommended" specific measures" for deterring ESA-listed large whales (i.e., blue, bowhead, fin, humpback, right, and sei whales); see Table 7.

Odontocetes

There are four ESA-listed odontocetes: (1) beluga whales, Cook Inlet (CI) DPS, (2) false killer whales (FKW), insular Hawaiian Islands DPS, (3) killer whales, Southern resident (SRKW) DPS, and (4) sperm whales; recommended specific measures for each species are noted in Table 7.

Table 7. Recommended specific measures for deterring ESA-listed marine mammals under the Preferred Alternative. Cells with check marks indicate the specific measure is recommended for that taxa or species; blank cells indicate those deterrents are not included as recommended specific measures.

	ESA-listed Mysticetes	**ESA-listed Odontocetes**				**ESA-listed Pinnipeds**		
Non-Acoustic Deterrents	**All Species**	**CI Beluga**	**Insular FKW**	**SRKW**	**Sperm whales**	**HMS**	**WSSL**	**All others**
VISUAL								
Air dancers, flags, pinwheels, streamers						✓	✓	✓
Bubble curtains	✓	✓	✓	✓	✓	✓	✓	✓
Flashing or strobe lights	✓	✓	✓	✓	✓	✓	✓	✓
Human attendants								
Predator shapes	✓	✓	✓	✓	✓	✓	✓	✓
Vessel patrolling	✓	✓	✓	✓	✓	✓	✓	✓
Unmanned aircraft systems	✓	✓	✓	✓	✓	✓	✓	✓
PHYSICAL BARRIERS								
Rigid fencing in air						✓	✓	✓
Horizontal bars/bull rails						✓	✓	✓
Gates/closely spaced bars						✓	✓	✓
Containment booms/waterway barriers	✓			✓	✓	✓	✓	✓

Swim step protectors						✓	✓	✓
TACTILE								
PROJECTILE: Paintballs and sponge grenades used with air rifle or hand held launcher						✓	✓	✓
PROJECTILE: Foam missiles/rounds with toy guns	✓			✓	✓	✓	✓	✓
PROJECTILE: Blunt objects with slingshot							✓	✓
MANUAL: Crowder boards, blunt-tipped poles, brooms, mop handles, etc.	✓		✓		✓	✓	✓	✓
ELECTRICAL: Electric fencing in air						✓	✓	✓
ELECTRICAL: Electrical mats						✓	✓	✓
WATER: Hose, sprinkler, water gun	✓	✓	✓	✓	✓	✓	✓	✓
	ESA-listed Mysticetes	**ESA-listed Odontocetes**				**ESA-listed Pinnipeds**		
Acoustic Deterrents	**All Species**	**CI Beluga**	**Insular FKW**	**SRKW**	**Sperm whales**	**HMS**	**WSSL**	**All others**
IMPULSIVE								
EXPLOSIVE: Aerial pyrotechnics/fireworks; bird bangers; bird whistler/screamers; bear bangers used with pencil launchers							✓	✓
EXPLOSIVE: Propane cannons							✓	✓

EXPLOSIVE: Explosive pest control devices (i.e., seal bombs, cracker shells, bird bombs, underwater firecrackers)								✓
NON-EXPLOSIVE: Low-frequency, broadband devices						✓	✓	✓
NON-EXPLOSIVE: Pulsed power devices						✓	✓	✓
NON-EXPLOSIVE: Banging objects underwater	✓			✓	✓	✓	✓	✓
NON-EXPLOSIVE: Banging objects in-air/passive acoustic deterrents						✓	✓	✓
NON-IMPULSIVE								
Underwater devices <170dB including acoustic alarms (i.e., pingers, transducers)	✓			✓		✓	✓	✓
Air horns, in-air noisemakers, sirens, whistles						✓	✓	✓
Predator sounds/alarm vocalizations using underwater speakers	✓			✓	✓	✓	✓	✓

List of Abbreviations in Table 7: CI – Cook Inlet; FKW – false killer whale; HMS – Hawaiian monk seal; SRKW – Southern Resident killer whale; WSSL – Western Steller sea lion.

2.3.2.3 Prohibitions

Under the preferred alternative, NMFS would prohibit deterrents that result in high adverse effects. The following table identifies proposed general prohibitions for all taxa as well as prohibitions specific to each taxa.

Table 8 Deterrents prohibited under the Preferred Alternative.

GENERAL PROHIBITIONS

- Targeting a deterrent action at a marine mammal calf or pup
- Striking a marine mammal's head or blowhole when attempting to deter a marine mammal
- Deploying or attempting to deploy a deterrent into the middle of a group of marine mammals
- Feeding or attempting to feed a marine mammal in a manner prohibited by 50 CFR 226.3 even for the purposes of deterrence
- Deterring or attempting to deter any marine mammal demonstrating signs of aggression, including charging or lunging, except when necessary to deter a marine mammal from endangering personal safety
- Approaching certain ESA-listed marine mammals, including humpback whales in Alaska, North Atlantic right whales, western Steller sea lions, and killer whales in Washington, pursuant to 50 CFR 223.214 and 224.103

	Mysticetes	**Odontocetes**	**Pinnipeds**
Non-Acoustic Deterrents	Vessel chasing	Vessel chasing	Patrol animals
	Using any chemical irritants, corrosive chemicals, and other taste deterrents to deter marine mammals	Using any chemical irritants, corrosive chemicals, and other taste deterrents to deter marine mammals	Vessel chasing
	Using a firearm, bow, or spear gun for deterring mysticetes	Using a firearm, bow, or spear gun for deterring odontocetes	Using any chemical irritants, corrosive chemicals, and other taste deterrents to deter marine mammals

	Mysticetes	Odontocetes	Pinnipeds
	Sharp objects	Sharp objects	Using a firearm, except for bird bombs and cracker shells
			Discharging a firearm at or within 100 yards (91.4 m) of a Steller sea lion west of 144° W longitude
			Sharp objects
Acoustic Deterrents	**Any impulsive explosives**	**Any impulsive explosives**	**Any impulsive explosives** not included in the guidelines or recommended specific measures
	Any non-impulsive device with an underwater source level ≥170 dB RMS, unless that device has been evaluated and meets criterion by NMFS or via the NMFS Acoustic Deterrent Web Tool	**Any non-impulsive device** with an underwater source level ≥170 dB RMS, unless that device has been evaluated and meets criterion by NMFS or via the NMFS Acoustic Deterrent Web Tool	**Seal bombs, underwater cracker shells, banging objects underwater, pulsed power devices, or low frequency broadband devices** when visibility is <100m (e.g., at night, fog)
			Any non-impulsive device with an underwater source level ≥170 dB RMS, unless that device has been evaluated and meets criterion by NMFS or via the NMFS Acoustic Deterrent Web Tool

2.3.2.4 Incidental Mortality and Injury Reporting Requirement

If a marine mammal is observed injured or killed during or as a result of using a deterrent included in the guidelines or recommended specific measures, that injury or death must be reported to NMFS within 48 hours in order for the protection from liability in section 101(a)(4)(B) to apply. If finalized, NMFS intends that, for commercial fishing vessel owners and operators, reporting requirements for deterrent-related mortality and injury of marine mammals will be integrated with existing reporting requirements under MMPA Section 118(e). Specifically, NMFS would seek to revise the existing form (Office of Management and Budget (OMB) number 0648-0292) to request additional information regarding deterrent use during the next update per the collection of information requirements of the Paperwork Reduction Act. Reporting requirements are applicable to all vessel owners and operators regardless of commercial fishery category on the MMPA List of Fisheries (i.e., Category I, Category II, or Category III[6]).

For the purposes of this EA, we considered the commercial fisheries as classified on the MMPA List of Fisheries (LOF). As required by the MMPA, NMFS annually publishes an LOF that classifies each commercial fishery into one of three categories based upon the level of mortality and serious injury of marine mammals that occurs incidental to fishing operations. The LOF is published annually in the *Federal Register* and is available on NMFS's website. For more information on how commercial fisheries are classified, see List of Fisheries website. NMFS uses the LOF to prioritize management actions, such as observing fisheries, convening take reduction teams, and implementing plans to reduce mortality and serious injury of marine mammals in commercial fisheries.

For anyone other than a commercial fisherman, when reporting a mortality or injury the following information will be required:

1. The name and address of the person deterring the marine mammal(s);
2. The vessel name, and Federal, state, or tribal registration numbers of the registered vessel and/or the saltwater angler registration number if deterrence occurred during fishing;
3. A description of the fishery, including gear type and target, or of the property where the deterrence occurred;
4. A description of the deterrent including number of attempts/deployments, specifications of devices, and any other relevant characteristics;
5. The species and number of each marine mammal incidentally killed or injured or a description (and/or photograph or video if available) of the animal(s) killed or injured if the species is unknown;
6. The disposition of the animal (*e.g.*, injured or dead, type of wounds);

[6] Category I, II, and III fisheries are included in the most recent MMPA List of Fisheries available at MMPA List of Fisheries

7. The date, time, and approximate geographic location where the mortality or injury occurred; and
8. Other relevant information such as the behavior of the animal in response to the deterrent, other protected species in the vicinity, etc.

2.4 Alternatives Considered, but Eliminated from Further Consideration

NMFS often considers a number of alternatives for a particular need. Some of these alternatives could be considered reasonable while others are unlikely to meet the purpose and need of the action. Alternatives rejected for further analysis include only those that are not required to evaluate alternatives beyond the reasonable range. If alternatives are eliminated from further analysis, the EA should briefly discuss the reasons for their elimination (40 CFR 1502.14(a)). Several alternatives were suggested in public comments and during internal scoping that did not meet all or most of the selection criteria or meet NMFS's regulatory mandate. For example, some of the alternatives have limited scientific support to demonstrate that they would result in mortality or serious injury in target or non-target marine mammals and others would have substantial economic impacts. Additional alternatives would not be feasible to administer or would be met with substantial enforcement obstacles to overcome. Additional alternatives that were considered but not further analyzed in this environmental assessment are described below. Alternatives not further analyzed could be considered alone or in combination with one another.

2.4.1 Issue Guidelines, Recommended Specific Measures, and Prohibitions for a Subset of Marine Mammals

Under this alternative, NMFS would issue guidelines, recommended specific measures, and prohibitions for some marine mammal species. This alternative would not meet the purpose and need of the proposed action to reduce damage to fishing gear and private property and would not adhere to the MMPA mandate. Section 101(a)(4)(D) states that authority to deter marine mammals applies to all marine mammals. NMFS needs to develop guidelines for non-listed marine mammals as well as recommended specific measures for ESA-listed marine mammals.

An example that precluded this approach is aggressive underwater interactions between Hawaiian monk seals, an endangered pinniped, and people. NMFS has received multiple reports of aggressive behavior by Hawaiian monk seals in the course of freediving and spearfishing (Hawaiian Monk Seal Research Program unpublished data). In such situations, members of the public need recommended specific measures for deterring the ESA-listed seal in a manner that both preserves human safety and ensures the seal is not killed or seriously injured. Recommended specific measures included in the Preferred Alternative would provide options to ensure personal safety, such as by allowing the use of the blunt end (i.e., handle/handgrip) of a speargun to deter the seal with a forward motion, ensuring that no physical contact is aimed at the animal's head. The prohibitions would also protect the seal by prohibiting the use of the sharp, penetrating end of the speargun and by ensuring the use of the blunt end is as least likely to cause injury as possible.

Additional complications are presented under this alternative as it requires the deterrent user to differentiate similar marine mammal species. This could be a potentially challenging task in a number of situations. It is extremely challenging to predict exactly which stocks and species will be in the area when a device is used and, therefore, impacts to all marine mammals should be evaluated.

2.4.2 Issue Guidelines, Recommended Specific Measures, and Prohibitions for a Subset of Deterrents

Under this alternative, NMFS would issue guidelines, recommended specific measures, and prohibitions for some deterrent devices and techniques, specifically non-acoustic devices. This alternative would provide some tools to fishermen and property owners, but there are many situations in which acoustic devices may be more practical than non-acoustic. As an example, a fisherman would have to remain onsite to use vessel patrolling as a deterrent and that is not feasible for fisheries where the gear soaks for many hours or days. Additionally, we have ample evidence that fishermen and property owners are currently using acoustic devices, possibly in ways that adversely affect marine mammals. If we do not issue guidelines and recommended specific measures and the minimum distances for acoustic deterrents, then it is possible and even likely that some of these devices could result in permanent hearing loss as well as other sublethal impacts.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

NMFS reviewed all possible environmental, cultural, historical, social, and economic resources based on the geographic location associated with NMFS' proposed action and alternatives for issuing guidelines for deterring marine mammals. Based on this review, this chapter describes the affected environment and existing (baseline) conditions for select resource categories. As explained in Chapter 1, certain resource categories are not affected by NMFS' proposed action and these were not carried forward for further consideration or evaluation in this EA. Chapter 4 provides an analysis and description of environmental impacts associated with the proposed action and alternatives and the select resource categories described herein.

3.1 Biological Environment

This section focuses on describing the marine mammals that may occur within any of the areas defined in Section 3.1.1 and provides baseline information for the marine mammal species important to the analysis of impacts in Chapter 4. Impacts to other species that may be in the area at the time a deterrent is used are expected to be insignificant given that impacts to marine mammals are being avoided or mitigated, and as such, these other species are not detailed here. Nonetheless, indirect impacts to these non-target species are considered in Chapter 4. A summary of the marine mammal species and stocks that may be commonly deterred is provided in Section 3.1.1. The information is mainly drawn from NMFS Stock Assessment Reports

(SARs), ESA Recovery Plans, and other NMFS publications. The SARs and ESA recovery plans can be accessed online at the following websites:

- NMFS Stock Assessment Reports
- ESA Recovery Plans

3.1.1 Marine Mammals

Marine mammals addressed within this EA include NMFS-managed species within three taxa: pinnipeds (seals and sea lions), odontocetes (toothed whales), and mysticetes (baleen whales). They are listed in the tables below. For most of these species, NMFS has identified more than one stock in waters under U.S. jurisdiction. A stock is a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature. NMFS prepares SARs in consultation with one or more of three regional Scientific Review Groups, and makes them available for public review and comment. For each marine mammal stock that may be subject to intentional or incidental harassment by deterrents assessed in this EA, current and historical SARs are available on the NMFS website (NMFS Stock Assessment Reports).

Table 9 Marine mammal species encountered in the U.S. Pacific Ocean Region – includes Hawaii and U.S. Territories in the Pacific Islands.

Common Name	Scientific Name
PINNIPEDS	
California sea lion	*Zalophus californianus*
Guadalupe fur seal	*Arctocephalus townsendi*
Harbor seal	*Phoca vitulina richardsii*
Hawaiian monk seal	*Neomonachus schauinslandi*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursiuns*
Steller sea lion	*Eumetopias jubatus*
ODONTOCETES	
Beaked whales	
• Baird's beaked whale	*Berardius bairdii*
• Blainville's beaked whale	*Mesoplodon densirostris*
• Cuvier's beaked whale	*Ziphius cavirostris*
• Deraniyagala's beaked whale	*Mesoplodon hotaula*
• Longman's beaked whale	*Indopacentus pacificus*
• Lesser beaked whale	*Mesoplodon peruvianus*
• Perrin's beaked whale	*Mesoplodon perrini*
• Stejneger's beaked whale	*Mesoplodon stejnegeri*
• Gingko-toothed beaked whale	*Mesoplodon gingkodens*
• Hubbs' beaked whale	*Mesoplodon carlhubbsi*
Bottlenose dolphin	*Tursiops truncatus*
Dall's porpoise	*Phocoenoides dalli*

Common Name	Scientific Name
Dwarf sperm whale	*Kogia sima*
False killer whale	*Pseudorca crassidens*
Fraser’s dolphin	*Lagenorhynchus hosei*
Harbor porpoise	*Phocoena*
Killer whale	*Orcinus orca*
Long-beaked common dolphin	*Delphinus capensis*
Melon-headed whale	*Peponocephala electra*
Northern right whale dolphin	*Lissodelphis borealis*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Pantropical spotted dolphin	*Stenella attenuata*
Pygmy killer whale	*Feresa attenuata*
Pygmy sperm whale	*Kogia breviceps*
Risso’s dolphin	*Grampus grisues*
Rough-toothed dolphin	*Steno bredanensis*
Short-beaked common dolphin	*Delphinus delphis*
Short-finned pilot whale	*Globicephala macrorhynchus*
Sperm whale	*Physeter macrocephalus*
Spinner dolphin	*Stenella longirostris*
Striped dolphin	*Stenella coeruleoalba*
MYSTICETES	
Blue whale	*Balaenoptera musculus*
Bryde’s whale	*Balaenoptera edeni*
Fin whale	*Balaenoptera physalis*
Gray whale	*Eschrichtius robustus*
Humpback whale	*Megaptera novaeangliae*
Minke whale	*Balaenoptera acutorostrata*
North Pacific right whale	*Eubalaena japonica*
Sei whale	*Balaenoptera borealis*

Table 10 Marine mammal species encountered in the U.S. Atlantic Ocean Region – includes the Gulf of Mexico and U.S. Territories in the Caribbean.

Common Name	Scientific Name
PINNIPEDS	
Gray seal	*Halichoerus grypus*
Harbor seal	*Phoca vitulina richardsii*
Harp seal	*Pagophilus groenlandica*
Hooded seal	*Cystophora cristata*
ODONTOCETES	
Atlantic spotted dolphin	*Stenella frontalis*
Atlantic white-sided dolphin	*Lagenorhynchus acutus*
Beaked whales	
• Blainville’s beaked whale	*Mesoplodon densirostris*

Common Name	Scientific Name
• Cuvier's beaked whale	*Ziphius cavirostris*
• Gervais' beaked whale	*Mesoplodon europaeus*
• Sowerby's beaked whale	*Mesoplodon biden*
• True's beaked whale	*Mesoplodon mirus*
Bottlenose dolphin	*Tursiops truncatus*
Clymene dolphin	*Stenella clymene*
Dwarf sperm whale	*Kogia sima*
False killer whale	*Pseudorca crassidens*
Fraser's dolphin	*Lagenorhynchus hosei*
Harbor porpoise	*Phocoena*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Melon-headed whale	*Peponocephala electra*
Northern bottlenose whale	*Hyperodon ampullatus*
Pantropical spotted dolphin	*Stenella attenuata*
Pygmy killer whale	*Feresa attenuata*
Pygmy sperm whale	*Kogia breviceps*
Risso's dolphin	*Grampus grisues*
Rough-toothed dolphin	*Steno bredanensis*
Short-beaked common dolphin	*Delphinus delphis*
Short-finned pilot whale	*Globicephala macrorhynchus*
Sperm whale	*Physeter macrocephalus*
Spinner dolphin	*Stenella longirostris*
Striped dolphin	*Stenella coeruleoalba*
White-beaked dolphin	*Lagenorhynchus albirostris*
MYSTICETES	
Blue whale	*Balaenoptera musculus*
Bryde's whale	*Balaenoptera edeni*
Fin whale	*Balaenoptera physalis*
Humpback whale	*Megaptera novaeangliae*
Minke whale	*Balaenoptera acutorostrata*
North Atlantic right whale	*Eubalaena glacialis*
Sei whale	*Balaenoptera borealis*

Table 11 Marine mammal species encountered in the Alaska Region

Common Name	Scientific Name
PINNIPEDS	
Bearded seal	*Erignathus barbatus nauticus*
California sea lion	*Zalophus californianus*
Harbor seal	*Phoca vitulina richardsii*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursiuns*

Common Name	Scientific Name
Ribbon seal	*Histriophoca fasciata*
Ringed seal	*Phoca hispida*
Spotted seal	*Phoca largha*
Steller sea lion	*Eumetopias jubatus*
ODONTOCETES	
Beaked whales	
• Baird’s beaked whale	*Berardius bairdii*
• Cuvier’s beaked whale	*Ziphius cavirostris*
• Stejneger’s beaked whale	*Mesoplodon stejnegeri*
Beluga whale	*Delphinopterus leucas*
Dall’s porpoise	*Phocoenoides dalli*
Harbor porpoise	*Phocoena*
Killer whale	*Orcinus orca*
Narwhal	*Monodon monocerus*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Sperm whale	*Physeter macrocephalus*
MYSTICETES	
Blue whale	*Balaenoptera musculus*
Bowhead whale	*Balaena mysticetes*
Fin whale	*Balaenoptera physalis*
Gray whale	*Eschrichtius robustus*
Humpback whale	*Megaptera novaeangliae*
Minke whale	*Balaenoptera acutorostrata*
North Pacific right whale	*Eubalaena japonica*
Sei whale	*Balaenoptera borealis*

In evaluating impacts from acoustic deterrents, we assessed impacts to marine mammals based on five described marine mammal hearing groups (Southall et al. 2007; DoN 2017; NMFS 2018) listed in Table 12.

Table 12 Marine mammal hearing groups (based on NMFS 2018).

