

Natasha, Amelia, & Miranda

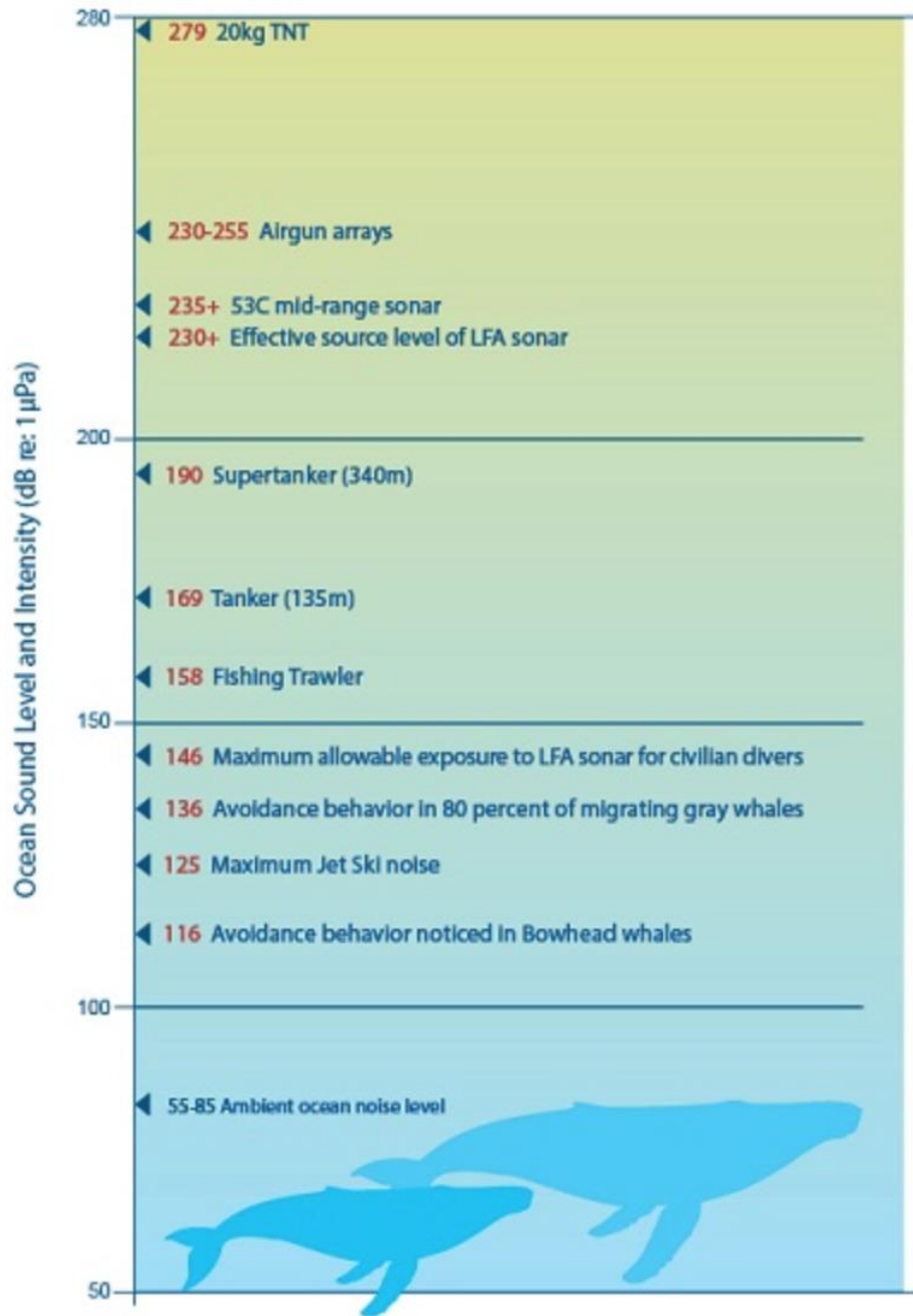
Noise Pollution & Whales

1. Define the challenge (Basic introduction to the topic)-Amelia (have the introduction be interrupted by loud noise) *

We often think of the oceans as these quiet pristine landscapes but the truth is that they are becoming increasingly noisy places.

