Bycatch Reduction Technique
Acoustic Deterrents 2017

Fact Sheet 1

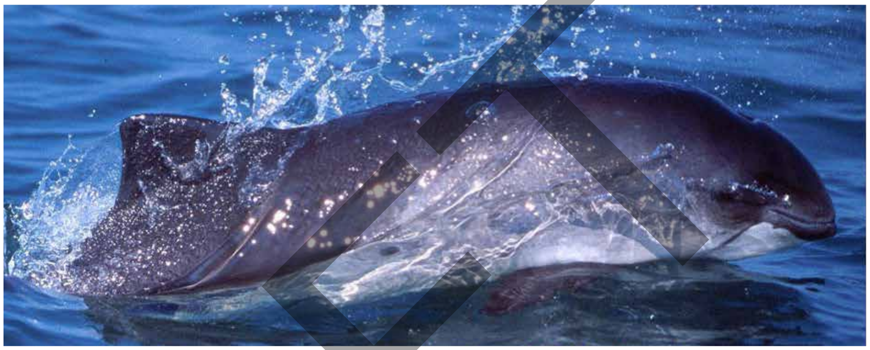


Photo: A. Friedlander

Technology Overview

Acoustic deterrents refer to a range of devices that emit or reflect sound deployed on or in the vicinity of fishing gear. They are designed to prevent interactions of nontarget species with fishing operations and are developed for marine mammal interactions.

The units that actively produce sound span a range of power output (measured in decibels [dB]), frequencies (Hz), and the periodicity of sound emission (its duty cycle, which may be regular, random, or triggered by echolocating cetaceans). Passive methods have also been proposed and tested as a way to alert species that use echolocation to the presence of fishing gear. Other devices are designed to mimic the noises produced by predators of marine mammals. Finally, pyrotechnics are used to scare away marine mammals by producing noise in air or water and causing pain or bodily injury when animals are hit by shotgun projectiles or detonated explosives.

Acoustic deterrents are the most widely researched and implemented technique for deterring marine mammal interactions with fisheries, so an exhaustive review of the research is not provided here. Summaries of nearly all studies undertaken are available through a search of the bycatch.org database by using the search term "acoustic deterrents."

Photo: L. Bernistone

Harbor porpoise *(Phocoena phocoena)* (top), Franciscana dolphin *(Pontoporia blainvillei)*(above): species for which multiple pinger trials have shown reduction in bycatch

Photo:S. Dawson

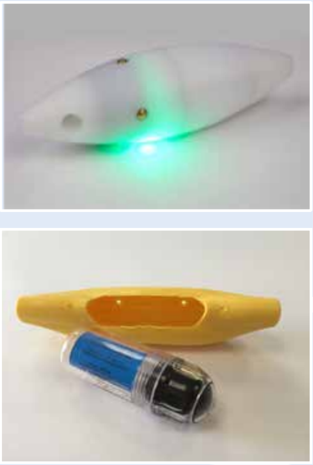
Hector's dolphin *(Cephalorhynchus hectori)*, a species for which pingers have not been shown effective

Utility of Technology

Marine mammals exhibit a wide variation in behavioral responses to acoustic deterrents. Among the factors that influence their responses include:

- **Species differences.** Different marine mammal species respond differently to acoustic deterrents. Harbor porpoise *(Phocoena phocoena)* avoided areas ensonified with acoustic pingers (typically at 10 kHz and 132 dB re 1 µPa @ 1 m) in more than a dozen experimental trials in different parts of the world. Where these pingers have been implemented in gillnet fisheries, bycatch reductions have occurred. Similar results have been obtained from either controlled experiments or analysis of long-term bycatch data involving more than 10 other small cetacean species. For others, no area avoidance effects were detected. In fact, some species may associate the acoustic signature of pingers with the presence of prey, and thus pingers may produce an opposite effect by attracting these species to fishing gear (Dawson et al., 2013). A large body of evidence indicates that pingers do not reduce bycatch of seals and sea lions, and often may create a "dinner bell" effect, in which the animals are attracted to fishing gear (Bordino et al., 2002; Caretta and Barlow, 2011). For baleen whales, no study from any fishery has demonstrated their utility in reducing gear entanglements (Werner et al., *in prep.*).
- **Different hearing sensitivities of individual animals and background environmental noise.** Repeated exposure to high-intensity sounds, or the emission of sound within environments already saturated with other noise such as from ship traffic, seismic surveys, depth sounders, fish finders, naval sonar, etc., can desensitize the ability of individual marine mammals to perceive acoustic deterrents (NRC, 2005). Furthermore, sound directionality can be critical, and sound waves propagate differently depending on factors that include water clarity, depth, temperature, and salinity.
- **Sound characteristics.** Active acoustic deterrents are sometimes categorized according to the intensity of disturbance they are intended to produce on their animal targets. At one end of the spectrum, Acoustic Harassment Devices (AHDs) generally use higher sound outputs to keep animals at bay, often by inflicting pain or discomfort, whereas Acoustic Deterrent Devices (ADDs) typically attempt to alert or warn marine mammals about the presence of fishing activity, but similarly seem to function by excluding animals from an area. Although the difference is not always clear-cut, this factsheet uses the convention of making a distinction between AHDs and ADDs, arbitrarily using 180dB as the dividing line for how to designate one type versus the other (Long et al., 2015). Acoustic deterrents have been tested in gillnet, trap, and trawl fisheries. AHDs are frequently used in aquaculture operations to keep seals and sea lions from preying on farmed fish. Also known as "seal scarers," these devices are intended to harass using sound. Several field evaluations of different versions of these devices have shown a temporary deterrent effect. However, the seals that were exposed to the sounds eventually overcame their initial avoidance of the ensonified area--that is, they habituated to the noise (Geiger and Jeffries, 1987; Gearin et al., 1988; Fjällinga et al., 2006). No study of whales has yet occurred as part of a fishing operation. However, behavioral studies so far have not indicated that acoustic deterrents are an encouraging strategy for reducing entanglements in gear.

An Argentine gillnet fisherman using a Dukane pinger. Several pinger trials in this fishery have shown that pingers produce significant reductions in bycatch of Franciscana dolphin *(Pontoporia blainvillei)*.



Examples of pingers:
(top) a 70kHz pinger with an LED;
(above) a Fishtek "banana pinger."

- **Type of deterrent.** *Passive deterrents* use air-filled or metallic components incorporated into fishing gear to increase their detection by echolocating cetaceans. This technique would be relatively cheap and easy to implement. However, it is generally not considered an effective approach and would only apply to animals that echolocate and do not depredate target catches. *Predator sounds*, which have mainly involved playing back killer whale sounds, showed some potential for deterring particular marine mammal species, but they can also affect the behavior of target fishes and therefore lead to reduced target catch (see, for example, Doksæter et al., 2009). With *active deterrents*, such as pingers and AHDs, variability in sound intensity, frequency, duty cycle, and directionality can produce different results. Also, units may not always perform according to manufacturer specifications, which can influence their efficacy.
- **Deployment.** The distance between where pingers are attached along a net can result in different levels of bycatch. For example, Larsen et al. (2013) increased pinger spacing to more than double that of the specified regulatory requirement for gillnets (every 200 meters), and recorded no bycatch of harbor porpoise, whereas an increase in an additional >100 meters did produce bycatch. Where fixed fishing gear is especially dense and acoustic deterrents effective, the entire fishing area may become ensonified so animals can become excluded entirely from those areas. This can be a problem if the habitat is critical to the population's survival. Also, under areas of high fixed gear density, the area avoidance effect in one set of gear may redirect an animal toward another set of gear or a gap in the sound coverage area, which can potentially increase bycatch.
- **Fishing gear.** Acoustic deterrents are mainly used in gillnets (including driftnets) and aquaculture. Tests in trawl gear have shown limited utility.