Hearing Group	Species	Generalized Hearing Range
Low-frequency (LF) cetaceans	Baleen whales	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans	Dolphins, beaked whales, and other non-porpoise toothed whales	150 Hz to 160 kHz
High-frequency (HF) cetaceans	Dall's and harbor porpoise; pygmy and dwarf sperm whales	275 Hz to 160 kHz
Phocid pinnipeds	True seals	50 Hz to 86 kHz (underwater) 75 Hz to 30 kHz (in air)
Otariid pinnipeds	Sea lions and fur seals	60 Hz to 39 kHz (underwater) 75 Hz to 30 kHz (in air)

3.1.2 Marine mammals listed as threatened or endangered

The guidelines analyzed for this EA apply generally to all marine mammal species irrespective of ESA listing status, with some exceptions such as western DPS Steller sea lions, Hawaiian monk seals, and a few species of odontocetes. Recommend specific measures for ESA-listed marine mammal species (including DPSs) are also evaluated in this EA. Table 13 lists the marine mammal species that may occur in waters under U.S. jurisdiction and are listed as endangered or threatened under the ESA.

Table 13 ESA-listed marine mammal species and DPSs in waters under U.S. jurisdiction

Common Name	ESA Status
PINNIPEDS	
Bearded seal Beringia DPS	Threatened
Guadalupe fur seal	Threatened
Hawaiian monk seal	Endangered
Ringed seal Arctic subspecies	Threatened
Steller sea lion Western DPS	Endangered
ODONTOCETES	
Beluga whale Cook Inlet DPS	Endangered
False killer whale Main Hawaiian Islands Insular DPS	Endangered
Killer whale Southern Resident DPS	Endangered
Sperm whale	Endangered
MYSTICETES	
Blue whale	Endangered
Bowhead whale	Endangered
Bryde's whale Gulf of Mexico subspecies	Endangered
Fin whale	Endangered
Gray whale Western North Pacific DPS	Endangered
Humpback whale • Mexico DPS	 Threatened

Common Name	ESA Status
• Central America DPS • Western North Pacific DPS	Endangered Endangered
North Atlantic right whale	Endangered
North Pacific right whale	Endangered
Sei whale	Endangered

4 ENVIRONMENTAL CONSEQUENCES

NMFS reviewed all possible direct, indirect, cumulative, short-term, and long-term impacts to marine mammals and the human environment associated with NMFS Preferred Alternative and the No Action Alternative.

Table 14 Comparison of Alternatives Magnitude of Impact on the Human Environment

Resource	**Alternative 1 (No Action)**	**Alternative 2 (*Preferred Alternative*)**
Biological	- Adverse, moderate effects to individual marine mammals such as death, serious injury, or permanent hearing loss from using deterrents that would be prohibited under Alternative 2 (i.e., vessel chasing, patrol animals, chemosensory deterrents, manual sharp objects, tactile projectiles used with a firearm, non-impulsive acoustic deterrents ≥ 170dB RMS). -Increased marine mammal depredation/bycatch and associated death and serious injury if fishermen do not attempt deterrence because guidelines and recommended specific measures are not available and instead rely on intentional killing. - Moderate direct effects overall as individuals may be killed or seriously injured but likely not at levels high enough to cause a population impact. - For other marine mammals outside NMFS jurisdiction, the direct and indirect effects of Alternative 1 would be the same as for other marine mammals, adverse, moderate effects to individuals if prohibitions were not in place. - For seabirds and sea turtles, the direct and indirect effects of Alternative 1 would be no effect. For invertebrates and fish, the direct effects of Alternative 1 could be an adverse moderate effect if acoustic deterrents ≥170dB are not prohibited.	-Beneficial, moderate direct effects to marine mammals because risk of death or serious injury from bycatch could be lower during depredation attempts or could negate other sublethal effects from disruption in normal behavior (e.g., marine mammals becoming dependent on humans for food). -The *Preferred Alternative* further reduces risk of mortality and serious injury when compared to the No Action alternative by requiring that certain best practices accompany the use of deterrents mentioned in guidelines and recommended measures. The guidelines and recommended specific measures would have no effect to moderate effects on the biological environment. - For non-acoustic deterrents, the *Preferred Alternative* would have direct and indirect impacts ranging from no effect to minor or moderate adverse effects. Direct negative effects include bruising, startle responses, or changes in behavior. Most indirect negative effects are related to energetic costs of displacement, particularly for pinnipeds. -Prohibiting certain deterrents determined to have a high adverse effect on marine mammals will result in fewer marine mammals killed, seriously injured, or with permanent hearing loss as a result of prohibited non-acoustic deterrents thereby resulting in a positive benefit for the biological environment. - For other marine mammals outside NMFS jurisdiction, the direct and indirect effects of the *Preferred Alternative* would be the same as for other marine mammals. - For seabirds, sea turtles and invertebrates, the direct and indirect effects of *Preferred Alternative* are no effect to beneficial effects. Seabirds and sea turtles are considered less susceptible to noise-induced hearing loss compared to marine mammals. And by prohibiting acoustic deterrents ≥170dB, direct effects on invertebrates would be positive. -For fish, hearing thresholds are comparable or higher than for marine mammals, so direct effects would be the same or less than that described for marine mammals.

4.1 Analytical Approach and Methodology

The following analyses address the biological environment identified as potentially impacted by the alternatives. The analyses describe expected conditions under the various alternatives when compared to the existing conditions in Section 3, Description of the Affected Environment. Resource impacts are summarized in Table 14. Impacts from certain deterrent devices or techniques have been avoided or reduced to a permissible level by developing taxa-specific guidelines.

The terms "effect" and "impact" are used synonymously under NEPA; consequently both terms may be used interchangeably in the following analyses. Direct effects are caused by the action itself and occur at the same time and place. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Cumulative impacts are those impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative effects are analyzed in Section 4.4.

The impact assessment methodology consists of the following steps:

1. Review and understand the proposed action and alternative
2. Identify and describe:
    a. Direct effects that would be "caused by the action and occur at the same time and place" (40 CFR § 1508.8(a)), and
    b. Indirect effects that would be "caused by the action and would occur later in time or further removed in distance, but are still reasonably foreseeable" (40 CFR § 1508.8(b)).
3. Compare the impacts to the baseline conditions described in Chapter 3 and characterize as major, moderate, or minor.

As described in Section 1.5, the purpose of an EA is to determine whether significant environmental impacts could result from a proposed action. If significant impacts are expected, an Environmental Impact Statement would be developed. If no significant impacts are expected, NMFS can document the decision on the proposed action with a Finding of No Significant Impact.

It is critical that the terminology used to describe potential impacts be clear and easily understood. Terminology such as major, moderate, and minor are subjective in nature and the meaning of the terms differs depending on the context in which they are used and the perspective of the reader. To this end, definitions for the qualitative ranking of potential impacts are provided in this EA.

Effects of alternatives were designated as having minor, moderate or major impacts. We considered both lengths of time and severity of the impact in the following terms.

Major impact: An impact is rated major if, due to its intensity (severity) and context (geography), it has the potential to result in a substantial number of marine mammals killed, seriously injured, and/or with permanent hearing loss across the majority of a particular stock's range.

Moderate impact: An impact is rated moderate if it is less than major, may have longer-term adverse or beneficial effects, and is perceptible and, typically, more amenable to quantification or measurement.

Minor impact: An impact is rated minor if it might be perceptible but is not amenable to measurement because of its relatively minor character; minor impacts are short-term and reversible.

We evaluated each alternative according to these terms in a broad sense, but also specifically considered the impacts of each individual deterrent included in the guidelines, recommended specific measures, and prohibitions. We considered the following during the selection process:

- Intended species to be deterred by a particular device or technique.
- Availability of information for deterrents, including all available manufacturer specifications, photographs, graphics, reports, literature, and data from any field trials or pilot studies.
- Any other information relative to the potential risk that a specific deterrent may pose in causing mortality or serious injury.
- Species-specific responses to various deterrents.
- Whether an acoustic deterrent is likely to result in onset of permanent threshold shift (PTS) within 100 m over the course of one hour for each of the five marine mammal functional hearing groups.
- The manner in which the deterrent is typically deployed and whether changing the manner in which the deterrent is used could reduce risk of mortality or serious injury.
- Whether a deterrent is likely to have a high adverse effect on marine mammals.
- Potential effects on other aspects of the human environment, including other protected species.

In general there is a lack of information on the impacts of deterrents on marine mammals. Therefore, we conducted a thorough literature review to support our analysis and considered a synthesis of opinions based on research, case studies, and professional judgement from a diverse group of experts in marine mammal biology and ecology, veterinarians, and others who have firsthand knowledge of deploying deterrents or evaluating injuries of stranded marine mammals (Long et al. 2015).

4.1.1 Non-acoustic Deterrents Impact Assessment Methodology

We evaluated non-acoustic deterrents summarized in Table 1 (visual, physical barriers, chemosensory, and tactile) for potential impacts on marine mammals based on the likelihood that a deterrent would impact a marine mammal and the potential severity of that impact. If an adverse impact was likely, for each taxa we considered the potential severity of the impact. Severity was assessed as lethal (mortality or serious injury) or sub-lethal including whether the impact was primary (e.g., physical trauma, acoustic trauma, toxicity) or secondary (e.g., infection, chronic stress, displacement from important habitat, decreased fitness).

Deterrents not likely to result in mortality or serious injury were included in the guidelines or recommended specific measures with implementation requirements for using each deterrent. NMFS evaluated whether a potential injury would be serious according to the NMFS Policy for Distinguishing Serious from Non-Serious Injury of Marine Mammals (77 FR 3233; January 23, 2012).

4.1.2 Acoustic Deterrents Impact Assessment Methodology

In analyzing impacts of the acoustic deterrents listed in Appendix B, we considered each deterrent's potential to cause acoustic injury (i.e., PTS) as well as direct physical, non-acoustic injury to the lungs and GI tract associated with underwater explosives. Quantitative mortality criteria (severe lung injury) resulting from exposure to sound are only available for underwater explosives. PTS onset, slight lung injury, and GI tract injury are considered Level A injuries under the MMPA and are used to evaluate impacts in this EA. Marine mammals were evaluated by hearing group as noted in Table 12. (NMFS 2018).

The potential for acoustic deterrents to cause acoustic injury was evaluated based upon marine mammal hearing group (Table 12) using the PTS onset thresholds in NMFS' Technical Guidance (NMFS 2018; Table 15). To account for incidental exposure of non-targeted marine mammal species, NMFS analyzed all acoustic deterrents for potential acoustic injury impacts to every marine mammal hearing group, whether the hearing group included targeted or non-targeted marine mammals. Thus, specifications were evaluated in consideration of the most susceptible hearing group.

Table 15. PTS onset criteria used to assess acoustic deterrents

Hearing Group*	**Impulsive**	**Non-Impulsive**
UNDERWATER*		
Low-Frequency (LF) Cetaceans	219 dB PK 183 dB SEL_{cum}	199 dB SEL_{cum}
Mid-Frequency (MF) Cetaceans	230 dB PK	198 dB SEL_{cum}

Hearing Group*	Impulsive	Non-Impulsive
	185 dB SEL_{cum}	
High-Frequency (HF) Cetaceans	202 dB PK 155 dB SEL_{cum}	173 dB SEL_{cum}
Phocid Pinnipeds (PW)	218 dB PK 185 dB SEL_{cum}	201 dB SEL_{cum}
Otariid Pinnipeds (OW)	232 dB PK 203 dB SEL_{cum}	219 dB SEL_{cum}
AIRBORNE*		
Phocid Pinnipeds (PA)	161 dB PK 138 dB SEL_{cum}	154 dB SEL_{cum}
Otariid Pinnipeds (OA)	176 dB PK 161 dB SEL_{cum}	177 dB SEL_{cum}

*Airborne thresholds are referenced to 20 micropascals, while underwater thresholds are referenced to 1 micropascal. Airborne thresholds are only available for pinnipeds and not available for cetaceans.

These thresholds were used to evaluate ~120 different acoustic deterrents for the potential for the devices to result in PTS at distances >100 m from the source after an hour of exposure (i.e., >100-m isopleth[7], 1-h; Figure 1).

[7] Isopleth is defined as a line drawn through all points having the same numerical value. In the case of sound, the line has equal sound pressure or exposure levels.

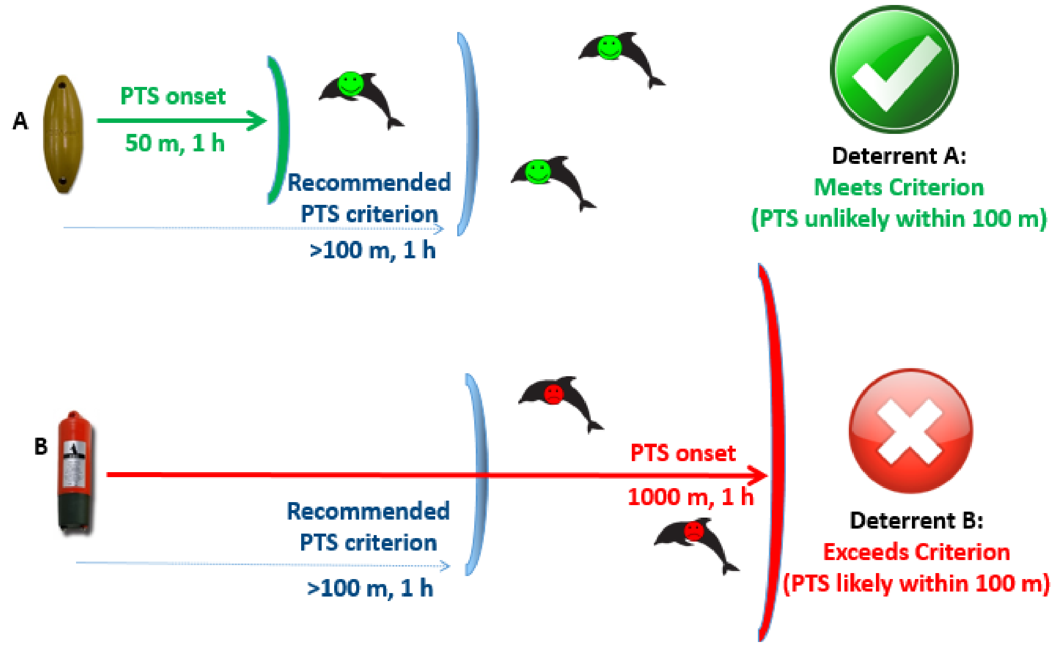

Figure 1 Example of two generic acoustic deterrents, where device A meets the >100-m, 1-h evaluation criterion (only produces a 50-m isopleth after 1-h) and where device B exceeds the >100-m, 1-h evaluation criterion (produces a 1000-m isopleth after 1-h).

We chose a 100-m isopleth for two reasons. First, 100 m is a minimum displacement distance for various devices and is a typical distance within which some of these devices are deployed from one another (reviewed in McGarry et al. 2020). Second, it represents a reasonable distance at which one can sight the most susceptible and difficult to sight marine mammal hearing group (HF cetaceans) with high probability using unaided vision. Of all the species Barlow et al. (2011) examined, harbor porpoises are likely the most difficult to detect based on the estimated effective strip width from vessel survey transect lines. As shown with the thresholds in Table 15 above, HF cetaceans, to which harbor porpoises belong, are the most susceptible hearing group to PTS. Thus, harbor porpoises are one of the most difficult to detect marine mammals and are the most susceptible to PTS. Based on Roberts et al. (2016), the probability of sighting harbor porpoises with unaided vision is high (i.e., detection probability ~ 1) out to around 100 m, after which sighting probability begins to steeply decline. Given this, we conservatively chose to use a 100-m isopleth as it provides reasonable assurance that an acoustic deterrent user would be able to sight the most susceptible and difficult to sight marine mammal species, and as such, all other less susceptible more easily sighted marine mammal species. This is consistent with a recent review of acoustic deterrents by McGarry et al. (2020), who determined a 100-m criterion was appropriate to evaluate deterrents for the likelihood of exposure resulting in PTS onset.

The 1-h exposure duration represents a reasonable maximum exposure duration expected for marine mammal mammals from a deterrent device within a 24-h period (e.g., exposure can be continuous or consist multiple shorter exposures throughout the day). NMFS's analysis used twice the duration used by McGarry et al. 2020 evaluation (i.e., 30-minutes) to account for the potential for multiple exposures to occur within a day. The PTS onset distances associated with the 1-h exposure duration represents the distance a mammal would have to remain at for an hour to experience potential PTS onset. If an animal occurs farther from the deterrent, PTS is unlikely to occur. If an animal is closer than 100-m, the likelihood of PTS would depend both on how close the animal gets to the deterrent and how long the animal remains within this isopleth.

All airborne acoustic deterrents were evaluated with respect to the same >100-m, 1-h evaluation criterion for PTS, but with respect to the airborne PTS onset thresholds identified in Table 15. Given that all impulsive devices airborne acoustic deterrents had RMS source levels below 142 dB (re 20 μPa) and all non-impulsive devices had RMS source levels below 158 dB (re 20 μPa), none of the airborne acoustic deterrents exceeded our criterion (Figure 2).

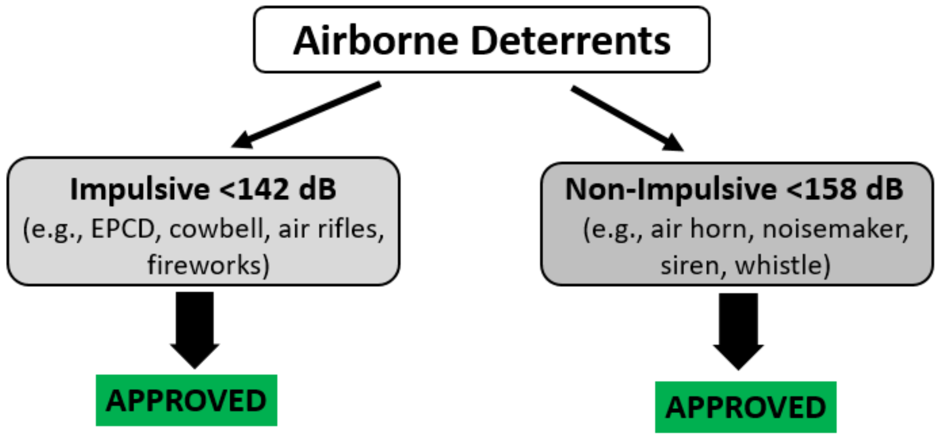

Figure 2 Airborne deterrent evaluation. Note: RMS source levels are referenced to 20 μPa.

For acoustic deterrents that involve the use of underwater explosives, NMFS also evaluated the potential for severe lung injury (mortality with the potential for serious injury), slight lung injury, and gastrointestinal tract injury (DoN 2017; Table 16).

Table 16 Underwater explosive criteria used to assess acoustic deterrents

Criteria	**Threshold**
Severe lung injury*	$144M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s (Pascal-seconds)
Slight lung injury*	$65.8M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s (Pascal-seconds)
GI tract injury	243 dB PK (peak sound pressure level)

*Susceptibility to lung injury from explosives is dependent on animal mass (M) in kilograms and animal depth (D) in meters.

Lung injury thresholds are dependent on animal mass (i.e., smaller mass individuals are more susceptible than those with higher mass; Table 17). For this analysis, we evaluated underwater explosive deterrents based on conservative assumptions: (1) that the animal was at the surface and (2) the smallest mass representative calf or pup in each hearing group was exposed (DoN 2017). Thus, when evaluating explosive deterrents, the criteria (lung, GI tract, or PTS onset) resulting in the largest isopleth was considered.

Table 17 Representative species calf/pup mass

Hearing Group	Representative Calf/Pup Species	Mass (kg)
Low-Frequency (LF) Cetaceans	Minke whale	200
Mid-Frequency (MF) Cetaceans	Striped dolphin	7
High-Frequency (HF) Cetaceans	Harbor porpoise	5
Phocid Pinnipeds (PW)	Harbor seal	8
Otariid Pinnipeds (OW)	Northern fur seal	12

For our analysis of impulsive, explosive acoustic deterrents, only seal bombs were evaluated, in terms of the potential for lung and GI tract injury, because these devices contain the largest net explosive weight (2.33 grams; i.e., all other underwater explosive devices NMFS evaluated would have smaller isopleths for lung and GI tract injury compared to seal bombs).

Acoustic devices were evaluated based on their specific acoustic characteristics, such as source level (underwater: dB re: 1 µPa at 1 m and airborne: dB re: 20 µPa at 1 m), frequency range (i.e., kilohertz, kHz), signal duration, and silent intervals between signals (inter-pulse interval or minimum silent interval between signals). To determine isopleths, practical geometric spreading (15 log R) was used to model transmission loss through the environment for all underwater sources, which aligns with McGarry et al.'s (2020) analysis, as well as modeling done by Lepper et al. (2014). The only exceptions were seal bombs and airborne devices, where it was considered more appropriate to rely upon spherical spreading (20 log R) (Attenborough 2014; Wiggins et al. 2019).

Some acoustic deterrents have specifications that can be manipulated or adjusted by the user. For example, a user can control the *distance* a deterrent is deployed from a marine mammal and/or the *time* (i.e., silent interval) between deployments. Additionally, deterrents may have multiple or programmable settings (e.g., duty cycle, silent interval between signals, and sound type/variety). For manually-deployed deterrents (e.g., hand held devices where the silent interval between signals can be controlled), we determined the minimum silent interval needed to meet the evaluation criterion for all marine mammal hearing groups. For programmable devices capable of producing output with a range of characteristics (e.g., adjustable source level or produced a broad range of frequencies), we evaluated the device by using the maximum potential value for each characteristic, recognizing that many combinations of specifications are possible, and determined the minimum silent interval needed to meet the evaluation criterion for all marine mammal hearing groups. This allowed us to evaluate the maximum potential impact of a given deterrent as well as how any deterrents *capable* of exceeding our criterion may be deployed in ways that are safe and within our criterion.