Between increased shipping traffic, sonar testing, and seismic surveys for fossil fuels, the ambient background noise in the ocean has doubled every decade since the 1950's and intermittent noise pollution sources are increasing as well. So imagine your home's natural background noise getting constantly louder and random, loud bursts of noise are increasing too. It's of no surprise then that this noise is creating a lot of issues for marine animals living in the ocean, and as of 2005, the UN now recognizes anthropogenic noise as a form of pollution.

To put these noise levels in the ocean into context, I have converted the noise levels of common sources of noise pollution in the ocean into decibel levels that we humans are used to hearing. Decibels are the way to measure the amplitude of a sound wave and contributes to the noise level we hear it at. With an increasing decibel level meaning a louder noise. A quick conversion needs to occur to go from ocean decibel readings to air decibel readings due to the pressure difference of the two mediums. 120 db in the air does not sound the same as 120 db underwater. Since water has more pressure than air, the decibel reading in water is higher than in air for the same level of noise in your ears. Additionally sound travels farther and faster in water than in air so these loud noises can often be heard thousands of kilometers away, making the distribution of noise in the ocean even worse. So imagine these noise sources in the air also travelling thousands of miles, no wonder the oceans are becoming increasingly noisy.



The ambient background noise of the ocean is currently about 40 air dB which is around the level of a quiet conversation, so not too terrible.

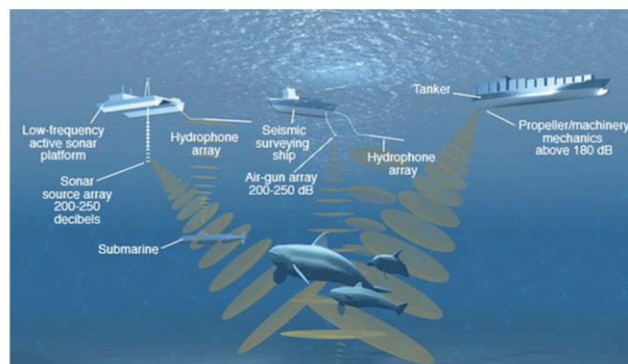
The noise level of a large boat propeller is about 180dB, the equivalent of 120 dB which is about the noise level of a loud car stereo.

The sonar the Navy tests register around 200-250db in the water which is equivalent to about 140db and a gunshot going off a meter away from your ear.

The airgun seismic survey blasts register around 255dB which is the equivalent of 190dB which is almost the limit as the what the atmosphere can register db (194dB). Nothing we experience registers on the scale, but for some context a jet engine taking off 30m away is only 150dB. And humans start experiencing pain at 130dB.

This noise pollution is creating lots of problems for marine life but some of the most well documented issues relates to whales in the ocean, both toothed whales and baleen whales. Their communication is interrupted and masked by this noise which is crucial to feeding, breeding, and childcare. It is speculated that many mass strandings of whales is caused by Navy sonar. It is predicted that whales can experience “the bends” from diving too fast to get away from noise. Many scientists are also worried that their prey is being affected from noise pollution as well.

However noise pollution is hard to address due to the frequency of the sound emitted depends on the type of engines, the type of propellers, the speed of the vessels, the distance of the vessel from wildlife, and even the temperature and salinity of the water. But there are some ways that scientists recommend turning down the volume on our oceans that have proven effective. Additionally this is one of the human induced problems facing our oceans today that can be instantly ceased.



Watch this acoustic buoy video to learn more about the important tools scientists use for ocean noise research. (NOAA)
[Download Image](#)

- o <https://www.noaa.gov/explainers/soundcheck-ocean-noise>

Source (

The potential area impacted by even one noise source can be large. For instance, the US Navy's low-frequency active (LFA) sonar, used to detect submarines, has a potential area of impact (over which received levels of 120 dB and above can be heard) on cetaceans estimated to be around 3.9 million km² (Johnson 2003), though it is probably audible to cetaceans over a much larger area. Noise from a single seismic survey, used to discover oil and gas deposits under the sea floor, can cover a region of almost 300 000 km², raising noise levels two orders of magnitude (20 dB) higher than normal, continuously for days at a time (International Whaling Commission 2005). Seismic survey noise from eastern Canada measured 3000 km away in the middle of the Atlantic was the loudest part of the background noise heard underwater (Nieukirk et al. 2004). Ocean background noise levels have doubled every decade for the last several decades in some areas, probably as a result of increases in commercial shipping (Ross 1993; Andrew et al. 2002; International Whaling Commission 2005; McDonald et al. 2006).

