SONIC SEA

DISCUSSION GUIDE

Film Summary

Sonic Sea is a 60-minute documentary about the impact of industrial and military ocean noise on whales and other marine life. It tells the story of a former US Navy officer who solved a tragic mystery and changed forever the way we understand our impact on the ocean. The film is narrated by Rachel McAdams and features Sting, in addition to the renowned ocean experts Dr. Sylvia Earle, Dr. Paul Spong, Dr. Christopher Clark and Jean-Michel Cousteau. *Sonic Sea* was produced by the Natural Resources Defense Council (NRDC) and Imaginary Forces in association with the International Fund for Animal Welfare (IFAW) and Diamond Docs.

www.sonicsea.org

Impacts of Noise on Marine Mammals

Marine life exists in a world dominated by sound. From pistol shrimp to blue whales, marine species use sound to find prey and communicate, sometimes over distances of hundreds of miles or more. But over the last 100 years or so, increasing levels of anthropogenic noise from shipping, oil and gas exploration, naval sonar training, construction, and other activities have begun to drown out the ocean's natural sound. For whales, dolphins, and other marine life, this has resulted in a myriad of impacts, including stress, deafness, avoidance behaviors that have diminished feeding opportunities, and even death. Fortunately, in many cases, relatively simple solutions exist to mitigate these problems; what is needed is the political will.

> *"That's what whales do; they give the ocean its voice, and the voice they give it is ethereal and unearthly."*
>
> *— Roger Payne*

Introduction

For many animals that live beneath the waves, the ability to create and hear natural sounds is vital to their existence. Numerous species, from whales to dolphins to shrimps, use sound to communicate, navigate, and feed. Indeed, because the underwater world can be severely limiting to other senses such as vision, for many marine species sound is the primary means to communicate and learn about their environment. Humans don't hear well beneath the waves because our ear canals fill with water, preventing our eardrums from vibrating, but marine species sense sound in different ways; in many cases, they literally hear sound in their bones.

The sounds they make, the reasons they make them, and the manner in which they do so are as various as ocean life itself. Pistol shrimps snap their giant claws with such force that the action produces an air bubble of sound powerful enough to stun the shrimps' prey. During courtship, at times of stress, or as a territorial display, fish may generate noises—described variously as grunts, groans, thuds, and barks—by grinding their teeth or tightening and loosening muscles to vibrate their swim bladders. Leopard seals in the waters surrounding the Antarctic have been reported to emit ultrasonic sounds when chasing prey, while the haunting sounds made by Weddell seals evoke the sound effects of old science-fiction movies and have been likened to techno music and a Pink Floyd concert. At the other end of the global ocean, walruses produce a repertoire of vocalizations that have been described as sounding like "a circus, a construction site, a Road Runner cartoon...They whistle, beep, rasp, strum, bark, and knock. They make bell tones, jackhammer drills, train track clatters, and the rubber-band boing of Wile E. Coyote being bonked on the head."

To listen through a hydrophone, or underwater microphone, to a pod of orcas on a hunt is to marvel at the social interplay and cooperation conveyed through their squeaks and clicks. Orca researcher Paul Spong has noted that, "Living in the ocean, these social mammals use sound to navigate, find their food, and stay in touch with each other. It's a very complex and varied world of sound."

But the deepest, loudest, and farthest-carrying noises in the underwater animal kingdom are the ones that are made by the great whales.