Results from all of the analyses of the acoustic deterrents (i.e., distances to thresholds) are presented in Section 4.3.1, and were used to inform the *Preferred Alternative* (i.e., minimum deployment distances as well as silent intervals for deterrents) in Section 2.3.2.

4.2 Direct and Indirect Effects of Alternative 1 (No Action)

This section presents an analysis of the potential direct and indirect effects of Alternative 1 (No Action) on the physical, biological, and socioeconomic environments. Under this alternative, NMFS would not develop guidelines for deterring marine mammals or recommended specific measures that may be used to deter safely ESA-listed marine mammals. Additionally, certain forms of deterrence that have a high adverse effect on marine mammals would not be prohibited.

The MMPA requires NMFS to establish guidelines for safely deterring marine mammals and recommended specific measures for ESA-listed marine mammals. For NMFS, Alternative 1 is inconsistent with our statutory obligation under the MMPA to prescribe guidelines and recommended specific measures for safely deterring marine mammals from damaging fishing gear/catch and property.

4.2.1 Biological Environment

Section 3.1.1 describes the marine mammals that are most likely to be deterred. This section describes the potential effects of deterrents on marine mammals under Alternative 1 (No Action). The potential effects of not implementing guidelines or recommended specific measures for nonlethally deterring marine mammals are driven primarily by a person's choice of deterrent and how that deterrent is deployed. If there are no guidelines or recommended specific measures directing deterrent use, people may use deterrents in ways that could result in high adverse effects such as mortality or serious injury to marine mammals and other protected species.

For situations where affected parties do not use deterrents due to the lack of guidelines, the potential adverse effects on marine mammals include:

- Intentional killing or seriously injuring marine mammals by shooting or other methods to decrease depredation and fishing gear/property damage;
- Increased mortality and serious injury of marine mammals in fishing gear as bycatch given depredation of bait or catch can lead to incidental capture; and
- Potential to slow recovery of marine mammal stocks.

Under the No-Action alternative, deterrents may be used without guidelines. The potential direct effects on marine mammals include increased mortality and serious injury as well as a permanent loss of hearing in all or part of an animal's hearing range (i.e., PTS) depending on which deterrent is used and how it is used. Potential indirect effects could include reduced recovery of stocks designated as depleted or ESA-listed marine mammals. The potential impacts of having no guidelines available for a subset of deterrents that are likely to kill, seriously injure, or results in PTS are described below.

Therefore, the *No Action* alternative would have moderate impacts to the biological environment, particularly to marine mammals. Because the No Action alternative means that NMFS would not issue guidelines, recommended specific measures, or prohibitions, some marine mammals could be killed, seriously injured, or experience PTS if deterrents are used that would otherwise be restricted or disallowed. Many of these deterrent devices and techniques have been in use for a long time and NMFS has evidence of mortality and serious injury through stranding records as previously noted. Those documented cases are amenable to quantification and in the case of serious injuries, we would expect the animal to have a greater than 50% chance of dying. This level of impact would not be significant because the number of documented killed or seriously injured animals is likely not substantial enough to cause population level impacts and negatively affect recovery.

Vessel chasing

Chasing marine mammals using a vessel could increase the risk of incidental vessel collisions that lead to death or serious injury or increase the risk of capture myopathy (exertional muscle damage) from extensive chasing.

Chemosensory

Feeding marine mammals is prohibited under MMPA regulations, but fishermen or property owners could use corrosive or chemical irritants to deter pinnipeds when in close proximity. Reactions to chemical irritants on the skin or eyes include: superficial reddening of skin, sloughing of dead skin, swelling, ulceration of the cornea, inflammation of the iris, an obvious swelling of the conjunctiva, partial eversion of the eyelids, or a diffuse crimson-red with individual vessels not easily discernable. Corrosive chemicals can pose direct health risks through all major routes of exposure and can cause immediate burns and damage that reduce the skin's ability to protect the body.

Tactile projectiles used with firearms

Ammunition used with rifles, shotguns, pistols, is by design intended to cause mortality and serious injury. Tissue and organ trauma result from the permanent wound cavity that occurs by direct impact of the bullet and also from radial expansion of the surrounding tissues. Sharp penetrating projectiles are likely to result in body cavity penetration or exposure. The NMFS Process for Injury Determinations (NMFS 2012b) includes several categories relevant to projectiles such as visible blood loss, body cavity penetration, and other body trauma that would classify these types of injuries as serious. Indirect effects of projectiles used with firearms (not including bird bombs and cracker shells), bows, and spear guns would occur if the body cavity is penetrated and exposure introduces bacteria into vital organs and the internal cavity and leads to infection. These secondary effects can lead to death or serious injury in an animal that is not immediately killed or seriously injured initially.

Manual, sharp objects

Arrows, darts, spears, nails, sharp rocks, and barbed wire have the potential to penetrate the skin and cause sharp force trauma that could lead to mortality or serious injury. Additionally, a pinniped encountering barbed wire could become trapped and eventually die if not found and rescued. There is a high likelihood of physical impacts severe enough to cause mortality or serious injury. Manual sharp penetrating objects have the potential to cause superficial and deep lacerations. Superficial lacerations do not penetrate deeper than the blubber layer and are considered non-serious injuries as they typically do not result in a decline in the health of the animal. Deep lacerations, however, pose substantial risk to an animal's health. Penetration of the body cavity, skeletal damage, or a deep wound that leads to substantial blood loss could result in death or serious injury. The NMFS Process for Injury Determinations (NMFS 2012b) includes several categories relevant to sharp objects such as visible blood loss, body cavity penetration, and other body trauma that would classify these types of injuries as serious. Indirect effects from infection of wounds could also occur.

Impulsive deterrents

In general, if impulsive explosive deterrents are deployed too close to an animal, blast injuries (e.g., ruptured eyeballs, lung and GI injury) could result in mortality or serious injury. Mortality and physical injuries associated with the use of seal bombs are predicted at close ranges (<4 m) (Myrick et al. 1990) and have been suspected in pinnipeds (Kerr and Scorse 2018).

Also, if deployed too close to an animal, PTS could occur, leaving the animal with permanent hearing loss. Simonis et al. (2020) used modeling to predict estimated ranges of impacts of seal bomb sound exposure on harbor porpoise in Monterey Bay, California. Seal bomb usage in this area can be as high as 355 detonations per day and can potentially result in noise-induced hearing loss (PTS/TTS), avoidance behavior, and/or reduced foraging. For animals exposed to multiple, repeated detonations (e.g., high use areas), potential cumulative effects from exposure could be a concern, especially for small, localized populations.

Non-impulsive acoustic deterrents

Depending on the source level (particularly those with RMS source levels >170 dB) and duty cycle, acoustic alarms and other non-impulsive acoustic deterrents could result in PTS, particularly for the most sensitive hearing group, high frequency cetaceans.

4.3 Direct and Indirect Effects of Alternative 2 (*Preferred Alternative*)

This section presents an analysis of the potential direct and indirect effects of Alternative 2 (*Preferred Alternative*) on the biological and economic environments. Under this alternative, NMFS would issue guidelines for safely deterring marine mammals, as well as recommended specific measures for deterring ESA-listed marine mammals.

4.3.1 Biological Environment

Section 3.1.1 describes the marine mammals that are most likely to be deterred. This section describes the potential effects of deterrents on marine mammals under Alternative 2 (*Preferred Alternative*).

Under the *Preferred Alternative*, NMFS would issue guidelines for safely deterring non-ESA marine mammals, recommended specific measures for deterring ESA-listed marine mammals, and prohibitions on deterrents determined to have a high adverse effect. Overall, this represents beneficial direct effects on marine mammals, particularly when compared to Alternative 1 (No action). Safely deterring marine mammals from fishing gear and catch is beneficial to marine mammals because such interactions could result in death or serious injury if bycatch occurs during depredation attempts or could result in other sublethal effects from disruption in normal behavior (e.g., marine mammals becoming dependent on humans for food). More broadly, by requiring that certain best practices accompany any deterrents guidelines and recommended specific measures, the *Preferred Alternative* further reduces risk of mortality and serious injury when compared to the No Action alternative. Also, prohibiting certain deterrents determined to have a high adverse effect on marine mammals will result in fewer marine mammals killed or seriously injured as a result of prohibited non-acoustic deterrents (e.g., corrosive chemicals, projectiles used with firearms, bows, spear guns, etc.) thereby resulting in a positive moderate benefit for the biological environment.

Acoustic Impacts

Marine mammals use sound via hearing and communication to perform vital life functions (NOAA 2016). Many marine mammals rely on sound for foraging, maintaining group cohesion, navigation, finding mates and avoiding predators. Hence, they may be affected by anthropogenic noise introduced into the marine environment. Sound (hearing and vocalization/echolocation) serves four primary functions for marine mammals, including: 1) providing information about their environment, 2) communication, 3) prey detection, and 4) predator detection. Introducing sound into their environment could disrupt those behaviors. The distance from the source at which anthropogenic sounds can be heard by marine mammals depends upon source level, frequency, ambient noise levels, the propagation characteristics of the environment, and sensitivity of the marine mammal (Richardson et al. 1995). Exposure to loud anthropogenic sounds may result in TTS or PTS depending upon the frequency and duration of the sound source as well as location of the marine mammal in relation to the source of the sound and the duration of exposure (NMFS 2018; Southall et al. 2019). PTS is a loss of hearing that is not fully regained or recovered to baseline levels. Hearing is fully regained in TTS cases. TTS in marine mammals may result in short-term inability to communicate, navigate, hunt, and hear predators (Kastak et al. 1999), all of which could have consequences for an individual's fitness.

Anthropogenic sounds may also cause masking, which is when a sound drowns out a softer sound or when the sound is at the same frequency as an important sound signal. Behavior and exposure levels (dose received) are also important considerations. Animals can become conditioned over time and can even be drawn to the sounds once they habituate to the lack of real danger or ignore it because they are motivated by the presence of a food source (Ellison et al. 2012).

The understanding of the effects of noise on marine mammal hearing has greatly advanced (e.g., Southall et al. 2007; Finneran 2015; Erbe et al. 2016; Southall et al. 2019) allowing for a more suitable determination of hearing thresholds using the current state of science.

For all acoustic deterrents, direct effects (i.e., behavioral and physiological) depend on a multitude of factors including hearing sensitivity, species-specific responses and behavioral context during exposure, motivation, proximity to the source, previous experience with the source or how novel it may be (Gilsdorf et al. 2003; van Marlen 2007; Ellison et al. 2012: Mackay and Knuckey 2013). Some species (i.e., beaked whales and harbor porpoises) have been identified as being particularly sensitive to sound sources in terms of consistent behavioral responses at a lower received level than other species (Southall et al. 2007; Carretta et al. 2008; Tyack et al. 2011). It remains unclear what factors make harbor porpoise particularly sensitive to sound exposure. Harbor porpoises and other HF cetaceans (e.g., Dall's porpoise) also have lower TTS and PTS onset thresholds (both for impulsive and non-impulsive sounds) compared to other marine mammal hearing groups (NMFS 2018; Southall et al. 2019). Thus, there is a higher likelihood of acoustic exposure eliciting TTS or PTS onset.

In general, acoustic impulsive sources have lower TTS onset thresholds compared to non-impulsive sources (NMFS 2018; Southall et al. 2019). Thus, there is a higher likelihood of exposure eliciting recoverable TTS, which would constitute a minor impact because it is short-term and reversible. Additionally, for explosive deterrents, smaller individuals (e.g., juveniles, calves, pups) and species are more susceptible to non-auditory injury from these devices compared to larger individuals or species (DoN 2017). We considered this in our evaluation and calculated minimum distances assuming the smallest animal was being deterred to mitigate these direct effects, therefore providing a substantial benefit over the No Action alternative.

Acoustic non-impulsive devices have less potential to cause acoustic injury compared to impulsive devices (NMFS 2018; Southall et al. 2019), due to differences in the nature of the sound produced, so any direct effects would be minor. Further, non-impulsive signals are not known to cause direct physical injury to the lungs and GI tract that can be associated with underwater explosives as noted above.

For all acoustic deterrents, the *Preferred Alternative* includes minimum distances, and for some, minimum silent intervals to ensure that any direct impacts of this alternative are minor. Additionally, when deploying acoustic deterrents, users in close proximity to each other and/or on the same vessel must coordinate deploying any acoustic deterrents that have a minimum silent interval to ensure compliance.

Potential indirect effects associated with repeated acoustic exposure include the potential of habituation, especially with resident populations exposed repeatedly (versus migratory populations) (Dawson et al. 1998). Additionally, there is the potential for these devices to act as unwanted attractors, such as the "dinner bell effect" (Mackay and Knuckey 2013). Excluding animals from important habitat is also a concern (Jefferson and Curry 1996; Kraus 1999; Culik et al. 2001; Petras 2003; Forney et al. 2017; van Beest et al. 2018), but it is likely these indirect effects are minor.

The *Preferred Alternative* prohibits acoustic deterrents that are likely to result in PTS for either the target or non-target marine mammals, thereby representing a substantial major benefit to the biological environment. Further, analysis of passive acoustic monitoring data have shown that up to 88 seal bomb deployments per hour in Monterey Bay, California (Simonis et al. 2020), and up to 550 per hour near Catalina Island in southern California (Meyer-Loebbecke et al. 2016). Thus, the *Preferred Alternative*, which allows a user to deploy a seal bomb only once every 3 minutes, will likely have the benefit of reducing overall seal bomb deployment, especially in high use areas. A visual scan in all directions for cetaceans and the prohibition on using seal bombs if cetaceans are sighted within 100 m will also provide moderate benefits over and above the *No Action Alternative*.

All marine mammals, as previously mentioned, rely upon sound as a means of performing essential life functions. Thus, non-targeted marine mammal species may experience similar consequences as targeted marine mammal species (e.g., masking, TTS/PTS, behavioral responses), if they become incidentally exposed to acoustic deterrents. To account for incidental exposure of non-targeted marine mammal species, NMFS analyzed acoustic deterrents for potential impacts to all marine mammal hearing groups and compared these to the evaluation criterion. Thus, minimum silent intervals and deployment distances were determined based upon the most susceptible marine mammal hearing group. Additionally, when analyzing underwater explosive deterrents, the smallest representative individual (calf/pup with smallest mass) for each hearing group was used to assess the potential for lung injury. Therefore, any indirect effects to non-targeted marine mammals would be minor.

Many acoustic deterrents that produce low frequency sounds to target pinniped's most susceptible hearing range (e.g., low frequency, broadband devices) may indirectly impact mysticetes, as these devices produce sounds that are also in this hearing group's suspected most susceptible hearing range. However, the direct effects of the preferred alternative range from no effect to minor because impacts would be short-term and recoverable.

Non-Acoustic Impacts

In general, the direct effects associated with non-acoustic deterrents range from no effect to moderate adverse effects on the biological environment. Visual deterrents largely have no direct impacts unless the deterrent itself poses an entanglement or entrapment risk, which is likely to be mitigated by best practices required in the *Preferred Alternative*. Additionally, some visual deterrents could flush pinnipeds from haulouts and result in indirect adverse effects of energetic costs associated with that displacement. Physical barriers simply exclude animals from an area and may cause indirect effects of energetic costs associated with that displacement. Tactile – electrical deterrents could have minor direct adverse effects for pinnipeds if systems are not safe for humans, but we would more likely expect indirect adverse effects associated with the energetic costs of displacement. Tactile – projectile deterrents would likely have no effect on mysticetes as foam projectiles are unlikely to be noticed given the large body size, while odontocetes may perceive foam projectiles, but with no lasting effects. Tactile – projectiles are likely to have a minor to moderate effects on pinnipeds given more types of projectiles are allowed for this taxa than cetaceans under the *Preferred Alternative*. Direct adverse effects are likely to include contusions. This would also be the case for manual, blunt objects. Water deterrents are unlikely to have any direct adverse effects on any of the three taxa, with slight potential for indirect adverse impacts of energetic costs related to displacement.

4.3.1.1 Guidelines and Recommended Specific Measures

In addition to comparing effects between the alternatives broadly, we have considered the potential impacts of each deterrent type for the marine mammal taxa that would likely be targeted by a given deterrent method or technology. It is important to note that few studies have systematically examined the effects of specific deterrents on marine mammals. Most studies involving marine mammals and nonlethal deterrents focus on efficacy of a deterrent method or technology rather than the impacts to animals targeted. Thus as noted previously we have used all available information, including stranding data, and professional judgement.

Non-Acoustic Deterrents

Visual

Air dancers, flags, pinwheels, and streamers

Pinnipeds: Potential direct effects of this category of deterrents on pinnipeds include entanglement risks from excess or unsecured streamers or flags. Concern with power supply to electric powered deterrents (e.g., air dancers) within this category pose a greater risk than the deterrent itself. All such effects can be properly mitigated through best practices. Indirect effects include energetic costs of displacement from haulout sites.

Bubble curtains:

All marine mammals: Bubble curtains have been used for excluding marine mammals from areas such as underwater construction sites with no documented adverse effects.

Flashing lights or strobe lights:

All marine mammals: Potential direct effects on are limited to impacts on vision or visual acuity due to light exposure. Effects would be unlikely if the intensity of light used does not exceed values deemed safe for normal human exposure.

Human attendants:

Pinnipeds: This deterrent is usually combined with a manually deployed tactile deterrent such as blunt objects (e.g., crowder board, brooms). Potential direct effects are limited to whether an animal comes into contact with a deterrent that could cause bruising or other soft tissue damage. Indirect effects likely include energetic costs of displacement from haulout sites.

Predator shapes:

All marine mammals: Potential direct effects of this category of deterrents on marine mammal species are limited to whether the animal comes into physical contact and sustains any soft tissue damage and whether the animal expends energy to flee.

Vessel patrolling:

All marine mammals: Vessel patrolling has the potential to affect directly marine mammals. The consistent and safe speed (i.e., in compliance with any and all applicable speed limitations (pursuant to 33 U.S.C. 1602)), and fixed direction of a patrolling vessel provides any marine mammal in the vicinity the opportunity to avoid direct interaction with the vessel as would be afforded in any other legal use of a watercraft.

Unmanned Aircraft System (UAS):

Pinnipeds: Potential direct effects of this category include animals being flushed from haulout sites, assuming the UAS is operated according to best practices so that there is no risk of the UAS coming into direct contact with an animal. Indirect effects likely include some energetic costs of displacement from haulout sites.

Mysticetes and Odontocetes: When UASs are flown over animals swimming under water, the air-water interface acts as a barrier to sound, so it is unlikely any direct effects would occur. While audiograms for several marine mammal species suggests that they may hear UASs in operation close to the surface of the water, the ambient noise often renders noise from the UAS inaudible (Christiansen et al. 2016).

Physical Barriers

Rigid fencing in air:

Pinnipeds: There are no potential direct effects of this category of deterrents on pinnipeds as animals are simply excluded from a structure. Indirect effects include some likely energetic costs of displacement from haulout sites.

Horizontal bars, bull rails, gates, and poles:

Pinnipeds: Potential direct effects of this category of deterrents on pinnipeds are minor. Design and installation of bull rails must be maintained in such a manner as to ensure the rails pose no risk of entrapment to target animals as they attempt to haul out and pass over or under the rails. Spacing between adjacent sections of rails could be designed to prevent entrapment. Indirect effects include some likely energetic costs of displacement from haulout sites.

Containment booms, waterway barriers, and log booms:

Pinnipeds: Design and installation of booms must be maintained in such a manner as to ensure the booms pose little to no risk of entrapment to target animals as they attempt to haul out or pass under the boom. Indirect effects include some likely energetic costs of displacement from haulout sites.

Mysticetes and Odontocetes: Design and installation of booms must be maintained in such a manner as to ensure the booms pose little to no risk of entrapment to target animals. Other direct effects of concern are entanglement risks from in-water lines. Such effects can be properly mitigated through best practices.

Swim step protectors:

Pinnipeds: There are no direct effects of this category of deterrents on pinnipeds given animals are simply prevented from occupying the swim step.

Tactile Deterrents

Electrical fencing in air:

Pinnipeds: The same potential effects for electrical fencing exist that do for rigid fencing as a physical barrier, described previously, with the additional effect of the electrical charge passing through the fencing. Electrical fencing in air would not pose additional risk to a pinniped if proper voltage accepted for livestock applications is followed and the power supply to the fencing is secured in such a manner as to not pose an additional electrocution risk to humans or target animals. Indirect effects include some likely energetic costs of displacement from haulout sites.

Electric mats:

Pinnipeds: Animals targeted in field trials of these devices responded to the deterrent stimulus and were observed swimming alongside the docks without physical harm or a loss of physical ability to both swim and haul out afterward. Given the low voltage, the electric stimulus is meant to create discomfort, not pain. Electric mats could pose an additional electrocution risk to humans or target animals because of improper voltage or unsecured power supply, though the mats we have analyzed have a failsafe to disable the system if the amperage becomes higher than 5 amps. Indirect effects include some likely energetic costs of displacement from haulout sites.

Projectiles – foam missiles/rounds, rocks, paintballs, sponge grenades

Pinnipeds: Potential direct effects of projectiles can be mitigated through best practices. Direct effects of non-penetrating objects are limited to contusions at the site of contact. Contusions, commonly referred to as bruises, are soft tissue injuries where underlying capillaries and venules are damaged by trauma. The localized trauma allows blood to leak into the surrounding interstitial tissues. Indirect effects are unlikely but could include small lacerations and associated infection.