Source: (The impacts of anthropogenic ocean noise on cetaceans and implications for management) <https://www.nrcresearchpress.com/doi/full/10.1139/Z07-101#.XO7Nki> MwnU

- Types of anthropogenic noise: <https://awionline.org/content/ocean-noise>
2. Evidence against the challenge (Is there any opposition to this topic)- Miranda

While noise pollution has been widely accepted as a serious threat to the sustainability of cetacean species for a variety of reasons, it is important to note the other threats that whales specifically are faced with:

- Ship trafficking, as Amelia mentioned, is a major source of noise pollution but is also responsible for several of the collision events experienced by whales. Blue whales in particular are most at risk for colliding with large vessels as they often feed at the water's surface and are very slow when diving to avoid an oncoming vehicle. These events have been shown to result in serious injuries and often death of whales. For example, in December of 2016 the whale J34, known as Double Stuf, was found floating off the coast of southern British Columbia, Canada. It was concluded that Double Stuf's death was caused by blunt force trauma from a ship strike. More recently, a Seattle ferry traveling to Bainbridge Island struck a gray whale that had unexpectedly surfaced approximately 5 feet in front of the vessel. Passengers described the whale as bleeding profusely directly after the collision before sinking below the water's surface. Investigations were unsuccessful in locating the whale and it is now presumed to be dead. Fishing vessels have been responsible for a number of these collisions worldwide, and these vehicles have an even greater impact on these organisms, specifically their food accessibility.

- As the diets of many whales can vary by species or environment, the impacts of fisheries on these organisms has been immense. A study in 2009 done by Dr. John Ford found that killer whales, for example, depend on a large population of Chinook salmon for sustenance. They demonstrated that the decline in killer whale populations was directly correlated with similar declines in the population of the salmon. Not only are fisheries depleting the available food resources for whales, but these mammals have also been impacted by bycatch, an event where non-target marine organisms are caught inadvertently during commercial fishing.
- Though bycatch has a large impact on all non-targeted marine species, it is estimated that at least 300,000 cetaceans are accidentally caught because of bycatch every year. Whales are also being tangled in fishing gear, such as nets, and due to such physical restriction has resulted in several of their deaths. For example, in April 2019, a humpback whale washed up off the coast of the United Kingdom and its death was attributed to the fishing gear it had been wrapped in for months, which most likely caused the whale to drown.
- While all of these issues and several more, such as water contamination, whaling in the 19th and 20th centuries, and climate change, have a compounding effect on whale populations and their survival, noise pollution, however, is of primary concern as it has the most direct effect on the lives of these talkative organisms.
- Sources:
 - i. <http://wildwhales.org/threats/>
 - ii. <https://www.nbcnews.com/news/us-news/ferry-strikes-whale-near-seattle-n1011211>
 - iii. <https://www.fisheries.noaa.gov/insight/understanding-vessel-strikes>
 - iv. <https://www.fisheries.noaa.gov/insight/understanding-bycatch#what-is-noaa-fisheries-doing-to-address-marine-mammal-bycatch?>
 - v. <https://iwc.int/bycatch>
 - vi. <https://www.bbc.com/news/uk-scotland-edinburgh-east-fife-48051954>
 - vii. https://wwf.panda.org/knowledge_hub/endangered_species/cetaceans/threats/

3. Evidence supporting the challenge (research evidence)-tash

In 2002, a series of navy sonar activities testing midrange frequency sonar off the coast of the Canary Islands resulted in mass strandings of 14 whales. For the first time, scientists were able to examine each whale postmortem. In all whales, they found congestion and hemorrhage around the acoustic jaw fat, ears, brain, and kidneys. Lesions associated with gas-bubbles, which accumulate during a fast ascent from depth to shallow waters, and fat embolisms were

present in vital organs. SCUBA divers may experience a sickness called “the bends” if they ascend from deep water to shallow water too quickly. It can result in bubbles in your blood that are filled with nitrogen that makes your bones and joints ache so bad you want to ‘bend’ over. Just like SCUBA divers experience this, so do whales. The injuries these whales sustained are directly related to the navy testing activities and this was one of the first studies to prove justly so.

