



# A Not So Silent Problem

## Ocean Noise Pollution: Focus on Shipping

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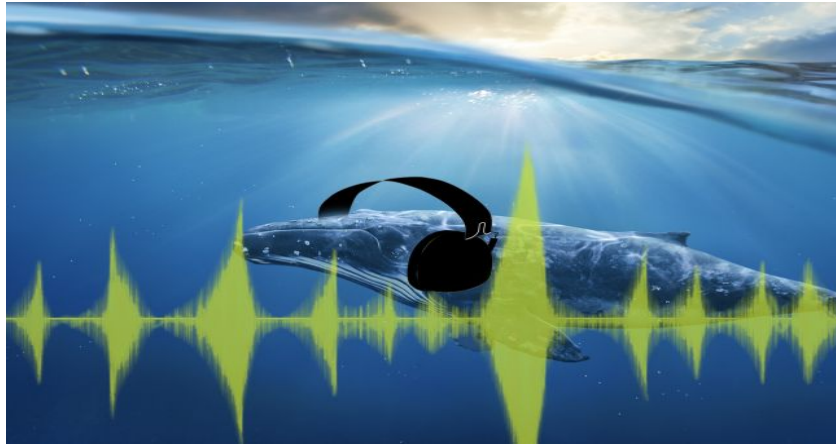


Image: Elena Scotti/Fusion

### What is Ocean Noise Pollution?

Whenever I ask people what they know about ocean noise pollution, they usually say that they've never heard of it. But it is a huge issue! Ocean noise pollution is human generated underwater noise that does great harm to ocean wildlife. Our peaceful oceans are being continuously assaulted by a cacophony of noise due to shipping, seismic exploration, naval sonar, and other human generated activities that are threatening marine mammals' survival.<sup>1</sup> The legendary Dr. Sylvia Earle summarized the issue of ocean noise pollution like this:

*"Undersea noise pollution is like the death of a thousand cuts. Each sound in itself may not be a matter of critical concern, but taken all together, the noise from shipping, seismic surveys, and military activity is creating a totally different environment than existed even fifty years ago. That high level of noise is bound to have a hard, sweeping impact on life in the sea."*<sup>2</sup>

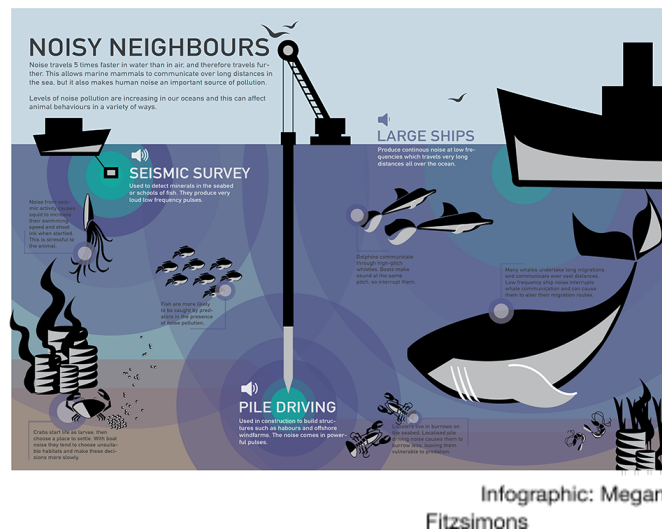
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<sup>1</sup> Schiffman, Richard. "How Ocean Noise Pollution Wreaks Havoc on Marine Life." Yale environment 360, 31 Mar. 2016.

<sup>2</sup> In "Sounding the Depths II: The Rising Toll of Sonar, Shipping and Industrial Ocean Noise on Marine Life." Jasny, Michael, et al. NRDC, NRDC, 15 Dec. 2016, Michael Jasny quoted Dr. Sylvia Earle.

## Some Background

Once called "The Silent World" by Jacques Cousteau, our oceans are now the complete opposite; today they are full of human generated noise. Commercial shipping, naval sonar, and seismic surveys make a lot of noise underwater, and even if humans can't hear it, marine animals can. The impact of all this noise on marine life is devastating and is harming so many sea creatures. Ocean noise pollution harms marine animals by causing deafness, blindness, internal bleeding, and in some cases, even death. In all, 55 marine species, including 24 species of whales,<sup>3</sup> are known to be affected by anthropogenic noise pollution.<sup>4</sup>



Commercial shipping, naval sonar, and seismic exploration each harm the ocean in their own specific ways. Shipping noise is extremely detrimental to marine mammals because it interferes with their acoustic signaling. Tragically, marine mammals can get struck by ships because they cannot hear the ships coming. The explosions from seismic surveys are so loud that seismic blasts have been heard in the Atlantic Ocean 3,000 km away from their source.