Odontocetes: Potential direct effects can be mitigated through best practices. Direct effects of non-penetrating objects are limited to contusions at the site of contact. Indirect effects are unlikely but could include small lacerations and associated infection.

Mysticetes: Potential direct effects are unlikely given the disproportionately larger body size than the projectile.

Manual - blunt objects

All marine mammals: Potential direct effects could include soft tissue damage (e.g. bruising) depending on force used to push animal away.

Water deterrents

All marine mammals: Direct effects are unlikely to result from water deterrents, particularly when best practices are followed.

Acoustic

In Section 4.1.2, we discussed our analysis of acoustic deterrents in detail, specifically a means by which we calculated the distance (i.e., isopleth) from acoustic deterrents to various potential impacts including PTS, as well as direct physical, non-acoustic injury to the lungs and GI tract associated with underwater explosives. The maximum of these distances for any given impact, shown below in the tables that follow, informs our understanding of the effects of the various types of acoustic deterrents that would be authorized under the *Preferred Alternative* when used according to the guidelines, special measures, best practices, and following all prohibitions.

Table 18 Results of airborne deterrents used to deter pinnipeds analyzed that meet the acoustic evaluation criterion.

Deterrent	**Phocid PTS Isopleth Distance**	**Otariid PTS Isopleth Distance**
IMPULSIVE		
Aerial pyrotechnics/ fireworks	23 meters	2 meters
Paintballs used with paintball guns	14 meters	1 meter
Sponge grenades used with air gun	14 meters	1 meter
Banging objects (e.g., cowbell) in air/Passive acoustic deterrents	24 meters	2 meters
Bear bangers using pencil launcher	2 meters	1 meter
Bird Banger	23 meters	2 meters
Bird Bomb	8 meters	1 meter
Bird Whistler/Screamer	5 meters	1 meter
Cracker Shells	24 meters	2 meters
Propane cannon	2 meters	1 meter
NON-IMPULSIVE		
Air horn	4 meters	1 meter
In-air noise maker (e.g., vuvuzela)	5 meters	1 meter
Sirens	2 meters	1 meter
Whistles	3 meters	1 meter

Table 19 Results of underwater impulsive non-explosive deterrents analyzed that meet the acoustic evaluation criterion.

Deterrent	Minimum Silent Interval Between Signals	LF Cetacean PTS Isopleth Distance	MF Cetacean PTS Isopleth Distance	HF Cetacean PTS Isopleth Distance	Phocid PTS Isopleth Distance	Otariid PTS Isopleth Distance
Actix Pulsed Powered Sea Lion Deterrent Device	1200 seconds (20 minutes)	2 meters	1 meter	97 meters	1 meter	1 meter
HAI Aquaculture Predator Protection System (39 psi)	300 seconds	99 meters	1 meters	1 meter	5 meters	1 meter
HAI Aquaculture Predator Protection System (27 psi)	120 seconds	99 meters	1 meter	1 meter	5 meters	1 meter
HAI Aquaculture Predator Protection System (12 psi)	30 seconds	85 meters	1 meter	1 meter	4 meters	1 meter
Banging objects (e.g., Oikomi pipes)	18 seconds	11 meters	3 meters	100 meters	8 meters	1 meter

Table 20 Results for underwater explosives acoustic deterrents other than seal bombs analyzed that meet the acoustic evaluation criterion.

Device	Minimum Silent Interval Between Deployments	Phocids PTS Isopleth Distance	Otariids PTS Isopleth Distance
Cracker shell	320 seconds	3 meters	1 meter
Underwater firecracker	1 second	1 meter	1 meter

Table 21 Results for seal bomb acoustic deterrents analyzed that meet the acoustic evaluation criterion based on deployment of a seal bomb once every 3 minutes (180 seconds)

Hearing Group	**PTS Isopleth Distance (based on deployment once every 180 seconds)**
Low-frequency (LF) cetaceans	100 m
Mid-frequency (MF) cetaceans	2 m
High-frequency (HF) cetaceans	40 m
Phocid pinnipeds	20 m
Otariid pinnipeds	2 m

Impulsive

Aerial Pyrotechnics/Fireworks:

<u>Pinnipeds (on land or with head out of water)</u>: Direct effects include short-term startle responses, decreases in vocalizations, and localized behavioral changes, including temporary abandonment of habitat (Pedreros et al. 2016; NMFS 2017), which could lead to indirect effects associated with energetic costs of displacement from haulout sites.

Bird bangers, bird whistlers/screamers, bear bangers with pencil launchers, and propane cannons:

<u>Pinnipeds (on land or with head out of water)</u>: Only short-term startle responses and localized behavioral changes, including an escape response/avoidance would be expected based on results from other terrestrial species (Bishop et al. 2003; Gilsdorf et al. 2003). Indirect effects include energetic costs of displacement from haulout sites.

Explosives (i.e., bird bombs, cracker shells, seal bombs, underwater firecrackers):

<u>Pinnipeds</u>: Effects could include TTS, behavioral responses, and increased acute stress (Olesiuk et al. 2002). Behavioral response could include habituation or increased sensitivity depending on exposure history and frequency of exposure (Petras 2003).

Low frequency, broadband device:

<u>Pinnipeds</u>: Potential direct effects would primarily consist of short-term startle responses and localized behavioral changes, such as avoidance similar to airguns (Gordon et al. 2004). However, source levels associated with these devices are much lower than those associated with commercial seismic arrays, and these devices consist of a single source, rather than multiple sources within an array.

Pulsed Power Devices:

Pinnipeds: Temporary avoidance has been observed with use of similar devices in laboratory settings, with sometimes behavioral responses (e.g., avoidance of source) increasing in severity with repeated use for pinnipeds (Finneran et al. 2003).

Banging Objects Underwater (e.g., Oikomi pipes, banging pipes, striking metal hull):

All marine mammals: Short-term, localized behavioral responses could be expected (Akamatsu et al. 1993; Ziccardi et al. 2015).

Banging Objects In-air/Passive Acoustic Devices (in-air) (e.g., cowbells, hanging chains, suspended aluminum cans):

Pinnipeds: Short-term, localized behavioral responses could be expected (Akamatsu et al. 1993; Ziccardi et al. 2015).

Non-Impulsive

Underwater Acoustic Alarms < 170 dB:

All marine mammals: Effects include temporary avoidance (McGarry et al. 2020: Kindt-Larsen et al. 2019) and/or recoverable TTS (NMFS 2018; Southall et al. 2019). Startle responses, as demonstrated in laboratory and free-ranging pinnipeds, are possible if the sound is designed to harness an autonomous reflex (i.e., startle reflex) associated with flight behavior (Götz and Janik 2010, 2011; Schakner et al. 2017). Target specificity can be achieved by choosing a frequency band where hearing sensitivity in the target species is higher than in non-target species (Götz and Janik 2015, 2016). There is a wide range of commercially-available non-impulsive devices that are classified as pingers, each marketed toward a specific application or for deterring a specific target species. These devices differ substantially in their acoustic characteristics, such as frequency and amplitude. In general, the acoustic output from commercially available acoustic alarms do not produce signals with source levels expected to cause PTS (NMFS 2018; Southall et al. 2019).

In-air noisemakers:

Pinnipeds (on land or with head out of water): Potential effects of this category of deterrents include temporary avoidance or startle responses.

Predator Sounds or Alarm Vocalizations Using underwater speakers:

All marine mammals: These deterrents may cause startle responses and temporary avoidance of the area (Jefferson and Curry 1996). Increased heart rate in response to these types of sound has been recorded in terrestrial species (Gilsdorf et al. 2003). Predator sounds could interfere with the target animal's ability to respond appropriately to genuine predators; they may, for example, become habituated to predator calls and thus not show avoidance of actual predators. Indirect effects include habituation (Jefferson and Curry 1996), masking, and other effects on marine mammal behavior, such as attraction or aggressive behavior (Ziccardi et al. 2015). Reactions to predatory sounds will vary by species and depend on previous experience associated with this type of playback (e.g., fight or flight) (Ford et al. 2008) and can be highly variable (Gordon et al. 2019). Often responses associated with these sounds occur at low received levels and animals are less likely to habituate because these sounds are particularly meaningful (Ellison et al. 2012; Bishop et al. 2003; Gilsdorf et al. 2003; Coram et al. 2014; Lepper et al. 2014).

4.3.1.2 Prohibitions

Table 22 Summary of adverse impacts for those deterrents that would be prohibited under Alternative 2 (*Preferred Alternative*).

Deterrent Device/Method	**Taxa Affected**	**Adverse Effects**
Vessel chasing	All marine mammals	- Increased risk of boat strike and associated mortality or serious injury - Increased risk of capture myopathy from extensive chasing
Chemosensory deterrents	All marine mammals	- Involve hand-feeding (i.e., direct provisioning) of target animals and feeding marine mammals is prohibited - Known responses to emetics could result in serious injury - Pose direct health risks through all major routes of exposure - Can lead to immediate burns and damage that reduce skin's ability to protect the body
Tactile projectiles used with a firearm (except cracker shells and bird bombs), bow, or spear gun	All marine mammals	- Risk of death or serious injury due to lacerations or contusions that result in sharp force trauma or blunt force trauma, respectively
Tactile manual sharp objects	All marine mammals	- Increased risk of causing internal injury, leading to death or serious injury, sharp force trauma
Acoustic non-impulsive deterrents ≥ 170 dB RMS*	All marine mammals	- Risk of discomfort, pain, permanent hearing loss

*****If device is does not meet the criterion via the NMFS Acoustic Deterrent Web Tool.

General

Deterring pups or calves

<u>All marine mammals</u>: Because of their smaller size, pups and calves may have a limited ability to withstand the force or other pressure from tactile deterrents as well as explosives.

Targeting an animal's head or blowhole

<u>All marine mammals</u>: An animal's head and blowhole are particularly sensitive from an injury perspective, especially the eyes and mouth. Injuries to the eyes and mouth could lead to a decreased ability to forage, which could impact survival.

Deploying or attempting to deploy any deterrent (e.g., seal bombs) into the middle of a group of pinnipeds

<u>Pinnipeds</u>: Pinnipeds may congregate into groups with some individuals on the surface and others swimming below. Prohibiting users from deploying or attempting to deploy any deterrent into the middle of a group of pinnipeds increases the likelihood that a deterrent that could cause death or injury (depending on how it is used) is not accidentally deployed too close to an animal or on top of an animal.

Visual

Vessel chasing

<u>All marine mammals</u>: Vessel chasing, in contrast to vessel patrolling could increase risk of a vessel strike (resulting in mortality or serious injury) due to changing speeds and directions involved in chasing, risk of increased swimming leading to exertional muscle damage (e.g. capture myopathy.

Patrol animals

<u>Pinnipeds</u>: Direct effects include risk of adverse interactions between patrol animals and wild animals, such as penetrating injuries and/or disease associated with bites.

Chemosensory

Taste deterrents; Learned aversion/emetics

<u>All marine mammals</u>: Despite the fact that some of the products in this category are explicitly designed to deter wildlife using natural products demonstrated to not cause permanent physical harm, there are specific concerns for their use on marine mammals. Smell or scent deterrents are not applicable to cetaceans as they have no sense of smell and no published reports of their use

on pinnipeds. The most common type of taste aversion involves placing an emetic, typically lithium chloride, in a potential prey item that is then consumed by the predator (Petras 2003). Following multiple treatments, the predator should be conditioned to associate the predation act with the ill effects of the emetic. In the case of lithium chloride, ingestion of the chemical leads to vomiting. Such conditioned taste aversion is very specific and not associated with a particular location, rather the aversion alters the behavior of the target species with regard to the specific food type in the exact context in which it is applied (Cowan et al. 2000). There is an implicit component involving provisioning or directly feeding as part of the method of use for such a deterrent. Feeding marine mammals in the wild is illegal per MMPA regulations. A taste aversion study on captive California sea lions (Kuljis 1986) elicited a response so strong that one sea lion refused to consume the prey species used in the study for 18 days. A study using lithium chloride to elicit conditioned taste aversion in seals depredating at salmon farms (Pemberton and Shaughnessy 1993) resulted in seals convulsing and vomiting following exposure.

Chemical irritants and Corrosive chemicals

<u>All marine mammals</u>: Chemical irritants and corrosive chemicals pose direct health risks to target animals through all major routes of exposure. Chemical irritants are designed to incapacitate targets by powerfully stinging eyes, causing breathing difficulties, and creating other extreme but temporary discomfort. While this may be acceptable in terrestrial applications where the incapacitated animal has dry land to remain on while affected, the use of such products in an aquatic environment has a substantial risk of drowning associated with it. Chemical irritants and corrosive chemicals can lead to immediate burns and damage that reduce the skin’s ability to protect the body. Chemical exposure can be temporary and/or permanent. Temporary damage includes dry, cracked skin with an inflammatory response that subsides with time once the skin is no longer in contact with the substance. Permanent skin damage may result if the skin is exposed to a chemical that is known to have a severe impact. Permanent damage may extend beyond the skin and damage the underlying body organs or systems. For example, topical exposure to certain solvents, in humans, is known to cause liver damage. Skin is an animal’s ultimate protective cover and the principle site of interaction with the surrounding environment. Damage to the skin reduces its ability to protect the body and could lead to indirect effects that reduce overall fitness (e.g., reproductive fitness).

Tactile

Projectiles used with a firearm (except bird bombs and cracker shells), bow, or spear gun

<u>All marine mammals</u>: Potential direct effects of projectiles used with firearms (not including bird bombs and cracker shells), bows, and spear guns involve a high probability of physical harm severe enough to cause mortality or serious injury. Live ammunition used with rifles, shotguns, pistols, is by design intended to cause mortality and serious injury. Tissue and organ trauma result from the permanent wound cavity that occurs by direct impact of the bullet and also from

radial expansion of the surrounding tissues. Potential direct effects of sharp projectiles such as arrows and spears involve a high probability of physical harm severe enough to cause mortality or serious injury. Sharp penetrating projectiles are likely to result in body cavity penetration or exposure. NMFS Process for Injury Determinations (NMFS 2012b) includes several categories relevant to projectiles such as visible blood loss, body cavity penetration, and other body trauma that would classify these types of injuries as serious. Indirect effects of projectiles used with firearms (not including bird bombs and cracker shells), bows, and spear guns could occur if body cavity penetration or exposure introduces bacteria into vital organs and the internal cavity and leads to infection. These secondary effects can lead to death or serious injury in an animal that is not immediately killed or seriously injured initially.

Manual, sharp objects

<u>All marine mammals</u>: Potential direct effects involve a high probability of physical impacts severe enough to cause mortality or serious injury. Manual sharp penetrating objects have the potential to cause superficial and deep lacerations. Superficial lacerations do not penetrate deeper than the blubber layer and are considered non-serious injuries as they typically do not result in a decline in the health of the animal. Deep lacerations, however, pose substantial risk to an animal's health. Penetration of the body cavity, skeletal damage, or a deep wound that leads to substantial blood loss could result in death or serious injury. NMFS Process for Injury Determinations (NMFS 2012b) includes several categories relevant to sharp objects such as visible blood loss, body cavity penetration, and other body trauma that would classify these types of injuries as serious. Indirect effect could include infection of wounds.

Acoustic

Underwater non-impulsive deterrents ≥ 170 dB RMS unless that device has been evaluated and meets criterion by NMFS or via the NMFS Acoustic Deterrent Web Tool

<u>All marine mammals</u>: Potential direct effects of these deterrents would more likely result in TTS (NMFS 2018; Southall et al. 2019) or effects such as habitat avoidance or behavioral responses. Devices ≥ 170 dB RMS have the potential to exceed the >100-m, 1-h evaluation criterion if they have a high duty cycle and/or produce frequencies in the most susceptible hearing range of HF cetaceans (~40 kHz) (NMFS 2018; Southall et al. 2019).

4.3.1.3 Effects on other species (i.e., not targeted for deterrence)

<u>Marine Mammals Outside NMFS' jurisdiction</u>

Southall et al. (2019) established PTS onset thresholds for all species of marine mammals, not just those under NMFS' jurisdiction. Most marine mammal species under the jurisdiction of the USFWS (i.e., sea otter, walrus, and polar bear) have the same thresholds as otariid pinnipeds, while Sirenian PTS onset thresholds are similar to those of phocid pinnipeds. Potential effects on these species would be similar to those expected for other non-target marine mammals.

Seabirds

In-air hearing ability for species of diving birds has been measured and indicates they hear best below 3 kHz (Crowell et al. 2015; DoN 2018; Mooney et al. 2019), which is consistent with terrestrial birds that hear best between 2 and 5 kHz (Dooling and Therrien 2012). Data on the underwater hearing ability of seabirds is limited to a single frequency in a single species (great cormorant at 2 kHz; Hansen et al. 2016). Deterrent devices producing sounds above 3 kHz are less likely to produce impacts from acoustic exposure. The only available underwater onset acoustic criteria are for marbled murrelets exposed to impact pile driving (impulsive sound source), where there is 202 dB SEL_{cum} threshold for the onset of auditory injury (SAIC 2012). This threshold is similar or higher than all other marine mammal hearing groups. Overall, seabirds are considered less susceptible to noise-induced hearing loss compared to marine mammals.

Sea Turtles

Sea turtles hear frequencies below 2 kHz underwater and below 1 kHz in air (NOAA 2016; DoN 2017; DoN 2018). Thus, any deterrent device producing sounds above 2 kHz are outside the hearing range for this group and no impacts from acoustic exposure are expected. Additionally, PTS onset threshold for both impulsive (204 dB SEL_{cum}, 232 dB PK) and non-impulsive sounds (220 dB SEL_{cum}) are higher than any marine mammal hearing group (DoN 2017). Thus, sea turtles are likely less susceptible to noise-induced hearing loss compared to marine mammals. Although some studies have shown several types of behavior changes in sea turtles in response to a few sound sources, other studies have documented no changes (NOAA 2016).

Fishes

Most fishes primarily hear below 3 kHz, although some species of herring-like fish (clupeids) can detect ultrasound (above 20 kHz). Additionally, most fishes detect particle motion, rather than the pressure component of sound (Popper et al. 2014; NOAA 2016). Fish susceptibility to noise exposure, in terms of hearing loss and physical injury, depends on whether a species has a swim bladder and whether the swim bladder directly contributes to their ability to hear (Popper et al. 2014; NOAA 2016). NMFS has thresholds for the onset of injury for fishes exposed to impact pile driving (impulsive sound source) (206 dB PK for all size fishes; 187 dB SEL_{cum} for fishes > 2 grams and 183 dB SEL_{cum} for fishes <2 grams (FHWG 2008). The SEL_{cum} thresholds are comparable to marine mammals, while the PK threshold is lower than all species of marine mammals, except HF cetaceans. Popper et al. (2014) provides additional criteria for fishes exposed to a variety of sound sources, all of which are typically comparable or higher than marine mammal thresholds. Documented impacts of noise on fish species range from no effects to “behavioral disturbance (avoidance, vocalization changes, changes in swim speed and direction, alarm responses), adverse stress responses, masking, hearing impairment (temporary or permanent), tissue damage, and death” (NOAA 2016).

Invertebrates

There have been limited studies on hearing ability of invertebrates. However, what studies have been completed suggest invertebrates primarily detect particle motion below 1 kHz (Hawkins and Popper 2016: NOAA 2016). Thus, deterrents producing sounds above 1 kHz are less likely to impact invertebrates. Nevertheless, invertebrates as small as zooplankton have experienced mortality when exposed to high levels of impulsive sound from airguns (McCauley et al. 2017). Little research has been done on impacts of noise on invertebrates, but some work on cephalopods has demonstrated “high intensity low frequency sounds, as well as long exposures to continuous sounds, may damage the hair cells in their statocysts, which could inhibit their ability to perform important life functions, although behavioral studies that would support such conclusions have not been conducted” (NOAA 2016). Therefore, the preferred alternative may have a beneficial impact for some invertebrates because it limits the amount of noise >170 dB RMS, which is well below source levels for air guns.

4.4 Cumulative Impacts

The U.S. Council on Environmental Quality defined “cumulative effects” (which we refer to as “cumulative impacts” to distinguish between NEPA and ESA uses of the same term) as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR §1508.7).

Cumulative impacts are the net result of all past, present, and reasonably foreseeable future actions on the human environment over time. An individual action may have only minor or moderate impacts, but the cumulative impacts of all actions may be major. NEPA requires an analysis of cumulative impacts to alert decision makers to the full environmental consequences of a proposed action and its alternatives on resource areas of concern. This analysis looks at the overall cumulative impact and the contribution of deterrence activities to the overall cumulative impact. In terms of deterring marine mammals, understanding how the cumulative impacts from nuisance animals, human activities, and trends in the natural environment have influenced the marine environment over time is key to understanding the importance of NMFS role in guiding nonlethal deterrence.

The MMPA and the ESA were enacted to help address specific conservation concerns and many human activities are subject to federal management measures to protect endangered and threatened marine species and promote recovery. Human efforts within the last 40 years to reduce pollution, restore degraded habitats, and effectively manage marine mammal stocks has reversed declining trends for many marine mammal stocks that were once hunted. A number of important marine mammal stocks have been recovered to healthy levels and others are in the recovery process, while others remain threatened or endangered (see Table 15) . However, cumulative impacts from human activities and trends in the natural environment over time have also continued to contribute to major adverse impacts to populations of marine mammals, sea turtles, and other marine species.