Other studies found that whales avoid boats or are completely displaced by them, often leaving valuable habitats because of stress levels.

Another study explored the noise levels associated with oil frackers and with humpback whales that inhabit the waters close to oil frackers. Off the coast of Brazil, there is a large aggregation of oil platforms that are directly in critical humpback habitats. Over a span of 2 years, 527 hours of acoustic samples of humpback whales and environmental noise were recorded on 69 separate days. During 10 of those recording sessions, humpback whale sounds and sounds coming from oil platforms were detected simultaneously, with oil platform sound frequency at the same or higher pitch than the whale noises. This could lead to masking of important communication calls such as mating, finding food, or detection of a predator by the humpback whales.

4. Case study examples- tash

A study conducted by scientists in the Bay of Fundy investigated the frequencies of baleen whale communication and their associated stress levels before and after the events of 9/11. The reduced ship traffic in the Bay of Fundy following the incident resulted in a reduction in noise by 6 decibels and 150 hz. Scientists were able to collect fecal matter from the whales to test stress levels and found that the reduction in noise was associated with a decrease in stress-related faecal hormones in the North Atlantic Right Whales. This is the first type of evidence that supports that low-frequency ship noise can cause chronic stress in right whales, which has implications for all baleen whales.

4. What could be the full extent of the consequences (big picture impacts) - Miranda

Noise pollution is already having direct effects on whale populations worldwide. As Natasha mentioned, the stress levels of whales are rising, which has negative impacts during long term exposure as this harms both their health and reproduction. Reproduction is most directly impacted by noise pollution as it has been shown to mask mating calls and may cause them to flee their native habitat for more dangerous, but quieter regions. Noise pollution is also projected to have indirect effects on whales and

entire marine systems. A 2017 study by Dr. Robert McCauley found that noise pollution could contribute to a bottom-up trophic cascade as a softer blast than is caused by a seismic gun killed $\frac{2}{3}$ of the phytoplankton in a $\frac{3}{4}$ mile radius. As phytoplankton make up the base of the marine food web, excessive depletions of these populations worldwide have the potential to remove food sources for all whales. Phytoplankton serve as a food source for zooplankton, such as krill and copepods. A decrease in phytoplankton would reduce the populations of essential zooplankton which serve as the main food source for baleen whales. Reduced zooplankton would also impact all toothed whales as zooplankton are a common food source for several marine fish. Marine fish are an important food source for toothed whales and if these fish populations were to decrease, these whales would be left with fewer food resources and could lead to unusual behaviour that may impact other food webs. It has been hypothesized that the aggressive whaling on right whales in the 19th and 20th centuries led killer whales to seek new food sources, such as seals. When that food source was depleted, they moved on to hunting sea otters, and this behaviour has greatly contributed to the excessive deforestation of kelp forests as sea otter predation no longer controls the feeding of sea urchins on kelp. It is also important to note the direct effects of noise pollution on marine fish as these organisms have been found to have decreased survival in noisy areas. Noise pollution from seismic testing has been shown to not only kill fish eggs and larvae, which greatly hinders the proliferation of fish populations, but can rupture the swim bladders of fish, which they use to modulate their buoyancy. This testing has also been found to rupture ear cells as well as cause internal bleeding and blindness. Sonar testing and seismic blasts have both been implicated in inducing chronic stress responses and hindering predation responses in marine fish which may also contribute to declining fish populations. As all of these consequences can be exacerbated by each other, noise pollution will likely be responsible for the collapse of whale populations as their health and reproduction are directly compromised as well as the destruction of necessary food web systems.

Sources:

- <https://www.nationalgeographic.org/media/plankton-revealed/>
- <https://www.nytimes.com/2019/01/22/science/oceans-whales-noise-offshore-drilling.html>
- <https://www.nature.com/articles/s41559-017-0195>
- <https://www.westcoast.fisheries.noaa.gov/protected-species/marine-mammals/cetaceans/baleen-and-toothed.html>
- <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0139157>

- <https://web.whoi.edu/big/how-marine-construction-impacts-more-than-just-the-seabed/>
- <https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2015/09/the-effects-of-underwater-noise-on-marine-life>
- <https://www.sciencedirect.com/science/article/pii/S0025326X17305647>

5. Are there solutions or actions we can do?-Amelia

Ocean noise pollution is one of the few human induced noise pollution sources today that we can instantly cease. Once the noise stops, the problem stops. Over the last decade many large government and non government agencies have tried to make guidelines and regulations regarding the reduction of noise pollution.