<sup>3</sup> Thomas, Peter O., and et al. "Status of the Worlds Baleen Whales." *Marine Mammal Science*, vol. 32, no. 2, Dec. 2015, pp. 682–734., doi:10.1111/mms.0.0.issue-0.

<sup>4</sup> Singla, Smita. "Effects of Noise Pollution from Ships on Marine Life." *Marine Environment* Updated 21 July, 2016.

In a desperate effort to get away from the source of the noise, whales will swim hundreds of miles and rapidly change their depths, sometimes leading to bleeding from their eyes and ears. Naval sonar has been linked to cetaceans stranding and beaching themselves.

The causes of ocean noise pollution are extremely complex, and so much can be written about each one. In the future, I plan to write about seismic surveys and sonar but in this paper, I am going to focus on the effects of commercial shipping on cetaceans.

Our oceans have always been full of biological sounds, but the noises humans are putting into the sea are unnatural, and marine mammals are not equipped to deal with them. My mentor Michael Stocker, the founder and executive director of Ocean Conservation Research, remarked, “You can argue that the ocean is noisy: the waves and the rain, the earthquakes and whatever else is making noise, but it's not the type of noise that animals are habituated or adapted to.”<sup>5</sup>



Michael Stocker and Me

Cetaceans have lived in the ocean for millions of years. In contrast, cargo ships have existed for less than two hundred. This means that whales that can live longer than two centuries, like bowhead whales, have seen their lives change right before their eyes. Dr. Charles “Stormy” Mayo, the senior scientist and the director of the Right Whale Ecology Program at the Center for Coastal Studies in Massachusetts stated:

*“These creatures live in an ocean that once was theirs and now it’s walled by nets and crossed by ships. They once lived in a silent ocean except for the sounds of animals. They now live in an ocean whose noise impairs their very livelihood, that is perilous. They live in an ocean that arguably is changing in such profound ways that thousands of generations of them have never seen anything like it.”*<sup>6</sup>

## Cetacean Communication

### Why is Anthropogenic Noise So Damaging in Water?

To understand why ocean noise pollution is especially devastating for whales, it helps to know a little bit about acoustic environments and how cetaceans communicate. Whales do not have well developed sight, and, even if they could see well, there is little visibility in the deep, dark ocean.

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<sup>5</sup>My interview with Michael Stocker, Ocean Conservation Research, 2 Dec. 2016

<sup>6</sup>George, Rose. *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate*. Metropolitan Books, August 2013.

To compensate for the poor visibility, cetaceans have evolved to use sound as their primary way of navigating through their environment and communicating with each other. Echolocation is a bio-sonar system where dolphins, porpoises and odontocete (toothed) whales call out to their environment and then listen to the echoes of their calls bouncing off various objects near them.

They use these echoes for a plethora of biological functions including communication, navigation, locating where they are in space, monitoring their surroundings, detecting predators, foraging for prey, attracting mates, and caring for their young. Michael Stocker explained:

*“Because it's dark and turbid, whatever is visual is not really refined for these animals. So, auditory perception is what's going to be the boss. If you talk about a dolphin or a porpoise, they really need to know exactly where they are at nighttime, when it's dark. They need to know where the predators are and where their resources are. So, they do that all through bio-sonar. They do really amazing things with sound which is largely beyond most humans' imagination.”<sup>7</sup>*

Cetaceans have extraordinary hearing. They can hear a much broader range of frequencies than land mammals. This is because they have extremely complex hearing and signal processing capabilities and their temporal lobes, which control higher auditory processing, take up most of their brains. In fact, dolphins and whales have three fold more nerve cells dedicated to hearing than any other animal.<sup>8</sup>

Whales communicate using an amazing variety of voices, and they can produce sounds at a wide variety of frequency levels. On the high end of the frequency scale, harbor porpoises produce sounds of 120-150 kilohertz (hz). On the ultra-low pitched end, blue whale noises have been tracked at lower than 20hz. Blue whale calls can last longer than 10-15 seconds and can travel many hundreds of kilometers. In fact, the vocalizations of both of those animals are beyond the range of human hearing!<sup>9</sup>

## Underwater Acoustics

Sound in the ocean can travel for thousands of miles. In fact, a supertanker can be heard in the ocean a whole day before it reaches its destination!<sup>10</sup> Sound travels faster in water than in air—1,230 meters per second compared to 340 meters per second—because water has a much greater density.<sup>11</sup> This means that sound also travels *farther* underwater.

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<sup>7</sup> My interview with Michael Stocker, Ocean Conservation Research, 2 Dec. 2016

<sup>8</sup> “Are Whales Smarter Than We Are?” *Scientific American Blog Network*, Mind Matters, 15 Jan. 2008.