The Songs of the Whales

The most famous ocean sounds of all are the ‘songs’ of humpback whales, long known to mariners but first truly examined by Roger and Katherine Payne and Scott McVay in 1967. It was the Paynes and McVay who discovered that the strange, haunting moans of humpbacks could truly be called songs, in that they involve repeated sequences called “themes,” each generally between 15 and 30 minutes long, that are, in Roger Payne’s words, “strung together without pauses so that a long singing session is an exuberant, uninterrupted river of sound that can flow for twenty-four hours or longer.” Katherine Payne made a further discovery: that the songs change over time; at any given moment, all the singing humpback whales in a particular region sing the same song, but they tinker with and alter that song, a piece at a time, until, over the course of several years, the song they all sing has evolved considerably. Only males sing; the songs are delivered with such power that, in Roger Payne’s telling, “When you swim up next to a singing whale through the cool, blue water, the song is so loud, so thundering in your chest and head, you feel as if someone is pressing you to a wall with their open palms, shaking you until your teeth rattle.”

Although humpback vocalizations are the most celebrated and melodious of those made by whales, they are not the only ones.

Right whales produce a fantastic variety of calls for different social situations, from low rumblings like those from a speaker with the bass turned up, to sounds like a gunshot or a firework disappearing into the sky, and “screams” that could be mistaken, out of context, for the cries of an elephant. Different vocalizations perform different functions.

Short “upcalls” for example, which are made most frequently, seem to be greetings, a way for each whale to announce its presence to others in the area; gunshot sounds, produced by males, are most likely reproductive in nature, and the elephant-like screams are made when right whales gather in groups at the surface.

The long, rumbling moans emitted by blue whales propagate immense distances across the ocean and have been picked up by hydrophones from distances of 700 miles. It had long been thought that blues and fins were largely solitary animals; now biologists believe they organize themselves in long-distance “herds,” not in each other’s sight but in constant contact across ocean basins because of their powerful vocalizations.

Some of the animals most directly affected by undersea noise are the largest ever to have lived on Earth.

#SonicSeaFilm

There are many other natural noises beneath the waves. The crashing of waves on the shore, a familiar sound to beachcombers, also reverberates beneath the surface. Increased wind strength can affect wave action at the sea's surface, raising background levels of sound. In Polar regions, sea ice dynamics—including ice formation and reformation, pressure ridging, and cracking—increase ambient noise levels over a broad range of frequencies. In the Antarctic, acoustic signals from icebergs include harmonically rich tremors that can last from hours to days.

Such background sounds have been present in the global ocean for millions of years, and have always been a part of whales' existence. Over the past century or so, however, new sounds have entered the ocean realm.

Anthropogenic Noise Interferes and Overwhelms

As the ocean has become industrialized, new noises have entered the undersea world, in many cases drowning out not only these background sounds but also causing physical harm to whales and other marine life. Explosives, pile-drivers, seismic airguns, and sonar produce acute noise that can induce stress, disrupt vital behavior, and even cause physical injury in species as diverse as fish, squid and cuttlefish, and marine mammals.

For example, studies have found damage to the swim bladders or inner ear sensory hair cells of some fish as a result of being exposed to explosions, pile driving, and seismic blasts. Catches of fish such as cod, haddock, and rockfish have declined significantly within large areas around seismic air gun surveys; cod and herring have been observed swimming away from ships, a behavior attributed to vessel noise, while cod and sole have shown changes in swimming behavior when exposed to recordings of pile driving, even at low levels. Mass strandings of giant squid on the coast of Spain in 2001 and 2003 correlated with seismic testing using powerful air guns, and the animals themselves exhibited lesions on tissues and organs indicative of damage from blast pressure. In short, various studies have documented increased stress, loss of anti-predator response, habitat displacement, severe injury, and other impacts in fish and invertebrates exposed to certain sources of manmade noise.

But the greatest amount of research on the impact of noise on marine life involves marine mammals, particularly whales. For example, the powerful blasts used by industry to prospect for offshore oil and gas have been shown to silence endangered great whales and displace them over vast areas of ocean, in some cases over hundreds of thousands of square miles, undermining their ability to feed or mate. Certain high-intensity naval sonars are known to cause whales to strand, sometimes in mass numbers, and to drive some deep-diving species to dangerously alter their diving behavior, leading to pathologies analogous to severe decompression sickness in humans, including bleeding around the brain and the development of lesions in organ tissue.