Guidelines for Evaluating the Potential Utility of ADDs

- *Does it work with the species of concern?* Evidence that it shows a deterrent effect on the population of concern can be tested through: (1) behavioral trials to determine if populations avoid the areas ensonified; (2) fisheries trials comparing bycatch between ensonified gear and non-ensonified gear; or (3) fisheries observer data showing that the use of acoustic deterrents cause bycatch reduction over time.
- *Does the population of animals become habituated to the deterrent's sound such that it no longer avoids the area where fishing occurs?* Evidence can be collected from one or more field studies on habituation over time.
- *Will population or environmental consequences outweigh likely bycatch benefits?* Evaluations should be carried out to examine: (1) if the area to be ensonified is of a size that would likely exclude the population from critical habitat; (2) that the deterrent will not have lethal or sub-lethal effects on the population such as by causing pain and suffering; (3) whether or not the size of the population is so low (endangered) that area displacement could force it to move into areas where it would be exposed to other threats (Forney et al., 2017); (4) if ADDs increase interactions with other nontarget marine mammals, such as through the "dinner bell effect"; and (5) if other adverse consequences to other species or the local environment are likely to occur.
- *Will use of the deterrents maintain fish catch CPUE and target sizes?* Fortunately, acoustic deterrents generally have been shown to not reduce target catch levels, but this should be determined on a case-by-case basis.
- *What type of deterrent is likely to be most effective?*
- *What are the acoustic characteristics of the environment in which the units would be used?* This can be measured using hydrophones.
- *What is the cost/fisherman of using acoustic deterrents?*

Unfortunately, there is no guarantee that a successful trial from one fishing ground will indicate success in another, and it is often the case that experimental results achieve higher bycatch reductions than in an actual fishery (Dawson 2013). Furthermore, the species of concern may not be one for which acoustic deterrents have yet been trialed. In those instances, one option is to carry out a relatively quick and inexpensive behavioral trial to see if the local animal population shows a larger closest proximate distance to a sound source when it is on versus off (see, for example, Carlström et al., 2009). If no area avoidance effect is observed, the use of another bycatch reduction technique likely makes more sense. Acoustic deterrents can also work in synergy with other techniques, such as time-area closures, to mitigate the potential downside of habitat exclusion (van Beest et al., 2017).

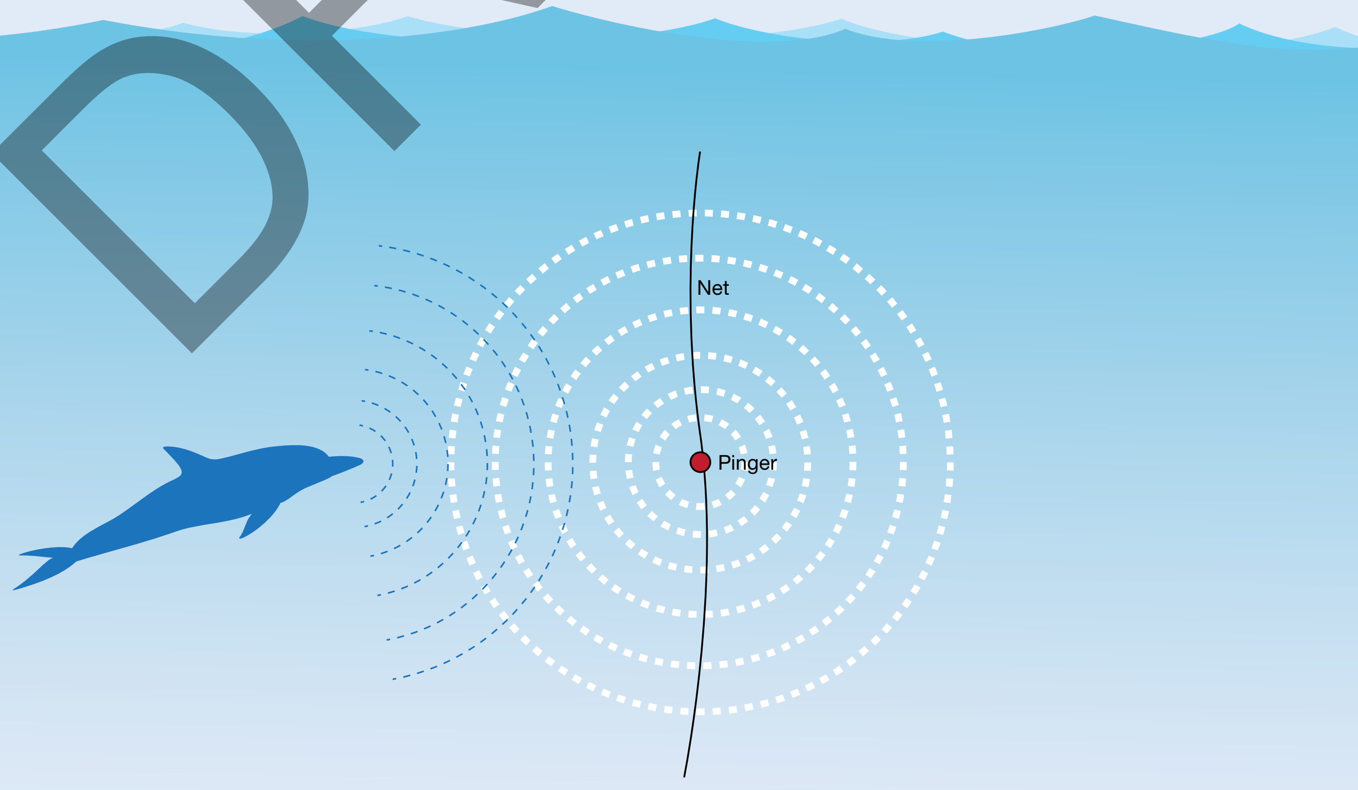
There have been almost no evaluations of acoustic deterrents for reducing bycatch of other animal groups. With seabirds, one study did show a reduction in bycatch of the Common Murre (Uria aalge) (Melvin et al., 1999) but not the Rhinoceros auklet (Cerorhinca monocerata).