<sup>9</sup> *ibid.*

<sup>10</sup> George, Rose. *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate*. Metropolitan Books, August 2013.

<sup>11</sup> Weis, Judith S. *Physiological, Developmental and Behavioral Effects of Marine Pollution*. Springer, 2014

Also, the ocean is full of natural acoustic channels which are like sound highways. If a sound enters a channel, it can travel thousands of miles across an ocean. Michael Stocker explained:

*“If you made a sound here in San Francisco that could be heard all the way up in Seattle, you’d have to explain it to people! But you CAN make a sound that you can broadcast off of the coast of California and you CAN hear it in Hawaii, 3,000 miles away! In fact, whales use this. You can hear their signals thousands of miles away. And it’s not a straight shot, it’s over the globe. So, essentially, you’re hearing the current of the Earth, because water serves as a transfer medium. It’s kind of like this table here. If I tap on top of it, you can barely hear it. But if you put your ear on this table, you hear it loud and clear because it transfers more efficiently. Water does the same thing - it doesn’t compress, it transfers sound really efficiently. And because of that, you can use it as a transmission to channel the sound.”<sup>12</sup>*

Because sound waves travel through water faster, farther, and at much higher intensity levels than they would in air, they are also much *louder*. This is important to remember because just as the cetaceans’ calls are amplified underwater, unfortunately, so is harmful anthropogenic noise.

For humans, chronic noise isn’t just annoying; it can cause real harm. Chronic exposure to noises above 55 decibels significantly increases our risk of heart disease and stroke. The World Health Organization estimates that every year, people lose at least a million healthy years of life due to traffic noise.<sup>13</sup> Chronic noise pollution has been proven to disrupt our concentration, interrupt our sleep, and raise our cortisol levels, which is a hormone we secrete when we’re stressed. Children who go to schools next to airports are slower to develop reading skills than children who don’t.<sup>14</sup> Even really low levels of chronic noise can cause signs of psychological and physiological stress. But unlike the ocean animals, at least humans can get away!

Sound levels in air	dB
Rocket launching pad	205 dB
Rock band (near speakers)	145 dB
Jet flyby 300m overhead	135-145 dB
Chain saw, pneumatic drill	125 dB

<sup>12</sup>My interview with Michael Stocker, Ocean Conservation Research, 2 Dec. 2016

<sup>13</sup>Graeme, Shannon. “How noise pollution is changing animal behaviour.” *Phys.org - News and Articles on Science and Technology*, 18 Dec. 2015,

<sup>14</sup> *ibid.*

Motorcycle, lawnmower	115 dB
Hair dryer, noisy restaurant	95 dB
Light traffic, 100 ft away	75-85 dB

Source of Noise - Science Notes, UC Santa Cruz

## The Biggest Culprit

Ninety percent of everything we eat, wear, and use is shipped to us from somewhere else. But transporting our goods this way is extremely detrimental to the oceans. Shipping noise is the single biggest culprit of human-made low frequency noise and it is doubling every decade.<sup>15</sup> As Michael Stocker explained that, “If you look at the shipping maps, boats are everywhere. The ocean is ten times louder now, particularly north of the equator, than it was fifty years ago, just because of boats.”<sup>16</sup>

Between 1992 and 2012, the number of ships in the ocean quadrupled.<sup>17</sup> Today at any given time, 60,000 commercial tankers and container ships are sailing our seas.<sup>18</sup> Also, to transport more goods as quickly and efficiently as possible, commercial ships are getting bigger. In 2000, the world’s biggest cargo ships could carry 8,000 containers; today the biggest can carry 18,000!<sup>19</sup> Since ships keep getting bigger and the number of vessels keeps increasing, it’s easy to see why commercial shipping is the single biggest culprit of anthropogenic ocean noise.

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<sup>15</sup> Suh, Rhea. “Sounding the Alarm on Ocean Noise.” Natural Resources Defense Council. 12 May 2016

<sup>16</sup> My interview with Michael Stocker, Ocean Conservation Research, 2 Dec. 2016

<sup>17</sup> Firestone, Jeremy and Jarvis, Christina. “Response and Responsibility: Regulating Noise Pollution in the Marine Environment.” *Journal of International Wildlife Law and Policy*

<sup>18</sup> Suh, Rhea. “Sounding the Alarm on Ocean Noise.” Natural Resources Defense Council. 12 May 2016

<sup>19</sup> Williams, Rob, et al. “Shhh... To Make Ocean Conservation Work We Should Keep the Noise Down.” *Elsevier*, 8 Oct. 2015.