Of great long-term concern is the ongoing rise in ambient noise, primarily from shipping, and its impacts on marine life, including the low-frequency great whales. According to Christopher Clark of Cornell University, a blue whale that was born in 1940 would have seen its "acoustic bubble—the distance over which its vocalizations can travel and be heard—shrink from 1,000 to 100 miles within its lifetime. It has also been found that endangered right whales experience greater stress amid the higher background noise produced by commercial ships, and have been driven to increase the volume of their calls in an attempt to surmount it. Other endangered whales have been found to increase their calling rates as background noise rises, expending needed energy to unknown benefit, and then to simply give up when the noise exceeds even moderate levels. All of this matters because of the whales' fundamental dependence on sound: to feed, to find mates, to detect predators, to keep in contact with their calves, to maintain their social bonds, to navigate and orient themselves in the ocean: to do, in effect, everything they must do to survive.

We humans place great importance on our ability to hear clearly, and expend much effort to combat noise pollution from industry, vehicles, and airplanes—and understandably so. Yet we are showing far less concern for the amount of noise we are generating beneath the waves, causing stress and damage in a world that is enveloped in sound in a way we can barely imagine. Consider navigating a world—day after day, year after year—where your vision is severely impaired, blinded by fog or mist; this is the world we are creating for marine animals that depend on sound like we depend on sight. And we are doing so at a time when marine species must be resilient in order to adapt to the rapidly changing conditions that ocean warming and acidification and other stressors are producing. We are only beginning to understand the significance of sound in the marine environment, let alone the damage we are causing by overpowering natural sounds with our own deafening noises. The good news is, having identified the existence of the problem, we also have solutions at our fingertips.

SHIPPING NOISE

The human activity most responsible for spreading noise beneath the waves is the traffic that transports people, their possessions, and their products.

More than 60,000 medium to very large commercial vessels—cargo ships, bulk carriers, container vessels, tankers, cruise ships, and ferries—are on the sea each year. Ninety percent of global trade is seaborne; the amount of trade carried by sea has quadrupled since 1970 and doubled over the last two decades. The combination of increasing amounts of commercial maritime trade, and increasing speed of the vessels in that trade, has increased the amount of noise that shipping traffic is spreading throughout the ocean. Indeed, the sound of commercial shipping is virtually ubiquitous throughout the global sea.

Underwater noise from large ships overlaps the same low-frequency sounds that many whale species use to communicate for feeding and mating. In Cape Cod Bay, noise pollution created primarily by shipping traffic has shrunk the acoustic space of right whales—the distance over which their vocalizations and the vocalizations of other right whales can be heard—by 80 percent, compromising the ability of this critically endangered species to feed. Other endangered baleen whales, like the great blue and fin whales that appear to communicate across ocean basins, are similarly compromised. But shipping noise affects even species that use higher frequencies to survive. Studies of Blainville's and Cuvier's beaked whales have shown that vessels can affect diving and acoustic behavior, interfering with foraging—even when those vessels are as far as 16 miles away. And shipping noise has increasingly been shown to have a wide range of impacts on fish and invertebrates, diminishing their ability to feed, breed, and respond to predators.