In addition to NMFS nonlethal deterrence guidelines, there are many current and reasonably foreseeable activities that may contribute to cumulative impacts on marine mammal species, including: conservation efforts, commercial shipping, commercial and recreational fisheries, oil and gas and renewable energy development, military activities, coastal development projects, marine research activities, and other human activities that contribute to global climate change which has the potential to impact populations and distributions of many marine mammal stocks. These actions can produce both adverse and beneficial impacts that directly and indirectly affect marine mammal stocks managed by NMFS.

As described in the Chapter 4 summary above, nonlethal deterrence activities would have minor adverse effects on the various resource components of the biological environment. Because of the protective measures and prohibitions that would be required under Alternative 2 (*Preferred Alternative*), NMFS issuing non-lethal deterrent guidelines would have some positive contribution to long-term, global environmental processes that ultimately have a large impact on marine mammal populations. The No Action alternative would have some negative contribution to the long-term, global environmental processes by potentially allowing more and louder underwater noise.

There is the potential for adverse cumulative effects on individuals exposed to multiple deterrent devices over space and time. Currently, there are no criteria available to assess potential cumulative effects of multiple stressors on marine mammals (NASEM 2016). However, given that the proposed guidelines are designed to reduce impacts from a single exposure to having little to no effect, possible adverse cumulative impacts resulting from multiple exposures to deterrents is not likely to be common or substantially affect entire stocks or populations. By their very nature, deterrence activities are local, and many are short-term, lasting just long enough to deter a marine mammal from a particular area. Moreover, nonlethal deterrence provides an important tool to defuse conflict between humans and marine mammals safely, which may become ever more important as marine mammal distributions shift and humans expand exploitation and use of the marine environment.

4.5 Conclusion

The MMPA allows for the deterrence of a marine mammal but there are no existing guidelines or recommended specific measures for safely deterring marine mammals. Nor are there any prohibitions on specific deterrents that may have detrimental effects. The preferred alternative proposes such guidelines, measures, and prohibitions.

As demonstrated in this Environmental Assessment, the only component of the human environment under NEPA that the *Preferred Alternative* (i.e. theproposed guidelines) may impact in comparison to the No Action alternative is marine mammals. Because of the geographic scale of the marine environment and the fact that deterrents are readily and legally available, NMFS does not know how many annual deterrence events occur. However, as the examples provided in Chapter 1 demonstrate, the cases are not isolated nor minor. In addition, NMFS does not believe that the adverse effects of deterrence events on marine mammals are significant for the purposes of NEPA as defined by the context (entire ocean) and intensity (incidence of known deterrent events that cause serious injury or mortality). NMFS annually evaluates mortality and serious injury of marine mammals as well as each stock's potential biological removal level (PBR) to determine whether human-caused mortality is affecting the stock's ability to recover or reach its optimum sustainable population. Such mortality and serious injury from deterrents does not contribute a substantial amount to the total human-caused mortality and serious injury for any marine mammal stock. Therefore, by itself, deterrent use is not significant for NEPA.

The proposed action is designed to reduce the incidence of mortality and serious injury from deterrence. Some deterrents would be prohibited, while guidelines and recommended specific measures will enable safe use of other deterrents. The proposed action will, as demonstrated in this EA, result in an incremental benefit to marine mammals. Given that the no-action alternative does not have a significant adverse effect, the incremental benefit must also result in a non-significant adverse effect.

5 REFERENCES

Akamatsu, T., Y. Hatakeyama, and N. Takatsu. 1993. Effect of pulse sounds on escape behavior of false killer whales. Nippon Suisan Gakkaishi 59: 1297-1303.

Anderson S.S., and A.D. Hawkins. 1978. Scaring seals by sound. Mammal Review 8: 19-24.

ATF (Bureau of Alcohol, Tobacco, Firearms and Explosives) 2016. Explosive Pest Control Device Requirements. Retrieved 11 July 2016: ATF Link

Attenborough, K. 2014. Sound propagation in the atmosphere. Pages 117-155 in Springer Handbook of Acoustics. New York: Springer.

Baker, G.B., S. Hamilton, R. McIntosh, and L. Finley. 2014. Technical Review: Development and Application of Bycatch Mitigation Devices for Marine Mammals in Mid-Water Trawl Gear. Report prepared for the Department of the Environment (on behalf of the expert panel) 12 May 2014.

Barlow, J., Ballance, L.T. and Forney, K.A., 2011. Effective strip widths for ship-based line-transect surveys of cetaceans. US Dept Commer, NOAA Tech Memo NMFS-SWFSC-484 pp.

Bishop, J., H. McKay, D. Parrott, and J. Allan. 2003. Review of international research literature regarding the effectiveness of auditory bird scaring techniques and potential alternatives. London: Central Science Laboratories for the Department for Environmental Food and Rural Affairs.

Carretta, J.V., J. Barlow, and L. Enriquez. 2008. Acoustic pingers eliminate beaked whale bycatch in a gill net fishery. Marine Mammal Science 24: 956-961.

Chapman, D.M.F., and D.D. Ellis. 1998. The elusive decibel: Thoughts on sonar and marine mammals. Canadian Acoustics 26: 29-31.

Christiansen, F., L. Rojano-Doñate, P.T. Madsen, and L. Bejder. 2016. Noise levels of multi-rotor unmanned aerial vehicles with implications for potential underwater impacts on marine mammals. Frontiers in Marine Science. doi: 10.3389/fmars.2016.00277.

Coram, A., J. Gordon, D. Thompson, and S. Northridge. 2014. Evaluating and assessing the relative effectiveness of non-lethal measures, including Acoustic Deterrent Devices, on marine mammals. Scottish Government. SMRU Publication.

Cowan, D.P., J.C. Reynolds, and E.L. Gill. 2000. Reducing predation through conditioned taste aversion. Pages 281-299 in L.M. Gosling and W.J. Sutherland, eds. Behavior and Conservation. Cambridge: Cambridge University Press, Cambridge.

Culik, B.M., S. Koschinski, N. Tregenza, and G.M. Ellis. 2001. Reactions of harbor porpoises *Phocoena* and herring *Clupea harengus* to acoustic alarms. Marine Ecology Progress Series 211: 255-260.

Crowell, S.E., A.M. Wells-Berlin, C.E. Carr, G.H. Olsen, R.E. Therrien, S.E. Yannuzzi, and D.R. Ketten. 2015. A comparison of auditory brainstem responses across diving bird Species. Journal of Comparative Physiology A. 201: 803–815.

Dawson, S.M., A. Read, and E. Slooten. 1998. Pingers, porpoises and power: uncertainties with using pingers to reduce bycatch of small cetaceans. Biological Conservation 84: 141–146.

Deecke, V. B., P.J.B. Slater, and J.K.B. Ford, J. K. B. 2002. Selective habituation shapes acoustic predator recognition in harbour seals. Nature 420: 171–173.

DoN (Department of the Navy). 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical Report. San Diego, California: SSC Pacific.

DoN (Department of the Navy). 2018. Atlantic Fleet Training and Testing Final Environmental Impact Statement/ Overseas Environmental Impact Statement. Washington, D.C.: United States Navy.

Dooling, R.J., and S.C. Therrien. 2012. Hearing in Birds: What changes from air to water. Pages 77-81 in A.N. Popper and A. Hawkins, eds. The Effects of Noise on Aquatic Life. New York: Springer.

Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology 26: 21-28.

Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke, and R. Dooling. 2016. Communication masking in marine mammals: A review and research strategy. Marine Pollution Bulletin 103: 15-38.

FHWG (Fisheries Hydroacoustic Working Group). 2008. Agreement in principle for interim criteria for injury to fish from pile driving activities. Memorandum of Agreement between NOAA Fisheries' Northwest and Southwest Regions; USFWS Regions 1 and 8; California, Washington, and Oregon Departments of Transportation; California Department of Fish and Game; and Federal Highways Administration. June 12, 2008.

Finneran, J.J., R. Dear, D.A. Carder, and S.H. Ridgway. 2003. Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer. Journal of the Acoustical Society of America 114: 1667-1677.

Finneran, J.J. 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. Journal of the Acoustical Society of America 138: 1702-1726.

Fish, J.F., and J.S. Vania. 1971. Killer whale, *Orcinus orca*, sounds repel white whales, *Delphinapterus leucas*. Fishery Bulletin 69: 531-535.

Forney, K.A., B.L. Southall, E. Slooten, S. Dawson, A.J. Read, R.W. Baird, and R.L. Brownell Jr. 2017. Nowhere to go: noise impact assessments for marine mammal populations with high site fidelity. Endangered Species Research 32: 391–413.

Gilsdorf, J.M., S.E. Hygnstrom, and K.C. VerCauteren. 2003. Use of frightening devices in wildlife management. Integrated Pest Management Reviews 7: 29-45.

Good Life, Inc. 2020. Guardian G2 Propane Cannon Instruction Manual. Medford, Oregon: Good Life, Inc.

Gordon, J., D. Gillespie, J. Potter. A. Frantzis, M.P. Simmonds, R. Swift, and D. Thompson. 2004. A Review of the Effects of Seismic Surveys on Marine Mammals. Marine Technology Society Journal 37: 16-34.

Gordon, J., C. Blight., E. Bryant, and D. Thompson. 2019. Measuring responses of harbour seals to potential aversive acoustic mitigation signals using controlled exposure behavioural response studies. Aquatic Conservation: Marine and Freshwater Ecosystems 29: 157-177.

Götz, T., and V.A. Janik. 2010. Aversiveness of sounds in phocid seals: psycho-physiological factors, learning processes and motivation. The Journal of Experimental Biology 213: 1536-1548.

Götz, T., and V.A. Janik. 2011. Repeated elicitation of the acoustic startle reflex leads to sensitisation in subsequent avoidance behaviour and induces fear conditioning. BioMed Central Neuroscience 12: 30.

Götz, T., and V.A Janik. 2015**.** Target-specific acoustic predator deterrence in the marine environment. Animal Conservation 18: 102-111.

Götz, T., and V.A Janik. 2016. Non-lethal management of carnivore predation: long-term tests with a startle reflex-based deterrence system on a fish farm. Animal Conservation 19: 212-221

Gustavson, C. R., J. Garcia, W.G. Hankins, and K.W. Rusiniak. 1974. Coyote predation control by aversive conditioning. Science 184: 581-583.

Gustavson, C. R., J.R. Jowsey, and D.N. Milligan. 1982. A 3-year evaluation of taste aversion coyote control in Saskatchewan. Journal of Range Management 35: 57-59.

Hamer, D.J., S.J. Childerhouse, and N.J. Gales. 2012. Odontocete bycatch and depredation in longline fisheries: A review of available literature and of potential solutions. Marine Mammal Science 28: E345-374.

Hansen, K.A., O.N. Larsen, and M. Wahlberg. 2016. Underwater hearing in the great cormorant (*Phalacrocorax carbo sinensis*): Methodological considerations. Proceedings of Meetings on Acoustics 27:010015.

Hasting, M., and A.N. Popper. 2005. Effects of Sound on Fish. Sacramento, California: Jones & Stokes.

Hawkins, A.D., and A.N. Popper. 2016. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science: doi:10.1093/icesjms/fsw205

Jefferson, T., and B. Curry. 1996. Acoustic methods of reducing or eliminating marine mammal-fishery interactions: do they work? Ocean Coastal Management 31: 41-70.

Kastak D, RJ Schusterman, BL Southall, and CL Reichmuth. 1999. Underwater temporary threshold shift induced by an octave-band noise in three species of pinniped. Journal of the Acoustical Society of America. 106: 1142-1148.

Kerr, A., and Scorse, J. 2018. The Use of Seal Bombs in California Fisheries. Monterey, CA: Middlebury Institute of International Studies.

Kindt-Larsen, L., C.W. Berg, S. Northridge, and F. Larsen. 2019. Harbor porpoise (*Phocoena phocoena*) reaction to pingers. Marine Mammal Science 35: 552-573.

Kraus, S. 1999. The once and future ping: Challenges for the use of acoustic deterrents in fisheries. Marine Technology Society Journal 30: 90-93.

Kuljis, B.A. 1986. Report on food aversion conditioning in sea lions (*Zalophus californianus*). Report to NMFS and California Fish and Game. No. 84-ABC-00167. 19 pp.

Lankford, J.E., D.K. Meinke, G.A. Flamme, D.S. Finan, M. Stewart, S. Tasko, and W.J. Murphy 2016. Auditory risk of air rifles. International Journal of Audiology 55: S51–S58.

Lee, K. 2016. Stranding mortality patterns in California sea lions and Steller sea lions in Oregon and southern Washington, 2006-2014. Dissertation and Theses. Portland State University, Paper 2995.

Lepper, P.A., J. Gordon, C. Booth, P. Theobald, S.P. Robinson, S. Northridge, S., and L. Wang. 2014. Establishing the sensitivity of cetaceans and seals to acoustic deterrent devices in Scotland. Scottish Natural Heritage Commissioned Report No. 517.

Long, K.J., M.L. DeAngelis, L.K. Engleby, D.A. Fauquier, A.J. Johnson, S.D. Kraus, and S.P. Northridge. 2015. Marine mammal non-lethal deterrents: Summary of the technical expert workshop on marine mammal non-lethal deterrents, 10-12 February 2015, Seattle, Washington. U.S. Department of Commerce NOAA Tech. Memo. NMFS-OPR-50. 38 pp.

Mackay, A.I., and I.A. Knuckey IA. 2013. Mitigation of marine mammal bycatch in gillnet fisheries using acoustic devices—literature review. Final Report to the Australian Fisheries Management Authority. South Australian Research and Development Institute (SARDI).

Mate, B.R., and J.T. Harvey. 1986. An acoustic harassment technique to reduce seal predation on salmon. Acoustical deterrents in marine mammal conflicts with fisheries. Pages 23-26 in A workshop held February 17-18, 1986 at Newport, Oregon. Oregon State University, Publication No. ORESU-W-86-001.

McCauley, R.D., R.D. Day, K.M. Swadling, Q.B. Fitzgibbon, R.A. Watson, and J.M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution 1:0195.

McGarry, T., R. de Silva, S. Canning, S. Mendes, A. Prior, S. Stephenson, and J. Wilson. 2020. Evidence base for application of Acoustic Deterrent Devices (ADDs) for marine mammal mitigation in coastal and offshore industries. Peterborough, U.K.: JNCC.

Meyer-Loebbecke A., A.J. Debich, A. Śirović, J.S. Trickey, M.A. Roch, J.V. Carretta, S.M. Wiggins, J.A. Hildebrand, A. Denzinger, H.U. Schnitzler, and S. Baumann-Pickering. 2016. Noise from explosive deterrents used by California fisheries and possible effects on marine life. Effects of Noise on Aquatic Life, 10-16 July 2016. Dublin, Ireland.

MMO (Marine Management Organisation). 2018. Assessing the Non-Lethal Seal Deterrent Options: Literature and Data Review. A report produced by the Marine Management Organisation. MMO Project No: 1131, October 2018, 45 pp.

Mooney, T.A., A. Smith, O.N. Larsen, K.A. Hansen, M. Wahlberg, and M.H. Rasmussen. 2019. Field-based hearing measurements of two seabird species. Journal of Experimental Biology 222: jeb190710.

Myrick, A.C., M. Fink, and C.B. Glick. 1990. Identification, chemistry, and behavior of seal bombs used to control dolphins in the yellowfish tuna purse-seine fishery in the eastern tropical Pacific: Potential hazards. Administrative Report LJ-90-08. La Jolla, California: National Marine Fisheries Service, Southwest Fisheries Center.

NASEM (National Academies of Sciences, Engineering, and Medicine). 2016. Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals. Washington, D.C.: The National Academies Press.

NMFS (National Marine Fisheries Service). 2012a. Policy for Distinguishing Serious from Non-Serious Injury of Marine Mammals. National Marine Fisheries Service Policy Directive 02-038. January 27, 2012.

NMFS (National Marine Fisheries Service). 2012b. Process for Injury Determinations. National Marine Fisheries Service Instruction 02-038-01. January 27, 2012.

NMFS (National Marine Fisheries Service). 2017. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Commercial Fireworks Displays at Monterey Bay National Marine Sanctuary. Federal Register 82: 27434-27443.

NMFS (National Marine Fisheries Service). 2018. Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). NOAA Technical Memorandum NMFS-OPR-59. Silver Spring, Maryland: National Marine Fisheries Service.

NOAA (National Oceanic and Atmospheric Administration). 2016. Ocean Noise Strategy Roadmap. Silver Spring, Maryland, National Oceanic and Atmospheric Administration. Link to Report

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37: 81-115.

Olesiuk, P.F., L.M. Nichol, M.J. Sowden, and J.K.B. Ford. 2002. Effect of the sound generated by an acoustic harassment device on the relative abundance and distribution of harbor porpoises (*Phocoena phocoena*) in Retreat Passage, British Columbia. Marine Mammal Science 18: 843-862.

Olesiuk, P.F., J.W. Lawson, and E.A. Trippel. 2010. Pathways of effects of noise associated with aquaculture on natural marine ecosystems in Canada. Research Document 2010/025. Ottawa, Ontario: Fisheries and Oceans Canada.

Pedreros, E., M. Sepúlveda, J. Gutierrez, P. Carrascoa, and R.A. Quiñones. 2016. Observations of the effect of a New Year's fireworks display on the behavior of the South American sea lion (*Otaria flavescens*) in a colony of central-south Chile Marine and Freshwater Behaviour and Physiology 49: 127-131.

Pemberton, D., and P.D. Shaughnessy. 1993. Interaction between seals and marine fish-farms in Tasmania, and management of the problem. Aquatic Conservation 3: 149-158.

Perrin, W. F., G.P. Donovan, and J. Barlow. 1994. Gillnets and Cetaceans, International Whaling Commission. Special Issue 15. 629 pp.

Petras, E. 2003. A review of marine mammal deterrents and their possible applications to limit killer whale (*Orcinus orca*) predation on steller sea lions (*Eumatopias jubatus*). Alaska Fisheries Science Center Processed Report 2003-02. 49 pp.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies, and W.N. Tavaolga. 2014. ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. New York: ASA Press.

Price, C.S., E. Keane, D. Morin, C. Vaccaro, D. Bean, and J.A. Morris, Jr. 2017. Protected Species & Marine Aquaculture Interactions. NOAA Technical Memorandum NOS NCCOS 211. 85 pp.

Reeves, R.R., R.J. Hofman, G.K. Silber, and D. Wilkinson. 1996. Acoustic deterrence of harmful marine mammal-fishery interactions: Proceedings of a workshop held in Seattle, Washington, 20-22 March 1996. U.S. Department of Commerce NOAA Tech. Memo. NMFS-OPR-10. 68 pp.

Reeves, R.R., A.J. Read, and G. Notarbartolo di Sciara. 2001. Report of the Workshop on Interactions between Dolphins and Fisheries in the Mediterranean: Evaluation of Mitigation Alternatives. Roma, 4-5 May. ICRAM: Rome.

Richardson, W.J., C.R Greene Jr., C.I. Malme, and D.H. Thompson. 1995. Marine Mammals and Noise. New York: Academic Press.

Roberts J.J., B.D. Best, L. Mannocci, E. Fujioka, P.N. Halpin, D.L. Palka, L.P. Garrison, K.D. Mullin, T.V.N. Cole, C.B. Khan, W.M. McLellan, D.A. Pabst, and G.G. Lockhart. 2016. Density Model for Harbor Porpoise (*Phocoena phocoena*) for the U.S. East Coast Version 3.4, 2016-04-21, and Supplementary Report. Marine Geospatial Ecology Lab, Duke University, Durham, North Carolina.

SAIC (Science Applications International Corporation). 2012. Marbled murrelet hydroacoustic science panel II. Bothell, Washington: SAIC.

Schakner, Z.A., T. Götz, V.M. Janik, and D.T. Blumstein. 2017. Can fear conditioning repel California sea lions from fishing activities? Animal Conservation 20 :425-432.

Scordino J. 2010. West Coast pinniped program investigations on California sea lion and Pacific harbor seal impacts on salmonids and other fishery resources. Portland, Oregon: Pacific States Marine Fisheries Commission.

Simonis, A.E., K.A. Forney, S. Rankin, J. Ryan, Y. Zhang, A. DeVogelaere, J. Joseph, T. Margolina, A. Krumpel, and S. Baumann-Pickering. 2020. Seal bomb noise as a potential threat to Monterey Bay harbor porpoise. Frontiers in Marine Science 7: Article 142.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33: 411-522.

Southall, B. L., J.J. Finneran, C. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45: 125-232.

Stoffle, B.W., and S.D. Allen. 2012. The Sociocultural Importance of Spearfishing in Hawai'i. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-PIFSC-31, 38 pp.

Tyack, P.L., W.M.X. Zimmer, D. Moretti, B.L. Southall, D.E. Claridge, J.W. Durban, C.W. Clark, A. D'Amico, N. DiMarzio, S. Jarvis, E. McCarthy, R. Morrissey, J. Ward, and I.L. Boyd. 2011. Beaked whales respond to simulated and actual Navy sonar. PLoS ONE 6:E17009.