Below is a picture of the Benjamin Franklin, the largest cargo ship to pass under the Golden Gate Bridge.



photo: Craig Miller

### Propeller Cavitation

The main cause of underwater noise from ships is propeller cavitation. Propeller cavitation happens when a ship's propeller spins and creates air bubbles that pop and release noise. Another cause is engine noise. Besides commercial shipping, other sources of ocean noise pollution are huge cruise ships, small vessels like motorboats and recreational watercraft, like jet skis and waverunners. Yep, sadly, going on a cruise or riding a jet ski can be harmful to the world's oceans.



photo: Imaginary Forces

## Dangerous Shipping Lanes/ Shipping Traffic

Dr. Christopher Clark, who leads the Bioacoustics Research Program at Cornell University, calls commercial shipping “by far the most ubiquitous anthropogenic contributor to ocean noise,”<sup>20</sup> and the noisiest places in the ocean are in the busy shipping lanes that crisscross the globe. He declared, “If you could lay down under the shipping lanes at Great South Channel (off Cape Cod) and spend the day there, you would get the impression of being on the tarmac at Logan Airport.”<sup>21</sup>

Although the North Atlantic right whale does not have a natural predator, it is one of the most at risk species in the world. This is because it has a human made predator: the ship. Unfortunately, North Atlantic right whales feed, nurse, and breed in busy shipping lanes, within one hundred miles of the eastern U.S. coastline, where they can easily be hit by a ship.

North Atlantic right whales have a Potential Biological Removal (PBR) of less than one.<sup>22</sup> The PBR is the number of whales that can be killed due to human causes and still maintain their population level. Since the North Atlantic right whales mate and feed in busy shipping lanes, a strike rate of more than one a year is very likely.

Between 1970 and 2007, of the 67 dead North Atlantic right whales were spotted, at least 24 of them died as the result of being hit by ships.<sup>23</sup>

In comparison, the right whales that live in the southern hemisphere have been thriving; their population has been increasing by 7-8 percent each year.<sup>24</sup> Here are Michael Stocker’s thoughts about the Northern right whale:

*“In the Northern hemisphere, there are about five hundred North Atlantic right whales, plus or minus ten or fifteen. And they’re just hanging in there. They have babies but they get hit by ships and they die. Meanwhile, the South Atlantic right whales are just populating like crazy. There are thousands of them! What’s the difference between the North and the South? Well, the North is where all the shipping lanes are. So, is it correlation or is it just anecdotal? It’s pretty clear the difference between the north and south has to do with the noise levels in the ocean; it’s really significant. The ocean is noisy in the North, and in the South, it’s not. So, that’s my concern: that the noise is going to decrease these animals’ ability to be able to maintain healthy populations.”<sup>25</sup>*

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<sup>20</sup> Schiffman, Richard. “How Ocean Noise Pollution Wreaks Havoc on Marine Life.” Yale environment 360, 31 Mar. 2016.

<sup>21</sup> *ibid.*

<sup>22</sup> Thomas, Peter O., and et al. “Status of the Worlds Baleen Whales.” *Marine Mammal Science*, vol. 32, no. 2, Dec. 2015, pp. 682–734., doi:10.1111/mms.0.0.issue-0.

<sup>23</sup> George, Rose. *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate.* Metropolitan Books, August 2013.

<sup>24</sup> Schiffman, Richard. “How Ocean Noise Pollution Wreaks Havoc on Marine Life.” Yale environment 360, 31 Mar. 2016.

<sup>25</sup> My interview with Michael Stocker, Ocean Conservation Research, 2 Dec. 2016



## How Ocean Noise Pollution Affects Cetaceans

How much cetaceans suffer due to ocean noise pollution depends on the distance they are from the source of the sound. If a whale is far away from a forceful human generated noise, it may become temporarily deaf but if it is close, it could become deaf permanently, suffer harm to its internal organs, or it could even die.

When human divers rise to the surface too quickly, they can get a dangerous decompression sickness called “the bends.” Symptoms of the bends include hemorrhages and damage to internal organs. When whales are exposed to a startling sound, they may panic and swim up to the surface too quickly while trying to get away. So, just like human divers, cetaceans can get the bends.<sup>26</sup>

### Deadly Ship Strikes

When whales have beached themselves, it is obvious when ship strikes caused their deaths because they have horrible gashes that are easily visible.<sup>27</sup> According to Michael Stocker, “It happens a lot. There was one, a juvenile grey whale that washed up and had contusions on his back from the propellers. He was clearly hit by a boat.”<sup>28</sup> But why wouldn’t a whale hear a ship and try to swim away before it gets too close? The reason is the masking effect.