In 2016 the National Oceanic and Atmospheric Association released their “Ocean Noise Strategy Roadmap”. This document outlines “several approaches that (NOAA) can take with other federal and non-federal partners to reduce how noise affects the species and places we manage,”. The document is meant to help curb noise pollution in the next 10 years from 2016. And they have been acting on some of these promises like implementing more extensive ocean acoustic monitoring devices.

In this document some solutions to the problem include

- Creating **designated “quiet” zones** where commercial shipping/sonar/seismic testing cannot occur. These quiet zones would be areas of high importance to whale species such as areas important to mating and calf rearing. NOAA recommends that these spatial and temporal distancing techniques are the most effective for cetaceans and noise harm but other technologies are being developed as well.

Other solutions are based on “source quieting methods” which aim to reduce the noise output of some of the most common noise pollution sources.

For **large boats** regular maintenance, change of propeller design, and speed reduction can decrease noise. However at this time the regulations surrounding decreased noise for boats is voluntary and nothing is binding or enforced. These regulations were adopted by the IMO (International Maritime Organization) in 2014.

For **seismic surveys** of fossil fuels changes in technology have been discovered. One solution is in marine vibroseis. Marine vibroseis is a technique that still relies on the output of noise for seismic surveying but instead of one loud high decibel blast from an airgun it now uses lower decibel emissions over a longer period of time to achieve the same result, not just resulting in a quieter background hum of around 40 dB. This technology is still in its testing phase but is

showing promising results. Another design change being looked into is to change the design of the airgun so the blast is directed almost perfectly vertical as to reduce noise pollution out horizontally.

For sonar testing it becomes trickier. While the navy has been taken to court numerous times by Environmental organizations for breach of environmental policies, the outcomes are not consistent. This is because the issue of balancing national security and marine safeguarding appear to be at odds. In 2008 a Supreme Court Ruling claimed that the Navy could not comply with Environmental Regulations such as NEPA, if the compliance was a threat to national security. Many environmentalists have claimed that they don't want the navy to stop sonar testing all together but change the noise level in training operations and move the training to less significant areas of importance to whales. Currently in the United States the Navy is required to turn off sonar systems if animals are in the area and are banned from using pulses higher than 180 decibels within 22.5 kilometres (14 miles) from coasts, especially coastlines belonging to 'biologically important' areas. But some environmentalists are skeptical that this protocol is being met and are pushing for more strict operation policies.

Overall many international bodies such as the UN, International Maritime Organization, and the EU have all agreed that anthropogenic noise pollution (caused by humans) is a problem and are calling for and funding more research into the problem. However international regulations and laws surrounding noise pollution are still lacking. Pressing for more concrete stringent laws and regulations for noise pollution reduction needs to occur to properly correct this issue.

<http://web.a.ebscohost.com.proxy.seattleu.edu/ehost/pdfviewer/pdfviewer?vid=4&sid=9977f820-9866-4b21-a269-64e3b3f2e4c5%40sessionmgr4008>

<https://awionline.org/content/ocean-noise>

6. Closing thoughts

Although the current situation of whales worldwide may sound dire and too large of a problem to correct, there is a large body of people trying to change current practices that are contributing to this anthropogenic ocean noise pollution. Scientists and politicians are working together in some countries, such as Canada and the United States, to change maritime laws that would require ships to slow down or change routes to avoid critical habitat areas. There is also an increasing amount of research going in to clean energy, which would allow us to lessen our dependence on fossil fuels and thus reduce seismic testing. Current legislation requires now that the United States Navy must prove that there are no marine mammals in a given area if they are to use sonar. There are several things that you can do to help decrease the impacts of

noise pollution, such as purchasing seafood from fisheries that are committed to following protocol that reduce their ocean noise pollution or relying less on fossil fuels which come from noisy ocean oil rigs. With the cooperation of fisheries, oil companies, and global legislation, anthropogenic ocean noise pollution and its effects can be reversed, allowing the ocean to once again become a quiet place filled with the songs of whales.