USFWS (U.S. Fish and Wildlife Service). 2015. Polar Bear Deterrent - Training Manual INSTRUCTOR GUIDELINES. Link to Guidelines

Urick, R.J. 1983. Principles of Underwater Sound. New York, New York: McGraw-Hill Book Company.

van Beest, F. M., L. Kindt-Larsen, F. Bastardie, V. Bartolino, and J. Nabe-Nielsen. 2018. Predicting the population-level impact of mitigating harbor porpoise bycatch with pingers and time-area fishing closures. Ecosphere 8:e01785.

van Marlen, B. 2007. NECESSITY final publishable activity report. Contract 501605. NEphrops and CEtacean Species Selection Information and TechnologY, Scientific Support to Policy (SSP). Wageningen IMARES, Netherlands.

Warlick, A.J., D. A. Duffield, D.M. Lambourn, S.J. Jeffries, J.M. Rice, J.K. Gaydos, J.L Huggins, J. Calambokidis, L.L. Lahner, J. Olson, E. D'Agnese, V. Souze, A. Elsby, and S.A. Norman. 2018. Spatio-Temporal Characterization of Pinniped Strandings and Human Interaction Cases in the Pacific Northwest, 1991-2016. Aquatic Mammals 44:229-318.

Wiggins, S.M., A. Krumpel, L.M. Dorman, J.A. Hildebrand, and S. Baumann-Pickering. 2019. Seal Bomb Sound Source Characterization. MPL Technical Memorandum 633. La Jolla, California: Scripps Institution of Oceanography.

Ziccardi, M.H., S.M. Wilkin, T.K. Rowles, and S. Johnson. 2015. Pinniped and Cetacean Oil Spill Response Guidelines. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-52, 138 pp

Zollett, E.A., and A.J. Read. 2006. Depredation by bottlenose dolphins on the king mackerel troll fishery in Florida. Fishery Bulletin 104: 343-349.

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7 APPENDICES

7.1 Appendix A – Photographic Examples of Deterrents

The following images are provided solely as a reference to enhance clarity regarding the various deterrents included in this assessment.

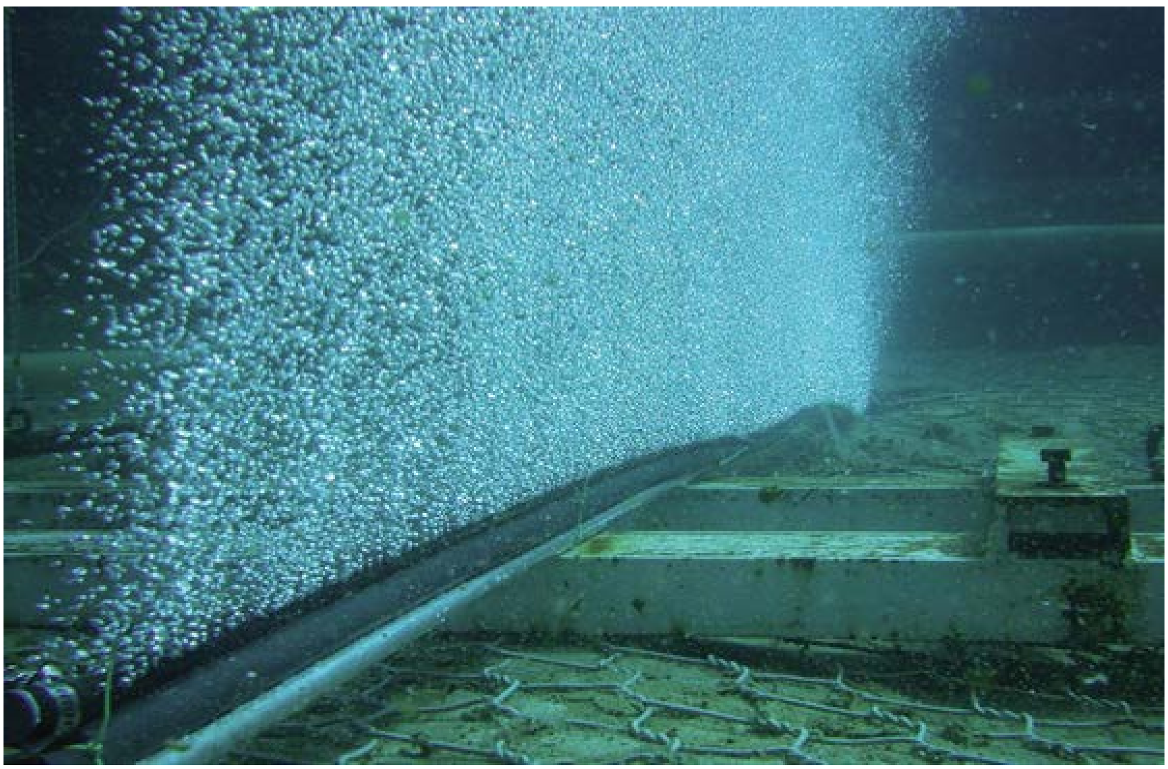
A.1: Air dancers used to deter sea lions from hauling out on docks in Astoria, Oregon
A.2: Colored flags used to deter sea lions from hauling out on docks in Astoria, Oregon
A.3: Pinwheels and streamers
A.4: Air bubble curtain system produced by CanadianPond.ca Products Ltd.
A.5: NOAA releasing an Unmanned Aircraft System or UAS
A.6: Human attendant patrolling a dock in the East Mooring Basin, Astoria, Oregon
A.7: Orca inspired predator-shaped watercraft in Astoria, Oregon
A.8: Rigid fencing in air used as a marine mammal deterrent on a marine dock
A.9: Bull rail configurations on docks in Seattle, Washington
A.10: Anti-predator netting
A.11: Containment booms
A.12: Conceptual sonar array and in-water electrical field exclusion system
A.13: Electrical mats installed on an offshore oil platform
A.14: Commercially-available blunt-tip arrows and arrow tips
A.15: Commercially-available rubber baton rounds and bullets
A.16: Commercially-available rubber ball shotgun cartridges
A.17: General schematic of rubber ball shotgun cartridges
A.18: Commercially-available bean bag rounds
A.19: Commercially-available sponge grenade rounds
A.20: Schematic ‘time-lapse’ view of net sleeve operation
A.21: Schematic diagram of *cage device* developed by the Australian Government
A.22: Schematic diagram of *chain device* developed by the Australian Government
A.23: Bird banger cartridges with firing caps and single-shot launcher
A.24: Bird whistler cartridges with firing caps, single-shot and double-shot launchers
A.25: Cracker shells and image of cracker shell being fired from a 12-gauge shotgun
A.26: Bird bomb cartridges with firing caps and single-shot launcher
A.27: Seal bombs, typical example of an Explosive Pest Control Device (EPCD)
A.28: Oikomi pipes deployed from the side of a boat
A.29: Standard pingers and diagram of pinger configuration on gillnet
A.30: In-air noisemakers: aerodynamic whistles, vuvuzelas, and sirens
A.31: AQUAmark® 848 by Aquatec
A.32: CetaSaver by IXTrawl
A.33: dB Plus II ™ acoustic deterrence system by AirMar
A.34: OrcaSaver™ by Savewave
A.35: SealScarer by Lofitech AS Ltd.
A.36: SealScrammer US3 by Ace Aquatic
A.37: SealScrammer US3 by Ace Aquatic: Low frequency variant

A.38: GenusWave

A.1. Air dancers used to deter sea lions from hauling out on docks in Astoria, Oregon. Photo credit: KOIN News, Portland, Oregon.

A.2. Colored flags used to deter sea lions from hauling out on docks in Astoria, Oregon. Photo credit: KOIN News, Portland, Oregon.

A.3. Pinwheels and streamers can be used to deter sea lions from hauling out on the dock. (Photo adopted from [AliExpress website] and [Flags and More Flags website])

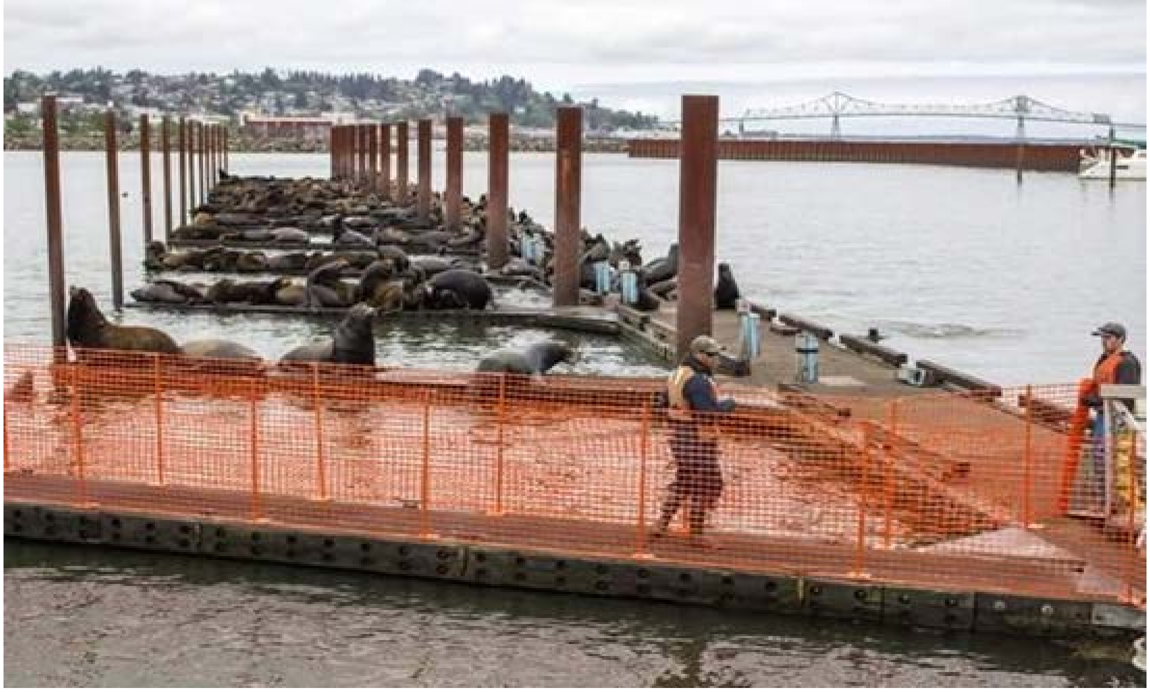


A.4. Air bubble curtain system designed by CanadianPond.ca Products Ltd. Photo credit: CanadianPond.ca Products Ltd.

A.5. Unmanned Aircraft Systems (UAS) being launched by NOAA for a research mission. Photo credit: NOAA

A.6. Human attendant patrolling a dock in the East Mooring Basin, Astoria, Oregon. Photo credit: Portland State University.

A.7. Watercraft designed as a predator shaped deterrent to deter sea lions from docks. Photo credit: KOIN News, Portland, Oregon.

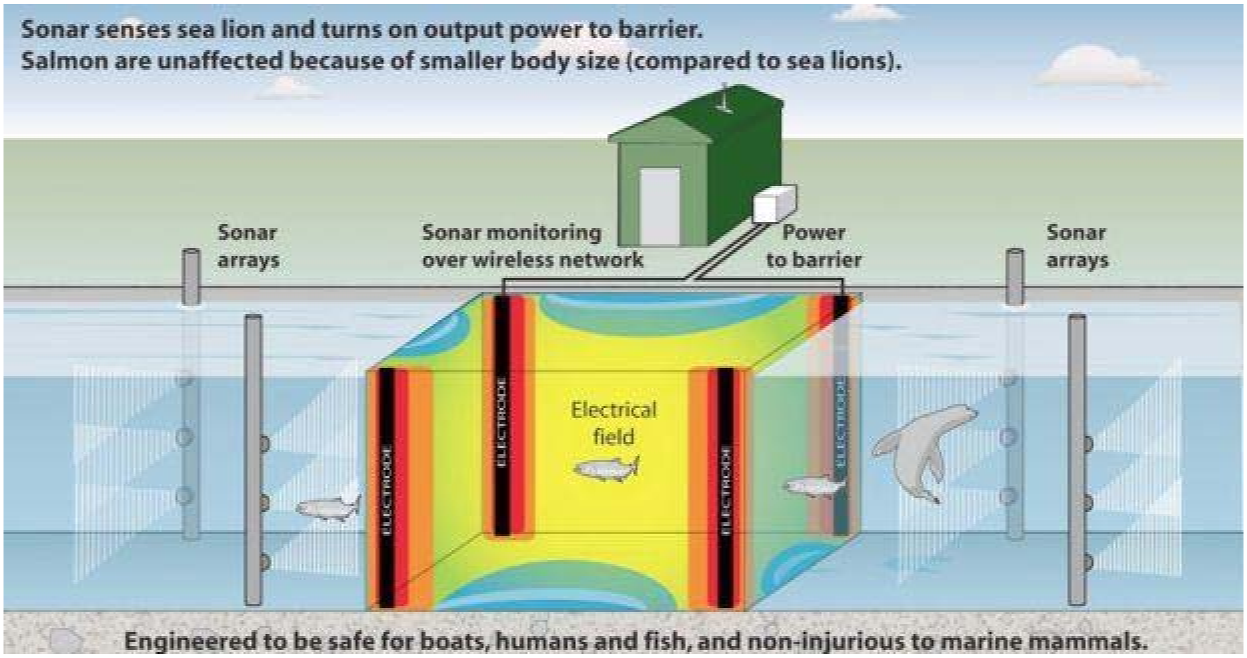


A.8. Rigid fencing as a marine mammal deterrent on a marine dock in Astoria, Oregon. Photo credit: Daily Astorian.

A.9. Bull rails with different vertical heights on docks in Seattle, Washington. Photo credits: NOAA.

A.10. Anti-predator netting. In this example, netting is suspended from an inflatable boom. Mesh size can vary, as shown here, for specific deterrent needs. Images from BoomSwim, Inc.

A.11. Examples of containment booms, also referred to as waterway barriers, debris barriers, and log booms. Images from Bolina Ltd., Worthington Products, Inc., and Structurflex, Ltd.



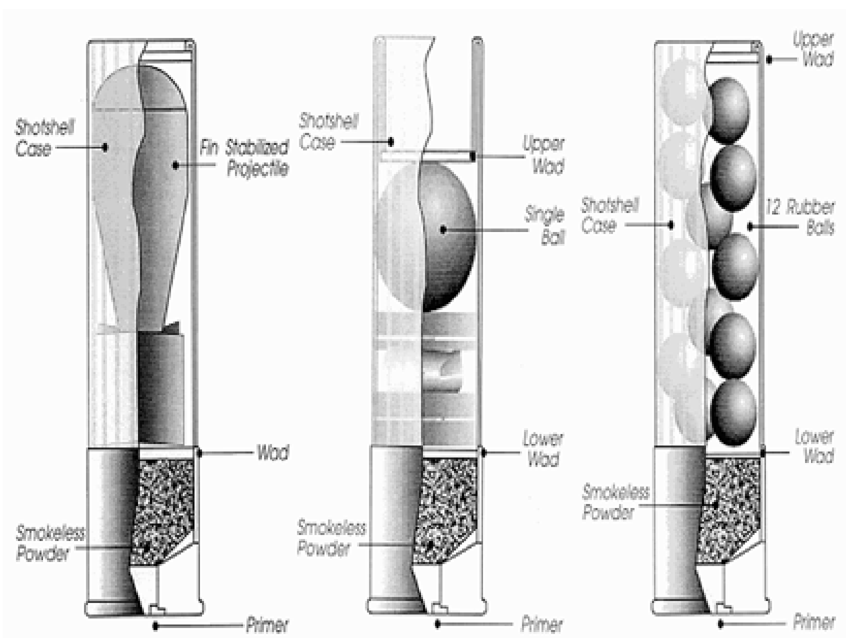
A.12. Conceptual sonar array and in-water electrical field exclusion system. (Image adopted from Smith-Root, Incorporated).

A.13. Pinniped Dock Deterrence System^{TM} installed on a dock. Photo credit: Smith-Root, Incorporated (Vancouver, Washington).

A. 14. Examples of commercially available blunt-tip arrows and arrow tips. (Image adopted from [Lancaster Archery Supply website])

A.15. Examples of rubber bullets and rubber baton rounds. A wide variety of shapes and sizes are manufactured to fire from a full range of firearms, the examples depicted here serve as examples of commercially available projectiles. (Image adopted from [Atlantic Tactical website])

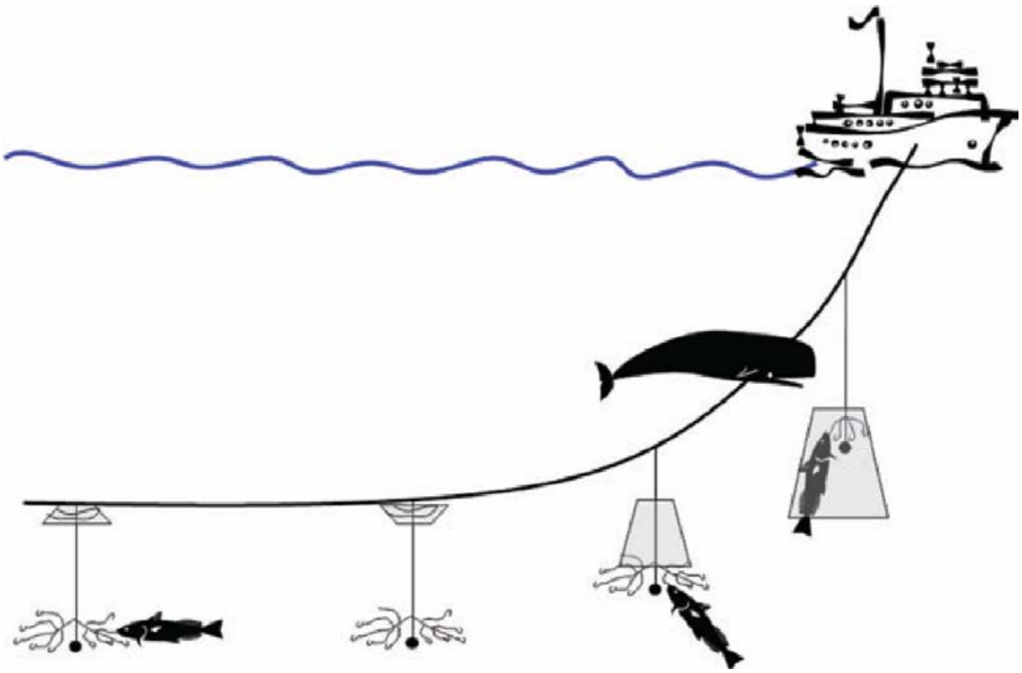
A.16. Examples of rubber ball shotgun shells with round rubber projectiles. Manufacturers design rubber ball shot gun shells with a full range of pellet numbers, the three versions depicted here serve as examples of commercially available cartridges. **(**Image adopted from [Midway USA website](#))



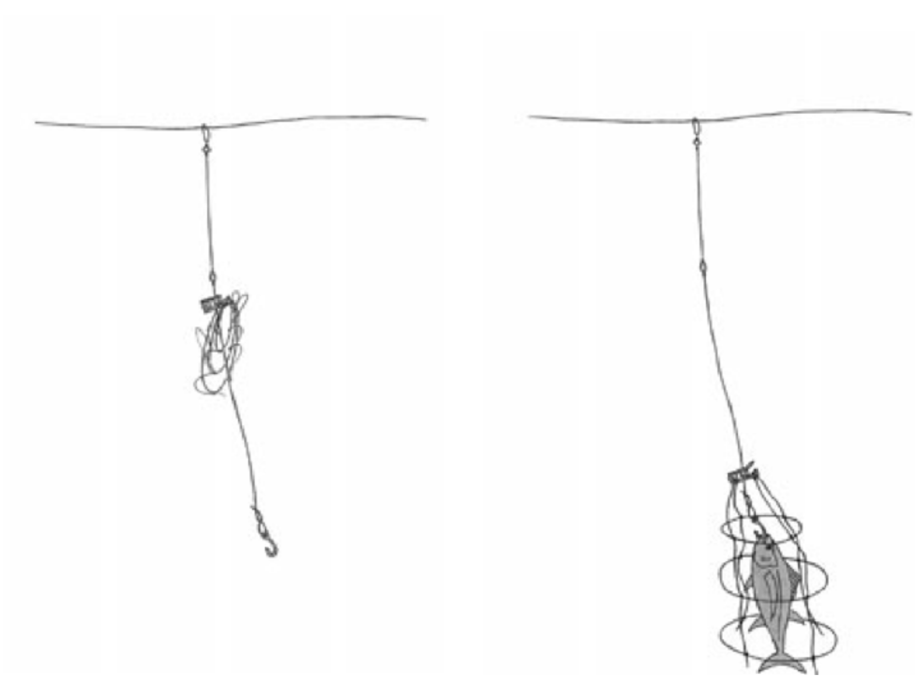
A.17. General schematic of shotgun cartridge with components labelled. (Image adopted from [Global Security website](#))

A.18. Examples of commercially available bean bag rounds. (Image adopted from www.atlantictactical.com; OfficerStore website)

A.19. Examples of low velocity sponge grenades, or foam batons, designed to be fired from a 40 mm M203 or M79 hand held launcher. (Image adopted from Atlantic Tactical website)



A.20. Schematic 'time-lapse' view of net sleeve operation, showing the protection of the fish and the physical deterrence of a sperm whale during haul in of catch. (Reprinted with permission from Hamer et al. 2012).