### The Masking Effect

The masking effect happens because commercial ships produce noise below 100hz., which is the same frequency that many species of whales and other marine animals use to communicate and navigate their environment.<sup>29</sup> Additionally, the cumulative effect of the thousands of container ships, tankers, cruise ships, and other vessels is a never-ending background fog throughout the oceans, that makes it much harder for cetaceans to interpret their environment.



Photo: John Calambokidis

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<sup>26</sup> StokstadApr, Erik, et al. “Why Do Whales Get the Bends?” *Science* | AAAS, American Association For the Advancement of Science, 10 Dec. 2017, [www.sciencemag.org/news/2007/12/why-do-whales-get-bends](http://www.sciencemag.org/news/2007/12/why-do-whales-get-bends).

<sup>27</sup> George, Rose. *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate*. Metropolitan Books, August 2013.

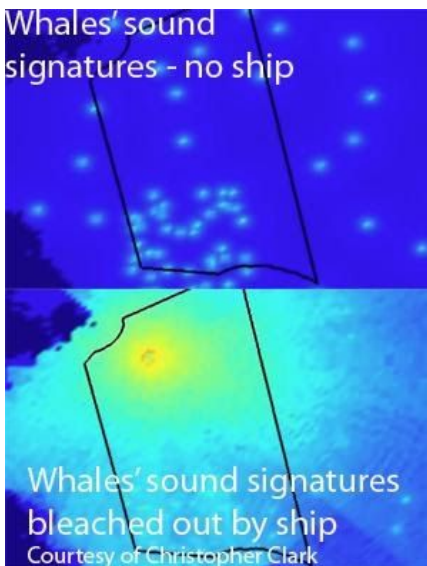
<sup>28</sup> My interview with Michael Stocker, Ocean Conservation Research, 2 Dec. 2016

<sup>29</sup> Veirs 1, Scott, et al. “Ship noise extends to frequencies used for echolocation by endangered killer whales.” *PeerJ*, PeerJ Inc., 2 Feb. 2016, [peerj.com/articles/1657/](http://peerj.com/articles/1657/).

As Dr. Christopher Clark shared, “We are injecting so much noise that we are effectively acoustically bleaching the world’s oceans.”<sup>30</sup> This masking effect is why cetaceans get struck by ships so often: because of the constant background din of low frequency noise, they don’t hear the ships coming in time to get out of the way.<sup>31</sup> In 2007, four blue whales were killed when they were struck by ships in shipping lanes off the coast of Santa Barbara.<sup>32</sup>

When low frequency shipping noise interferes with cetaceans’ ability to interpret auditory signals, they can become disoriented. Tragically, this can result in whales heading away from their deep water habitats, getting stuck in too shallow water, and beaching themselves.

Low frequency noise from commercial shipping masks important biological sounds that are essential for cetaceans’ survival. For example, if whales communicate that they have found a good food source, but other whales can’t hear them, those whales lose an opportunity to feed.<sup>33</sup> If female cetaceans can’t hear the males singing through the smog of anthropogenic noise, they lose breeding opportunities.<sup>34</sup> This is really bad because many of these species are endangered, and if they miss opportunities to breed, they can’t replace the numbers they’ve lost, much less increase their populations.<sup>35</sup>



<sup>30</sup> Schiffman, Richard. “How Ocean Noise Pollution Wreaks Havoc on Marine Life.” *Yale environment* 360, 31 Mar. 2016.

<sup>31</sup> Jasny, Michael, et al. “Sounding the Depths II: The Rising Toll of Sonar, Shipping and Industrial Ocean Noise on Marine Life.” *NRDC*, NRDC, 15 Dec. 2016.

<sup>32</sup> Bohan, Suzanne. “Drowning in sound: Large ships’ propellers creating underwater din for whales, other marine animals.” *East Bay Times*, East Bay Times, 15 Aug. 2016.

<sup>33</sup> Schiffman, Richard. “How Ocean Noise Pollution Wreaks Havoc on Marine Life.” *Yale environment* 360, 31 Mar. 2016.

<sup>34</sup> Schiffman, Richard. “How Ocean Noise Pollution Wreaks Havoc on Marine Life.” *Yale environment* 360, 31 Mar. 2016.

<sup>35</sup> *ibid.*

Shipping noise makes communication much more difficult for cetaceans because it masks their calls and reduces the distance over which they can communicate, forcing them to use more energy to be heard clearly. Today, humpback whales have ten percent of the auditory range they used to have.<sup>36</sup> North Atlantic right whales have lost up to eighty percent of their communication range,<sup>37</sup> and Blue whales' acoustic range has been shrunk by ninety percent.<sup>38</sup> As the range of cetaceans can communicate continues to shrink, their chances of finding food, mates, and even surviving have all been dangerously reduced.<sup>39</sup>



Photo: Asha de Vos

Some whale species try to compensate for the masking effect by vocalizing in higher frequencies.<sup>40</sup> Other species, like sperm whales and bowhead whales, stop vocalizing for several hours or even several days when they're disturbed by anthropogenic noise.<sup>41</sup> Christopher Clark explained that "when the noise level goes beyond a certain threshold, the counter-calling, the chit chat between right whales just stops — they just give up. When the noise decreases, they start up again."<sup>42</sup> Cetaceans are extremely social animals and their relationships are based on sound.