Operational and Safety Considerations for Using Acoustic Deterrents

As with fishing gear, deterrents require maintenance. Most devices are about the size of a carbonated beverage can, and should be checked regularly to ensure they are functioning adequately. Bat detectors or hydrophones can measure the frequency of units that are inaudible to the human ear, and some pingers now include LEDs that flash to indicate their batteries are operating.

Fishermen report battery life and the relative high cost of pingers as their main concerns about using them. Individual units can cost between approximately $100 and into the $1000s, and batteries can last for two or more years, but for less time if emitting sound more frequently. Gillnets require several pingers along a net string at varying intervals but as close as every 50 meters, such that a single fisherman would need multiple units. In the northeastern United States, fishermen have reported devices exploding when deployed in deeper waters. However, newer units have been redesigned to take this problem into account. Pyrotechnics obviously involve some danger of detonation and require special safety precautions when using them. Due to their lethality and potentially severe health effects on the targeted animals, the use of these devices should not be encouraged.

A net showing how a pinger works, showing how the sound field around a net creates an exclusion zone.



Acoustic Deterrent Resources

Research Organizations with Experience in Acoustic Deterrents

Aquamarina, Argentina – *http://aquamarina.org/*

Consortium for Wildlife Bycatch Reduction, New England Aquarium – *http://www.bycatch.org/*

Duke University, Marine Lab – *https://nicholas.duke.edu/marinelab*

National Institute of Aquatic Resources, Technical University of Denmark – *http://www.aqua.dtu.dk/english*

NOAA Southwest Fisheries Science Center – *https://swfsc.noaa.gov/*

NOAA Northeast Fisheries Science Research Center – *https://www.nefsc.noaa.gov/*

Pro-Delfinus, Peru – *https://www.prodelphinusperu.com/*

St. Andrews University, Sea Mammal Research Unit – *http://www.smru.st-andrews.ac.uk/*

Industry Groups with Experience in Using Pingers

California Seafood Council – *http://caseafood.californiawetfish.org/*

Northeast Seafood Coalition – *https://northeastseafoodcoalition.org/*

Some Manufacturers of Acoustic Deterrents

AQUAMark – *http://www.aquatecgroup.com/*

Fishtek – *https://www.fishtekmarine.com/*

Future Oceans – *https://futureoceans.com/*

STM Products – *http://www.stm-products.com/en/company.html*

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New England Aquarium

Protecting the blue planet

This Factsheet was produced by the Consortium for Wildlife Bycatch Reduction as a tool for commercial fishermen and fish farms in considering the use of such devices to reduce bycatch or interactions between catch and non-target catch.

Please direct any questions or comments to bycatch@neaq.org.