A.21. Schematic diagram of the *cage device* (not triggered and triggered) developed by the Australian Government to be tested in the Pacific and Indian Oceans. Before the devices are triggered by the tension of a caught fish, they remain clear of the baited hook and close to the mainline or swivel. Upon being triggered, the devices release the cage and then descend toward the caught fish, eventually enveloping it. (Reprinted with permission from Hamer et al. 2012).

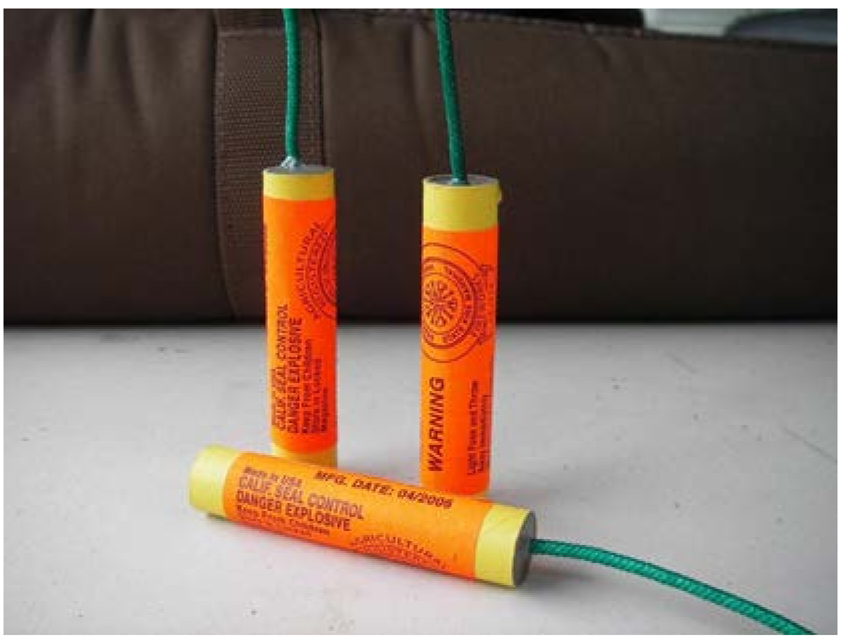
A.22. Schematic diagram of the *chain device* (not triggered and triggered) developed by the Australian Government to be tested in the Pacific and Indian Oceans. Before the devices are triggered by the tension of a caught fish, they remain clear of the baited hook and close to the mainline or swivel. Upon being triggered, the devices release the chain streamers and then descend toward the caught fish, eventually enveloping it. (Reprinted with permission from Hamer et al. 2012).

A.23. Bird Bangers® produced by Sutton Agricultural Enterprises (Salinas, California, USA). Photos of cartridges, firing caps, single-shot launcher, and Bird Bangers® cartridge (Image adopted from Sutton Ag website)

A.24. Bird Whistlers® produced by Sutton Agricultural Enterprises (Salinas, California, USA). Photos of cartridges with firing caps, single-shot launcher, double-shot launcher, and Bird Whistler® cartridge adopted from Sutton Ag website.

A.25. Cracker shells are fired from a 12 gauge shotgun and can travel over 200 ft before detonating. Photos of cartridges and shell adopted from www.suttonag.com/ shell_crackers.html. Photo of Oregon Department of Fish and Wildlife employee firing cracker shells from a 12 gauge shotgun adopted from Oregon Live website.

A.26. Bird Bombs® produced by Sutton Agricultural Enterprises (Salinas, California, USA). Photos of cartridges with firing caps, single-shot launcher, and Bird Bomb® cartridge adopted from www.suttonag.com/bird_bombs.html. A number of other manufacturers produce products under the generic name “bird bombs”.



A. 27. Seal bombs, one of a list of types of commercially available Explosive Pest Control Devices (EPCDs). Photo credit: National Marine Fisheries Service.

A.28. Oikomi pipe suspended from a small vessel. Photo courtesy of Washington Department of Fish and Wildlife.

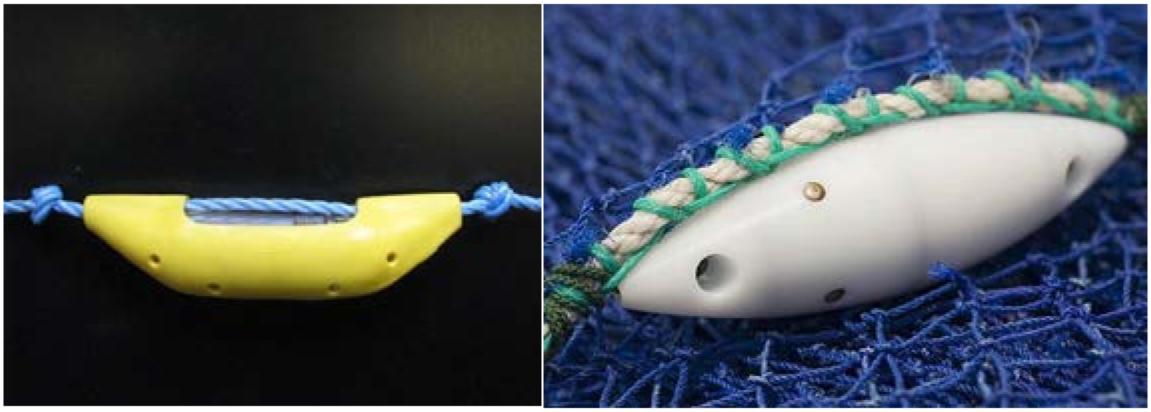
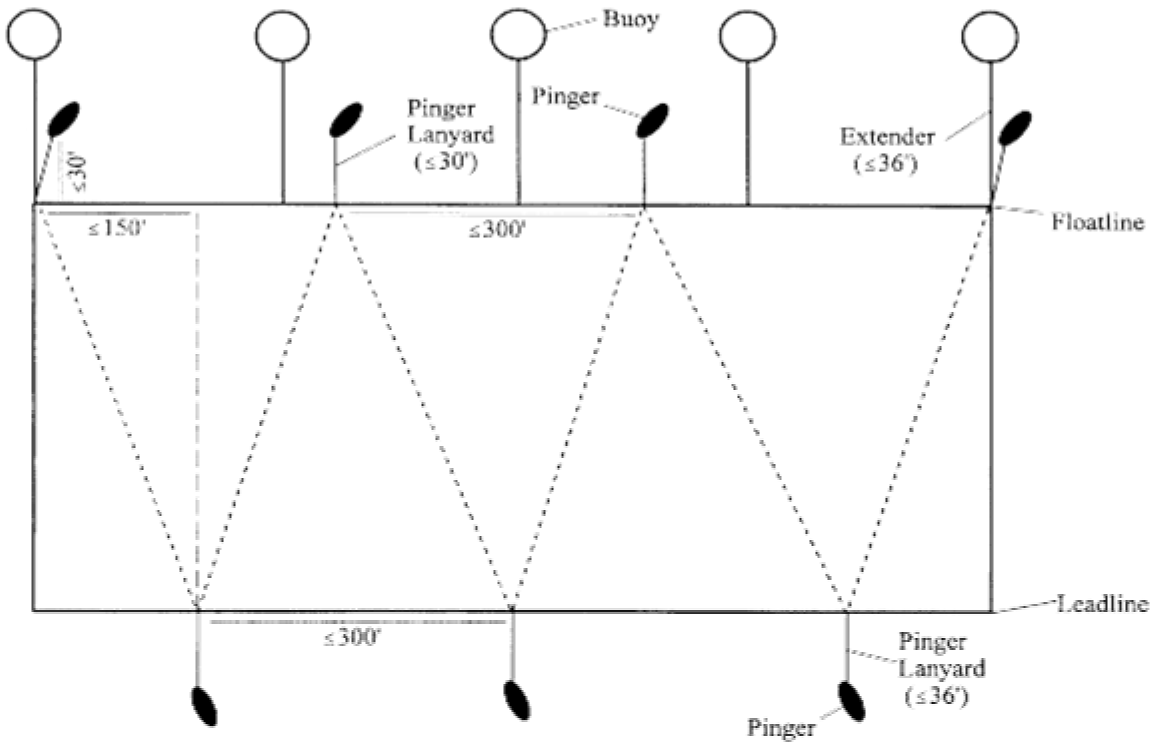


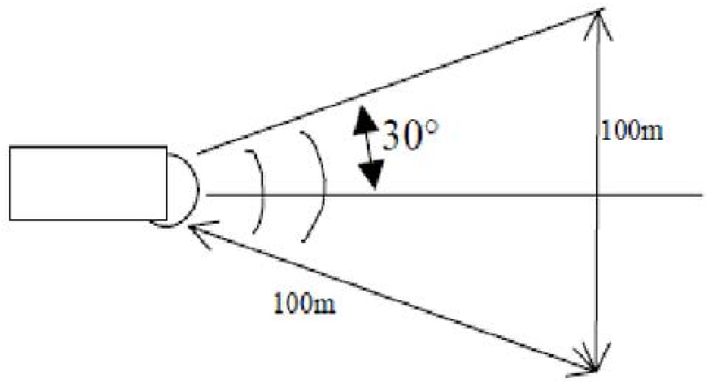
Figure 1. Drift Gillnet Pinger Configuration and Extender Requirements



A.29. Examples of standard pingers and diagram of pinger configuration on gillnet. Models shown here: Banana Pinger by Fishtek (upper left) and Porpoise Pinger by Fumunda (upper right). Configuration diagram adapted from 50 CFR Part 229 Figure 1.

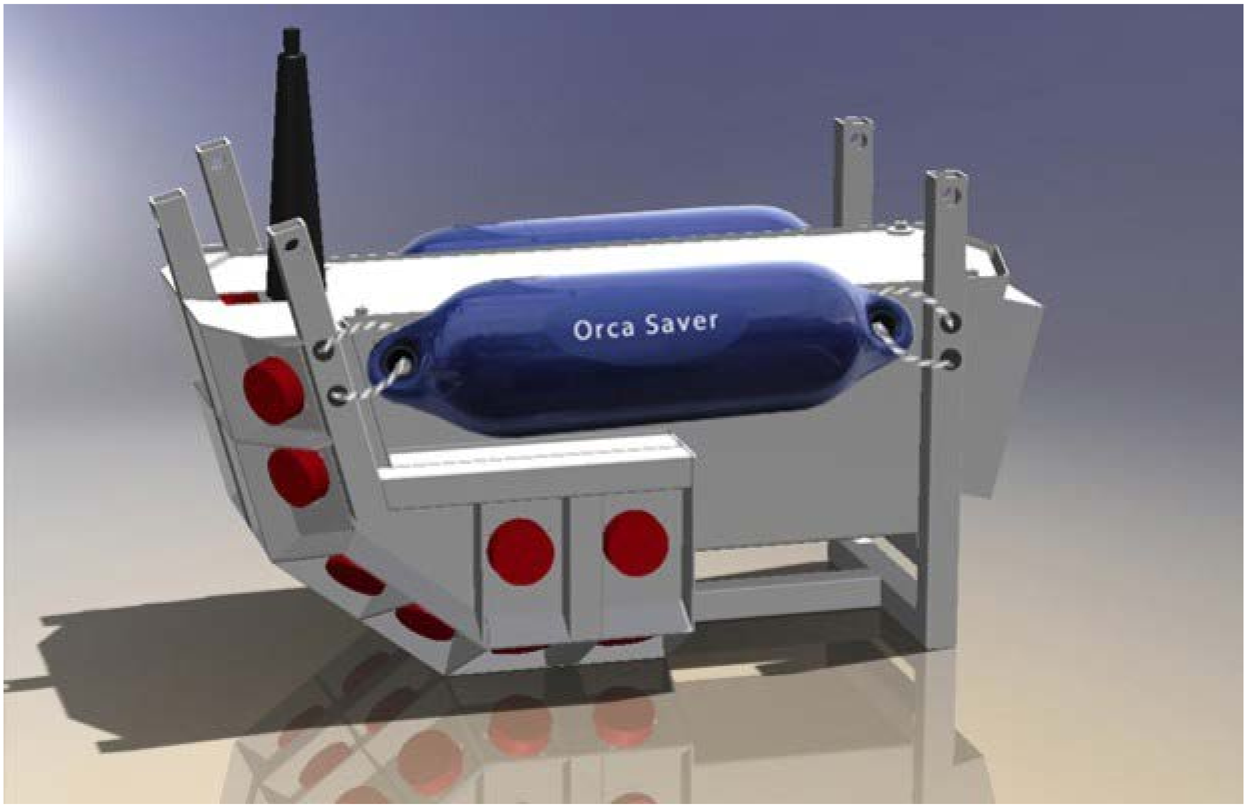
A.30. Examples of in-air noisemakers: (from left to right) aerodynamic whistles, vuvuzelas, and sirens. (Images adopted from Fox 40 website; Promotional Product website; and Altex website, respectively)

A.31. AQUAmark- Model 848- Programmable Acoustic Pinger. (Image adopted from AQUAmark website).



A.32. CetaSaver by IXTrawl**. (**Image adopted from Baker et al. 2014)

A.33. dB Plus II™ Acoustic Deterrent System by Airmar. Photo credit: National Marine Fisheries Service



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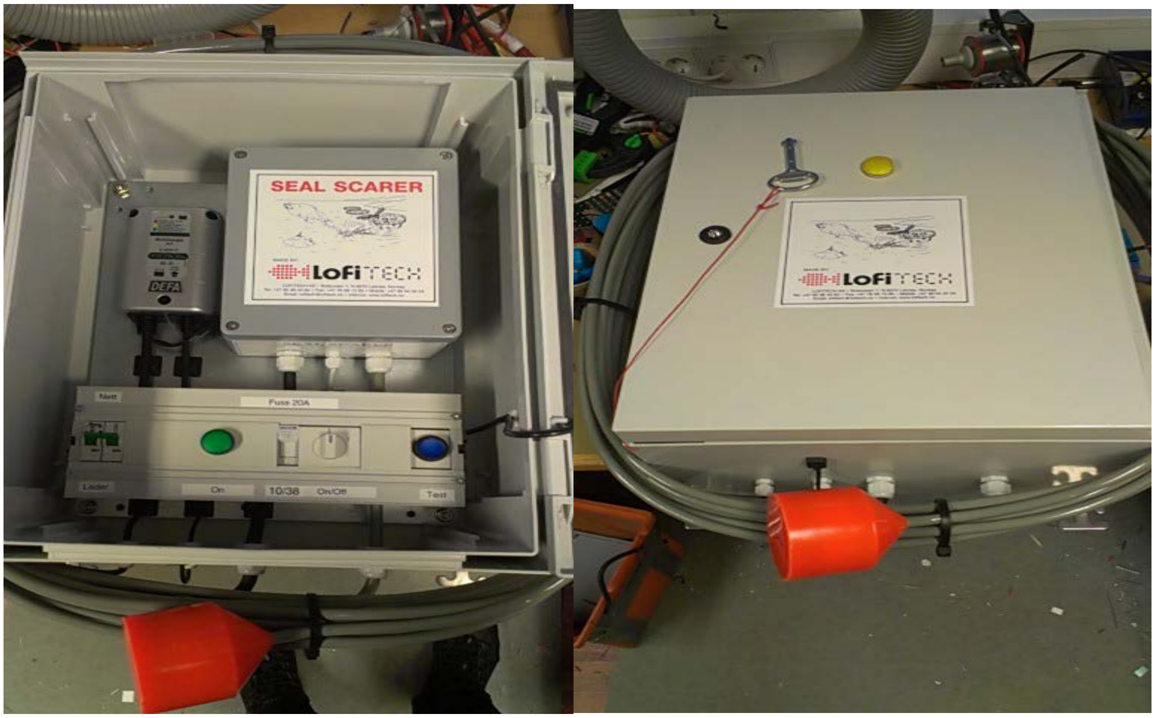
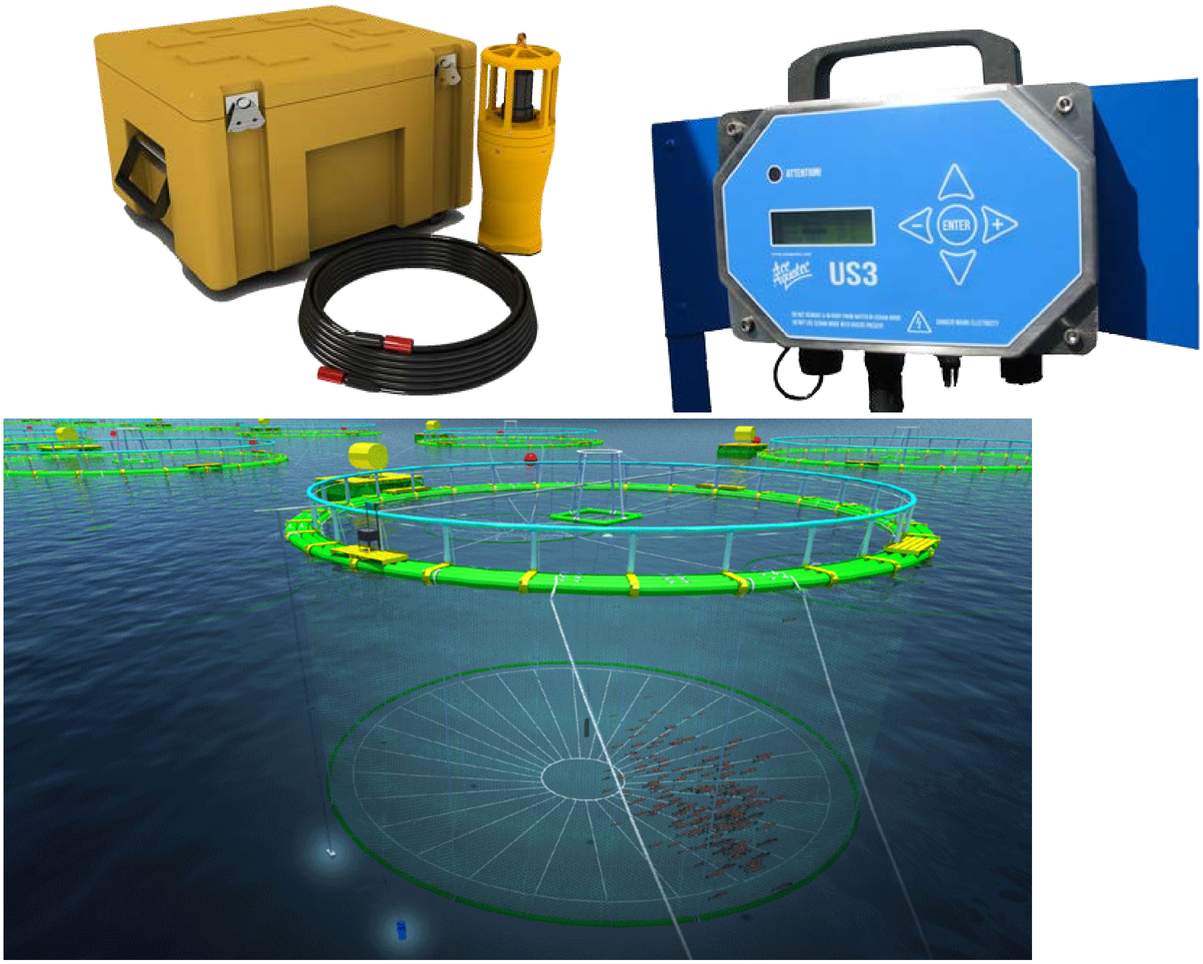
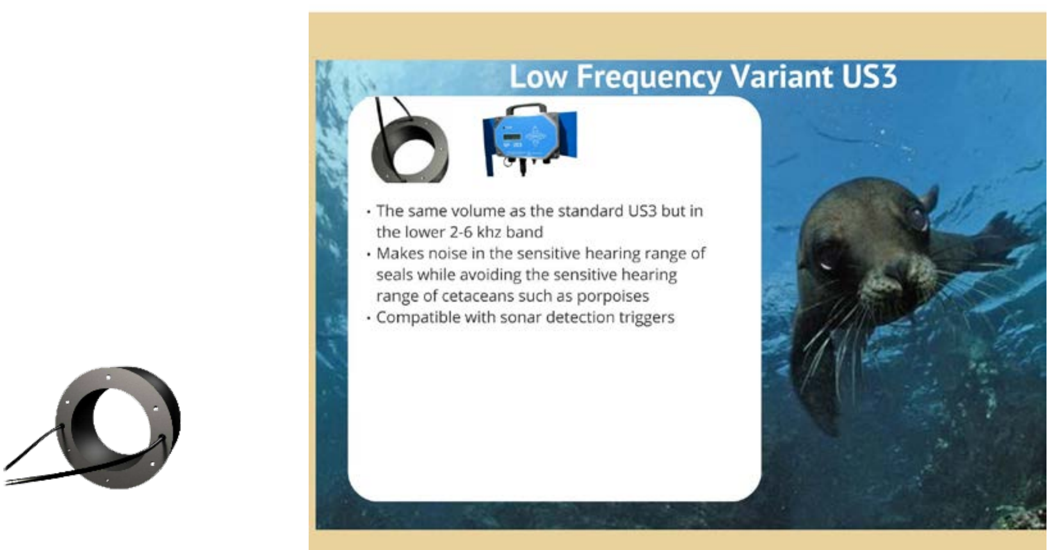
A.34. OrcaSaver™ by SaveWave (Image adopted from Ramphatos Investments website)



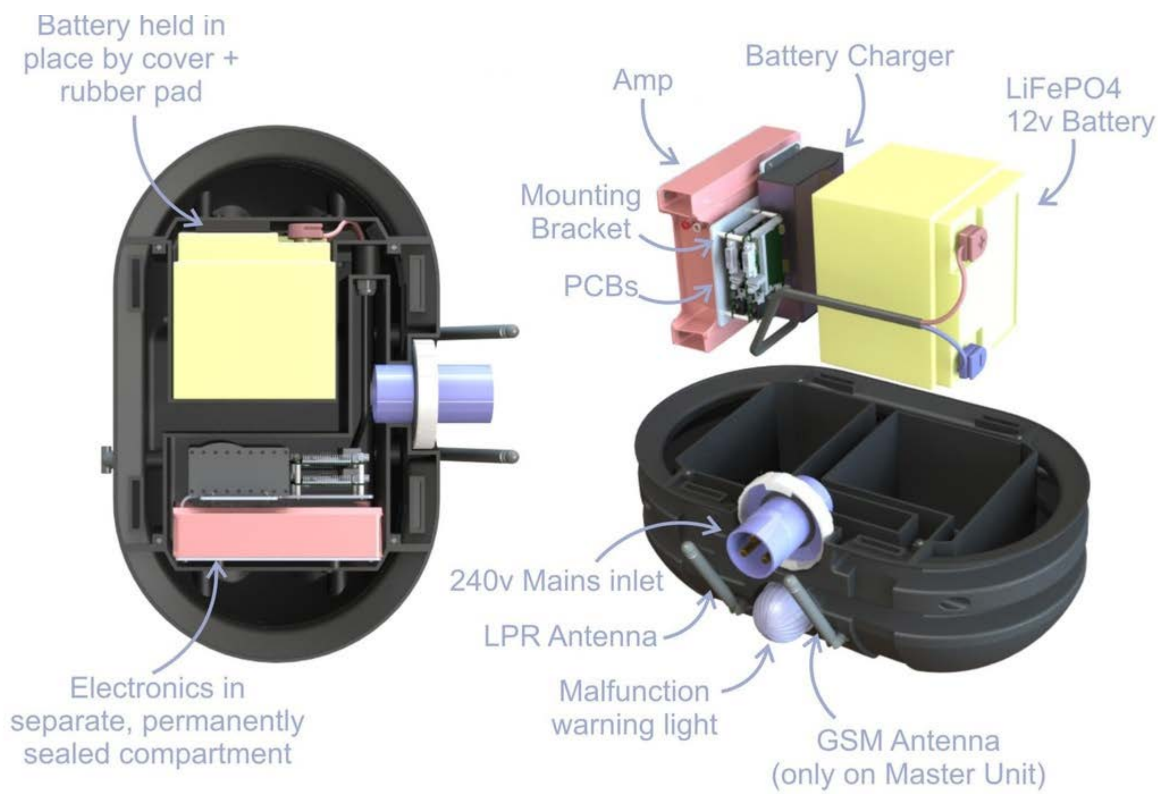
A.35. SealScarer by Lofitech AS Ltd. (Image adopted from Lofitech website)



A.36. SealScrammer US3 by Ace Aquatec. (Image adopted from [Ace Aquatec website]).