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<sup>36</sup> George, Rose. *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate*. Metropolitan Books, August 2013.

<sup>37</sup> Martinez, Kimiko. "Sonic Sea: Award-Winning Documentary Exposes Impact of Industrial Ocean Noise on Whales." *NRDC*, 15 Dec. 2016.

<sup>38</sup> Noone, Kevin J., et al. *Managing ocean environments in a changing climate: sustainability and economic perspectives*. Elsevier, 2013.

<sup>39</sup> George, Rose. *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate*. Metropolitan Books, August 2013.

<sup>40</sup> *ibid.*

<sup>41</sup> "Behavioral Changes in Mammals." *Discovery of Sound in the Sea*, University of Rhode Island, 15 Dec. 2017, [dosits.org/animals/effects-of-sound-on-marine-mammals/behavioral-changes-in-mammals/](https://dosits.org/animals/effects-of-sound-on-marine-mammals/behavioral-changes-in-mammals/).

<sup>42</sup> Schiffman, Richard. "How Ocean Noise Pollution Wreaks Havoc on Marine Life." *Yale environment* 360, 31 Mar. 2016.

Clark explained what happens to their relationships when they are constantly exposed to human generated ocean noise pollution: “There is this constant stopping and starting of their communication. What you are doing is you are tearing that social fabric over and over again.”<sup>43</sup>

### Habitat Abandonment

When large numbers of cetaceans leave their natural feeding and breeding grounds, scientists call it long term abandonment. In the 1960s, California gray whales abandoned their Baja Lagoon habitat due to noise from commercial shipping and other industrial noise. Several seasons later, when the human generated activities had stopped, they returned.<sup>44</sup>

Sometimes, cetaceans actually abandon their habitats altogether. Long term abandonment is a huge cause for concern because it has led to population declines and the loss of biodiversity in many regions.<sup>45</sup>

In areas where there is heavy shipping, cetaceans will change their natural migration paths to avoid human generated noise pollution.<sup>46</sup> Gray whales have been known to go a mile out of the way of their normal routes to get away from anthropogenic noise and beluga whales have been known to stop feeding and swim away in order to escape from the sound of icebreakers thirty miles away.<sup>47</sup>

As Michael Stocker stated, “We are putting all these horrible noises in the ocean and these animals aren't going to have a place to find any respite.”<sup>48</sup> Cetaceans need refuges from human made noise pollution but unfortunately, there are fewer and fewer to be found.<sup>49</sup>

### Evidence That Ocean Noise Pollution Harms Cetaceans

It is very difficult to prove that ocean noise pollution hurts cetaceans because it's hard to monitor and track free swimming whales. Also, when whales die, they sink very quickly, so there's no opportunity for scientists to perform necropsies to understand what caused their deaths. However, when cetaceans beach themselves, and scientists examine them, the visible hearing damage and hemorrhages they've suffered are real evidence that anthropogenic ocean noise can kill. Of the 39 North Atlantic right whales that were necropsied between 1975 and 2005, 19 of them died as a result of a ship strike.<sup>50</sup>

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<sup>43</sup> *ibid.*

<sup>44</sup> “Behavioral Changes in Mammals.” *Discovery of Sound in the Sea*, University of Rhode Island, 15 Dec. 2017, [dosits.org/animals/effects-of-sound-on-marine-mammals/behavioral-changes-in-mammals/](https://dosits.org/animals/effects-of-sound-on-marine-mammals/behavioral-changes-in-mammals/).

<sup>45</sup> Williams, R., et al. “Impacts of anthropogenic noise on marine life: Publication patterns, new discoveries, and future directions in research and management.” *Ocean & Coastal Management*, vol. 115, Oct. 2015, pp. 17–24., doi:10.1016/j.ocecoaman.2015.05.021

<sup>46</sup> “Behavioral Changes in Mammals.” *Discovery of Sound in the Sea*, University of Rhode Island, 15 Dec. 2017, [dosits.org/animals/effects-of-sound-on-marine-mammals/behavioral-changes-in-mammals/](https://dosits.org/animals/effects-of-sound-on-marine-mammals/behavioral-changes-in-mammals/).

<sup>47</sup> *ibid.*

<sup>48</sup> My interview with Michael Stocker, Ocean Conservation Research, 2 Dec. 2016

<sup>49</sup> Suh, Rhea. “Sounding the Alarm on Ocean Noise.” Natural Resources Defense Council. 12 May 2016

<sup>50</sup> Thomas, Peter O., and et al. “Status of the Worlds Baleen Whales.” *Marine Mammal Science*, vol. 32, no. 2, Dec. 2015, pp. 682–734., doi:10.1111/mms.0.0.issue-0.

## The Famous Poop Study

In February 2012, the Royal Society published a study by Roz Rolland and Susan Parks that strongly suggested a connection between the stress levels of baleen whales and anthropogenic noise pollution.<sup>51</sup> The evidence for this study came from the feces of baleen whales.

Roz Rolland, a veterinarian at the New England Aquarium, conducted the study because she was concerned about the low reproductive rates of North Atlantic right whales. She hypothesized that their low reproductive rates might be caused by stress from anthropogenic noise pollution since stress can interfere with reproduction. She studied baleen whales in the Bay of Fundy because every year in the late summer and early fall, they gather there to feed and nurse their young. She wanted to test the whales' cortisol levels but there was no way for her to acquire blood samples from them and, of course, there was no way to control shipping traffic nor the amount of noise in the sea.

In 2001, Rolland came up with the idea to study the whales' feces because animal poop is full of hormones (such as cortisol) and it actually briefly floats. She trained sniffer dogs to help her find the feces and then she collected samples before they sank. Meanwhile, at the same time that Rolland was doing her study, Susan Parks, a biologist from Syracuse University was also in the Bay of Fundy, recording right whale calls to try to understand their behavior.

Then, 9/11 happened and shipping traffic in the Bay of Fundy dramatically decreased for several days following the terrorist attacks.<sup>52</sup> Rolland remarked, "There was nobody else there. It was like being on the primal ocean."<sup>53</sup> Both Rolland and Parks had data sets from pre and post 9/11. Parks recorded that on 9/11 and for a few days after, anthropogenic noise in the Bay of Fundy was six decibels lower than the days pre 9/11 and there was a significant reduction in low frequency noise. Rolland recorded that 2001 was the only year that whales' cortisol levels decreased.

In 2009, they put their two data sets together and created one study showing that when the ocean was loud, cortisol levels in the baleen whales' feces increased, and when it was quieter, their levels decreased. Their findings showed the most direct evidence that chronic stress in whales may be linked to exposure to low-frequency noise from shipping.

## Ideas for Combatting Ocean Noise Pollution

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<sup>51</sup> Rosalind M. Rolland, Susan E. Parks, et al. "Evidence that ship noise increases stress in right whales." *Royal Society Publishing*, 8 Feb. 2012. DOI: 10.1098/rspb.2011.2429

<sup>52</sup> Fields, Helen. "Shhh ... Ocean Noises Stress Out Whales." *Science*, Feb. 2012.

<sup>53</sup> *ibid.*



We can't just stop commercial shipping because we rely on it for the transport of goods. But it is possible to reduce the noise the ships cause. The documentary "Sonic Sea" suggests several ideas that can help us reduce anthropogenic ocean noise and help lessen the impact on endangered marine mammals.<sup>54</sup>

## We Can Design Quieter Ships



a symbolic and visual connection between noise and nature for 'sound form wave' by Anna Marinenko

According to Dr. Christopher Clark, ships can be designed to be quieter.<sup>55</sup> Engines can be mounted so they're not in contact with the hull, and pumps and air compressors can be put on vibration isolators. Most importantly, propellers can be shaped to reduce cavitation. Since noisy propellers are inefficient and waste fuel, quieter ships can benefit the shipping industry by reducing fuel consumption. In fact, the International Maritime Organization has made building quieter ships an official part of their charter.

## We Can Slow Ships Down

According to Jackie Dragon, the Senior Oceans Campaign Manager at Greenpeace USA, ocean noise pollution can be mitigated by requiring shipping companies to reduce their speeds from 25 knots to a maximum of 10 knots.<sup>56</sup> Dragon explained, "The magic number is 10 knots. If ships were traveling slower, they'd be cleaner, they'd be quieter and they would be safer."<sup>57</sup> Limiting ships to 10 knots lessens sound disturbances due to propeller cavitation and engine vibration. It also gives marine animals more time to become aware of ships near them

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<sup>54</sup> "Review: Sonic Sea at the Environmental Film Festival." *The Conversation*, 21 Oct. 2016,

<sup>55</sup> Schiffman, Richard. "How Ocean Noise Pollution Wreaks Havoc on Marine Life." *Yale environment* 360, 31 Mar. 2016.