A.37. Low frequency variant of SealScrammer US3by Ace Aquatec. (Image adopted from [Ace Aquatec website]).



A.38. GenusWave SalmonSafe targeted acoustic startle technology. (Image adopted from www.salmonsafe.co.uk)

7.2 Appendix B – Characteristics of Acoustic Deterrents Analyzed in this EA.

A variety of different dB-based metrics can be used to characterize a sound source. The source level represents the SPL referenced at a distance of 1 m from the source and is written as dB re: 1 µPa at 1 m, while the received level is the SPL at the listener's position (i.e., 0 m from the listener) and thus is written as dB re: 1 µPa with no distance. Root mean square sound pressure level (RMS), a commonly used metric, is the quadratic mean sound pressure over the duration of an impulse. RMS is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick 1983). RMS accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). Sound exposure level (SEL; represented as dB re: 1 µPa2-s) represents the total energy contained within a certain time period and considers both intensity and duration of a sound. For a single pulse of an impulsive sound, SEL may be written as SELss, whereas cumulative sound levels over multiple pulses may be written as SELcum. Peak sound pressure level, PK, (also referred to as zero-to-peak sound pressure or 0-pk) is the maximum instantaneous sound pressure measurable at a specified distance from the source, and is represented in the same units as the RMS sound pressure.

Table B.1. Characteristics of impulsive explosive deterrents analyzed in this EA

Airborne source levels are referenced to 20 micropascals, while underwater source levels are referenced to 1 micropascal. Italics indicate where specifications were estimated because data were unavailable. Silent interval was determined to meet acoustic deterrent evaluation criterion.

Device	Frequency (kHz)	Source Level (RMS SPL)	Signal Duration (seconds)	Silent Interval Between Signals (seconds)	Duty Cycle
UNDERWATER					
Cracker shell	*0.2 to 10 kHz*	*200 dB*	0.01	320	0.005
Seal Bombs	<0.4 kHz	226 dB	0.03	180	0.0001
Underwater firecrackers	(<1 kHz)	127 dB	*0.1*	1	0.091
AIRBORNE					
Bear bangers used with pencil launchers	Broadband	115 dB	*0.1*	1	0.09
Bird Banger	Broadband	140 dB	*0.1*	1	0.09
Bird Bomb	Broadband	130 dB	*0.1*	1	0.09
Bird Whistler/Screamer	Broadband	115 dB	*30*	1	0.97
Cracker shell	Broadband	130 dB	*30*	1	0.97
Fireworks	Broadband	140 dB	*0.1*	1	0.09
Propane Cannon	Broadband	120 dB	*1*	30	0.032

Additional details for Seal Bombs

Seal bombs are low-energy explosive, acoustic harassment devices that contain a 2.33-gram (~36 grains) charge. Seal bombs are weighted so that they deflagrate at depths from 1 to 4 below the water's surface (Myrick et al. 1990a; Wiggins et al. 2019). Recent measurements of seal bombs made by Wiggins et al. (2019) are considered the best available science and were directly used in our analysis.

- Impulse (psi-ms) source level was used to evaluate the potential for lung injury (severe and slight injury): 29 psi-ms
    - Myrick et al. (1990a) provided predictions of how impulse levels change with distance from the source (up to 4 m). These predictions were used to extrapolate impulse levels up to 4 m from the source based on source levels provided by Wiggins et al. 2019.
- Root mean square (RMS) source level was used to evaluate the potential for PTS onset (SEL_{cum}): 226 dB

- For the SEL_{cum} metric NMFS needed to specify how often a seal bomb could be safely deployed.
- For NMFS analysis, it was assumed that seal bombs, even though they are broadband, produced the most sound at ~0.4 kHz (Olesiuk et al. 2010).

- <u>Peak sound pressure level (PK) source level</u> was used to evaluate the potential for GI tract injury and PTS onset (PK): 234 dB

Wiggins et al. (2019) measured transmission loss (X log R) associated with seal bombs and predicted spherical spreading (20 log R) 262 m from the source, which was the closest measurement taken. Their measurements occurred in depths ranging from 635 to 870 m off southern California. They indicate it is possible that nonlinear propagation with higher transmission loss than spherical spreading (e.g., high explosive modeling predicts X = 22.6) could be occurring closer to the source. Thus, NMFS relied upon 20 log R (spherical spreading) to evaluate seal bombs, supported by empirical data from Wiggins et al. (2019) that transmission loss is likely conservative (i.e., higher transmission loss possible closer to source). Furthermore, in this EA, NMFS evaluated seal bombs deployed every 180 seconds (3-minutes) in terms of the SEL_{cum} metric.

Table B.2. Characteristics of impulsive non-explosive deterrents analyzed in this EA

Airborne source levels are referenced to 20 micropascals, while underwater source levels are referenced to 1 micropascal. Italics indicate where specifications were estimated because data were unavailable. Silent interval was determined to meet acoustic deterrent evaluation criterion.

Device	Frequency (kHz)	Source Level (RMS SPL)	Signal Duration (seconds)	Silent Interval Between Signals (seconds)	Duty Cycle
UNDERWATER					
Banging objects (e.g., Oikomi pipes)	0.2 to 5.2 kHz	205 dB	0.001	18	0.00006
Actix Pulsed Powered Sea Lion Deterrent Device	Broadband	220 dB	0.0001	1200	0.0000001
HAI Aquaculture Predator Protection System (39 psi)	(mostly <0.1 kHz)	219 dB	*0.1*	300	0.0003
HAI Aquaculture Predator Protection System (27 psi)	(mostly <0.1 kHz)	215 dB	*0.1*	120	0.001
HAI Aquaculture Predator Protection System (12 psi)	(mostly <0.1 kHz)	208 dB	*0.1*	30	0.003
AIRBORNE					
Air guns/air rifles	Broadband	133.5 dB	*0.1*	*1*	*0.09*
Banging objects (e.g., pipes, cowbell)/passive acoustic deterrent (e.g., aluminum cans, chains, other makeshift wind chimes)	Broadband	113 dB	*1*	*1*	*0.50*

Table B.3 Characteristics of non-impulsive deterrents analyzed in this EA

For devices capable of a range of characteristics (e.g., adjustable source level, signal duration or silent interval between signals, or a broad range of frequencies), we used the maximum specification for the analysis. Italics indicate where specifications were estimated because data were unavailable. Airborne source levels are referenced to 20 micropascals, while underwater source levels are referenced to 1 micropascal.

Device	Source Level (RMS SPL)	Frequency (kHz)	Signal Duration (seconds)	Silent Interval Between Signals (seconds)	Duty Cycle
UNDERWATER ALARMS					
Ace Aquatec MMD (Low)	205 dB	1-5 kHz	2.5	25	0.091
Ace Aquatec MMD (Ultra LF)	184 dB	0.02 to 0.09 kHz	2.5	*25*	0.091
Ace Aquatec MMD (MF)	205 dB	8 to 24 kHz	2.5	*25*	0.091
Ace Aquatec MMD (HF)	184 dB	20 to 40 kHz	2.5	*25*	0.091
Ace Aquatec MMD: Standard	195 dB	10 to 20 kHz	*0.5*	*4*	*0.111*
Ace Aquatec MMD: Flood ring	190 dB	1 to 4 kHz	*0.5*	*4*	*0.111*
Ace Aquatec MMD: Omnidirectional	201 dB	10 to 30 kHz	*0.5*	*4*	*0.111*
Ace Aquatec RT1	195 dB	1 to 5 kHz	*4*	*46*	0.080
Ace Aquatec, Universal Scrammer3	193 dB	10 to 65 kHz	0.014	*0.014*	0.500
Ace Aquatec US2	194 dB	8 to 30 kHz	40	*1300*	0.030
Ace Aquatec US3	195 dB	10 to 20 kHz	*4*	*46*	0.080
Ace Aquatec US3 (variant)	194 dB	10 to 20 kHz	*0.5*	*4*	*0.111*
Ace Aquatec US3 (low-frequency variant)	194 dB	2 to 5 kHz	*0.5*	*4*	*0.111*
Airmar 70 kHz pinger	132 dB	70 kHz	0.3	3.7	0.075
Airmar dB Plus II	198 dB	10.3 kHz	0.0812	4.16	0.019
Airmar drift gillnet pinger	132 dB	10 kHz	0.3	3.7	0.075
Airmar Pinger	170 dB	1 to 3 kHz	1	19	0.050
Airmar Technologies Corp pinger	194 dB	10 kHz	4.3	0.099	0.023
Aquamark 200 pinger	145 dB	5 to 160 kHz	0.3	3.7	0.075

Device	Source Level (RMS SPL)	Frequency (kHz)	Signal Duration (seconds)	Silent Interval Between Signals (seconds)	Duty Cycle
AquaMark 300 pinger	132 dB	10 kHz	0.3	3.7	0.075
Aquamark 848	165 dB	5 to 30 kHz	*0.3*	*4*	*0.070*
Aquatec or Aquamark 100 pinger	145 dB	20 to 160 kHz	0.3	4.7	0.060
Aquatec or Aquamark 210 pinger	155 dB	5 to 160 kHz	0.3	4.7	0.060
Aquamark Responsive Pinger	165 dB	35 to 160 kHz	0.3	4.27	0.060
Aquamark Responsive Pinger	157 dB	35 to 160 kHz	1	4	0.200
Aquatec Continuous pinger	165 dB	20 to 160 kHz	0.999	4	0.200
Bird Alarm	*100 dB*	2 to 3 kHz	0.8	1.2	0.400
Custom Pinger (harbor porpoise)	125 dB	3 and 20 kHz	*0.5*	*4*	*0.111*
Dolphin Dissuasive Device (DDD) pinger	165 dB	5 to 500 kHz	*0.5*	*4*	*0.111*
Dukane 2MP Pinger	152 dB	9 to 15 kHz	0.3	2	0.130
Dukane HS20-80 pinger	118 dB	20 to 80 kHz	0.3	2	0.130
Dukane XP-10 Pinger	163 dB	9 to 15 kHz	0.3	4.8	0.059
Dukane Netmark 1000 pinger	146[f] dB	10 to 12 kHz	0.3	3.7	0.075
Ferranti-Thomson Mk2 Seal Scrammer	194 dB	8 to 30 kHz	*0.02*	*0.65*	0.030
Ferranti-Thomson Mk2 4x	200 dB	7 to 95 kHz	*0.02*	*0.65*	0.030
Ferranti-Thomson MK3 Seal Scrammer	135 dB	10 to 40 kHz	*0.02*	*0.65*	*0.030*
FishTek banana pinger BP154	154 dB	40 to 110 kHz	0.4	3.6	0.100
Fishtek Dolphin anti-depredation pinger	178 dB	40 kHz	0.3	3.7	0.075
Fishtek Porpoise & Dolphin	148 dB	50 to 120 kHz	0.3	3.7	0.075
Fishtek Porpoise & Dolphin	138 dB	10 kHz	0.3	3.7	0.075
Fishtek Whale	138 dB	3 to 20 kHz	0.3	3.7	0.075
Fumunda 3 pinger (whale pinger)	139 dB	3 kHz	0.3	3.7	0.075
Fumunda 10 pinger (porpoise)	132 dB	10 kHz	0.3	3.7	0.075

Device	Source Level (RMS SPL)	Frequency (kHz)	Signal Duration (seconds)	Silent Interval Between Signals (seconds)	Duty Cycle
Fumunda F70 pinger	145 dB	70 kHz	0.3	3.7	0.075
Future Oceans “Netguard” Porpoise pinger	132 dB	10 kHz	0.3	3.7	0.075
Future Oceans “Netguard” Dolphin pinger	145 dB	70 kHz	0.3	3.7	0.075
Future Oceans “Netguard” Whale pinger	145 dB	3 kHz	0.3	3.7	0.075
Future Oceans “Netshield” Dolphin Anti-Depredation pinger	175 dB	70 kHz	0.06	4	0.015
Gael Force Seaguard seal deterrent	198 dB	1.5 to 50 kHz	*0.5*	*4*	*0.111*
GenusWave (odontocete setting)	180 dB	10 kHz	0.2	1.8	0.100
GenusWave (pinniped setting)	180 dB	1 kHz	0.2	1.8	0.100
GenusWave Fishery Safe (pinniped setting)	182 dB	0.05 to 1.5 kHz	*0.2*	*4.8*	0.040
GenusWave Fishery Safe (odontocete setting)	175 dB	0.7 to 1.5 kHz	*0.2*	*4.8*	0.040
GenusWave Turbine/Construction Safe (pinniped setting)	182 dB	0.5 to 1.5 kHz	*0.03*	*5*	0.006
GenusWave Turbine/Construction Safe (odontocete setting)	185 dB	5 to 20 kHz	*0.03*	*3.5*	0.008
GenusWave, SalmonSafe	182 dB	0.7 to 1.5 kHz	*0.2*	*20*	0.040
HP 33120A	161 dB	8, 16, 32, 45 kHz	0.25	4.75	0.050
HPTRP pinger specifications	136 dB	10 kHz	0.3	3.7	0.075
IFREMER/IXTrawl CETASAVER	190 dB	30 to 150 kHz	1	2	0.333
IFREMER/IXTrawl CETASAVER V.03	165 dB	30 to 150 kHz	1	2	0.333
Lien	123 dB	2.9 kHz	0.3	0.3	0.500
Lofitech seal scarer	198[i] dB	10 to 20 kHz	0.752	*4*	*0.158*

Device	Source Level (RMS SPL)	Frequency (kHz)	Signal Duration (seconds)	Silent Interval Between Signals (seconds)	Duty Cycle
Lofitech universal seal scarer	182 dB	14 kHz	0.5	*1.5*	0.250
Loughborough University LU-1 pinger	145 dB	40 to 120 kHz	0.3	4.7	0.060
Marexi pinger V2.2	132 dB	10 kHz	0.3	3.7	0.075
Maritime Technology Porpoise PAL	145 dB	133 kHz	1	7	0.125
Maritime Technology 10 kHz PAL	132 dB	10 kHz	0.3	3.7	0.075
Maritime Technology Wideband PAL	145 dB	20 to 160 kHz	0.3	3.7	0.075
Maritime Technology Whale PAL	145 dB	3 kHz	0.3	3.7	0.075
Modified Aquatec Responsive Pinger	157 dB	20 to 160 kHz	10	1	0.909
OTAQ SealFENCE: Patrol Mod	165 dB	9 to 11 kHz	2	20	0.091
OTAQ SealFENCE: Protect Mode	189 dB	9 to 11 kHz	3	3	0.500
PALfi porpoise alarm	153 dB	115 to 141 kHz	1.30	56.1	0.023
PICE-99 pinger	145 dB	20 to 160 kHz	0.3	3.7	0.075
Savewave HiProtect	145 dB	20 to 80 kHz	0.3	2.7	0.100
Savewave Orca Saver	198 dB	6.5 kHz	1	*4*	0.200
Savewave Seal Salmon Saver	155 dB	5 to 160 kHz	0.9	3.1	0.225
Savewave Long Line Saver	155 dB	5 to 60 kHz	0.4	3.6	0.100
Savewave Endurance Saver	140 dB	5 to 90 kHz	0.4	3.6	0.100
Seacom Netmark 1000 pinger	130 dB	10 to 80 kHz	0.4	3.6	0.100
Sealchaser	188 dB	12 to 15 kHz	0.06	0.2	0.231
Seamaster Fish Protector	165 dB	10 to 90 kHz	1.9	13.1	0.127
Seamarco Fauna Guard Porpoise	172 dB	6 to 150 kHz	18	3	0.857
Seamarco Fauna Guard Seal	182 dB	0.2 to 20 kHz	10	3	0.769

Device	Source Level (RMS SPL)	Frequency (kHz)	Signal Duration (seconds)	Silent Interval Between Signals (seconds)	Duty Cycle
Seamarco Fauna Guard Turtle	197 dB	0.2 to 1 kHz	10	*6.7*	0.600
Seamarco Fauna Guard Fish	197 dB	0.2 to 1 kHz	10	3	0.769
Simrad "Fishguard"	191 dB	15 kHz	0.5	*0.5*	0.500
STM Products DDD-02F	174 dB	5 to 150 kHz	9	*4*	*0.692*
STM Products DDD-03L	174 dB	5 to 500 kHz	9	141	0.060
STM Products DDD-03N	174 dB	5 to 500 kHz	9	81	0.100
STM Products DDD-03H	174 dB	30 to 80 kHz	9	31	0.225
STM Products DDD-03U	174 dB	5 to 500 kHz	9	16	0.360
STM Products Dolphin Interactive Dissuaser (DiD01)	174 dB	5 to 150 kHz	9	*4*	*0.692*
Terecos Ltd, DSMS-4 (Program 1)	178 dB	1.8 to 3.8 kHz	0.08	*0.08*	*0.500*
Terecos Ltd, DSMS-4 (Program 2)	179 dB	4.7 to 6.8 kHz	*0.08*	*0.08*	*0.500*
Terecos Ltd, DSMS-4 (Program 3)	178 dB	2.4 to 6 kHz	0.064	*0.064*	*0.500*
Terecos Ltd, DSMS-4 (Program 4	178 dB	1.8 to 6 kHz	*0.08*	*0.08*	*0.500*
Wave generator (FG501, Toellner 7607, EDO 6166) pinger	125 dB	50 kHz	1	0	1.000
Wavetek 136 or HP 3314A	153 dB	100 to 140 kHz	0.2	3.8	0.050
UNDERWATER OTHER (NON-ALARMS)					
Directional transducer	205 dB	10 to 15 kHz	*0.5*	*4*	*0.111*
Killer Whale Vocalizations	170 dB	0.6 to 10 kHz	*1.8*	*0.001*	*0.999*
Lubell underwater speaker	197 dB	1, 10, 25, and 32 kHz	*0.2*	*4*	*0.048*

Device	**Source Level (RMS SPL)**	**Frequency (kHz)**	**Signal Duration (seconds)**	**Silent Interval Between Signals (seconds)**	**Duty Cycle**
Underwater Noise Pulses from Panasonic SL-S120 CD player	170 dB	10 kHz	*0.2*	*0.005*	*0.976*
AIRBORNE					
Air horn	129 dB	Broadband			*1*
In-air noise maker (e.g., vuvuzela)	131 dB	Broadband			*1*
Sirens	120 dB	Broadband			*1*
Whistles	127.6 dB	Broadband			*1*