<sup>56</sup> Bohan, Suzanne. "Drowning in sound: large ships' propellers creating underwater din for whales, other marine animals." *East Bay Times*, 4 Sept. 2009, updated 15 Aug. 2016

<sup>57</sup> *ibid.*



and react, hopefully resulting in fewer ship strikes. In fact, if a whale gets hit by a ship traveling at 17 knots, it only has a ten percent chance of survival. However, if it's hit by a ship traveling at 10 knots, the whale's chance of survival goes up to fifty percent.<sup>58</sup>

Slowing down also has some advantages for humans: it can save on fuel costs and provide a smoother ride with less vibration, which would be more pleasant for passengers.

It can also reduce the number of containers that fall off cargo ships into the sea, saving companies from losing merchandise they had planned to sell.<sup>59</sup>

### We Can Change Shipping Lanes

Many experts, including Dr. Christopher Clark and Jackie Dragon, say that adjusting shipping lanes to go around areas where cetaceans are known to breed, nurse, and feed, can help cut down on anthropogenic noise and reduce ship strikes. For example, ships can be rerouted to go *around* the Great Barrier Reef instead of going *through* it. Yes, unbelievably, there are shipping lanes located inside the Great Barrier Reef, even though it's a Marine Protected Area!<sup>60</sup>

Amy Knowlton, a colleague of Roz Rolland, formed a ship strike committee with ocean conservationists, port authorities, scientists, and shipping industry people to share ideas that might help right whales. It's so inspiring that these groups, that might normally be against each other, were able to work together and come up with solutions. What's even more amazing is that they actually got international laws changed. The ship strike committee convinced the International Marine Organization to put in seasonal speed restrictions and to change the shipping lanes in the Bay of Fundy. That may not sound all that impressive, but to move the shipping lanes, seven nautical charts had to be changed at a cost of \$30,000 per chart!

### Biomimicry

In his paper, "Potential Solution Strategies to Some Sources of Ocean Noise," Michael Stocker explained that building ships using the Pax Streamlining Principle would significantly decrease vessel turbulence and propeller cavitation.<sup>61</sup> The Pax Streamlining Principle uses the concept of biomimicry which means it "takes examples from natural fluid flow patterns and applies them to various applications."<sup>62</sup> The thinking behind using biomimicry is that even if some human generated sounds can't be made quieter, at least they could be made to sound more pleasant to marine animals.

Michael Stocker explained the idea like this:

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<sup>58</sup> Milman, Oliver. "Great Barrier Reef 'whale zones' proposed to reduce deadly ship strikes." *The Guardian*, Guardian News and Media, 3 July 2014

<sup>59</sup> Bohan, Suzanne. "Drowning in sound: large ships' propellers creating underwater din for whales, other marine animals." *East Bay Times*, 4 Sept. 2009, updated 15 Aug. 2016

<sup>60</sup> Milman, Oliver. "Great Barrier Reef 'whale zones' proposed to reduce deadly ship strikes." *The Guardian*, Guardian News and Media, 3 July 2014

<sup>61</sup> Stocker, Michael. "Potential Solution Strategies to Some Sources of Ocean Noise." *Ocean Conservation Research*, [ocr.org/ocr/pdfs/papers/potential-solutions\\_ocr.pdf](http://ocr.org/ocr/pdfs/papers/potential-solutions_ocr.pdf)

<sup>62</sup> *ibid.*

*“We know that we're going to be engaged doing noisy things in the ocean. What I would like to do is get those communication systems to use biological-sounding signals that these animals are adapted to, as opposed to these really nasty, scratchy, fingernail on a blackboard signals. Biomimicry mimics biological systems to help, not necessarily decrease the noise, but to make the noise more agreeable. So we can co-inhabit the ocean with these animals without damaging them. That's really what we're looking at.”*

### **There IS Hope!**

By reducing the noise produced by the noisiest 10% of ships in use today, overall marine noise could be reduced by more than half!<sup>63</sup> We really can curb the noise, but we need to act now. As a person with really sensitive hearing, ocean noise pollution is especially upsetting because I imagine what the marine animals are going through. At least when an environment is too loud for me, I can leave and escape to another room but ocean animals do not have that luxury. I relate to this issue because I know how those animals feel. I love ocean animals so much and I want the ocean to be around for generations to come. The ocean is full of so much unwanted noise and it's up to us to stop it. Ocean noise pollution is a serious threat, and I want to convince the world to turn down the volume.



Photo: silent ocean

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<sup>63</sup> Williams, Rob, et al. “Shhh... To Make Ocean Conservation Work We Should Keep the Noise Down.” *Elsevier*, 8 Oct. 2015.