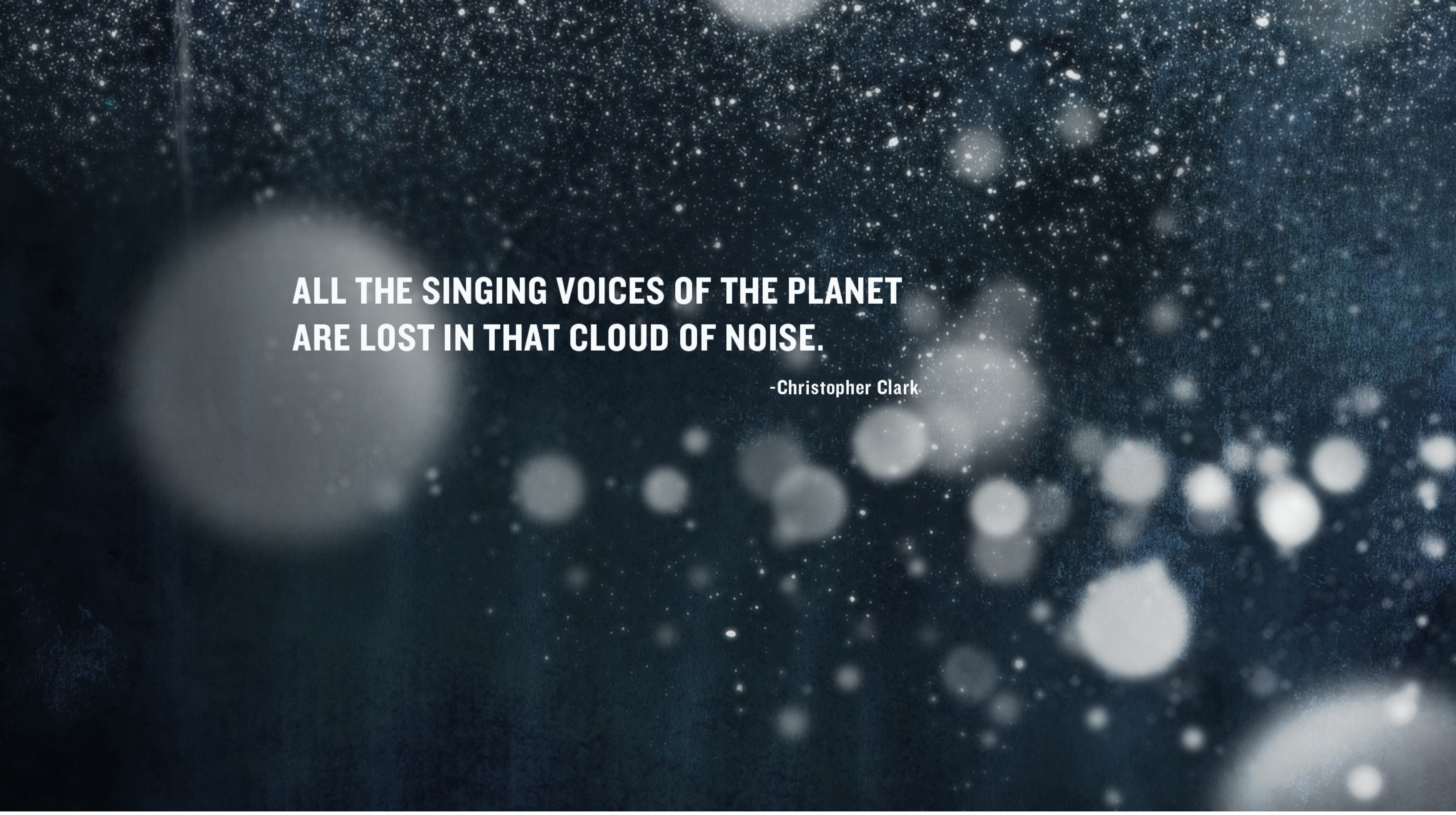
The extent to which shipping traffic can affect whales was demonstrated through an accidental discovery in the wake of the terrorist attacks of September 11, 2001. Two teams of scientists were studying whale singing and health in the Bay of Fundy when commercial transportation around the world was brought to a standstill to assess security measures following the attacks. The slowdown resulted in a significant decrease in underwater noise from large ships—and the decrease in noise coincided with a dramatic decrease in stress-related hormones in the feces of North Atlantic right whales. The study's authors observed that the results have "implications for all baleen whales in heavy ship traffic areas and for recovery of this endangered right whale population."

The reason large vessels are such a major factor in underwater noise is that they produce sounds that are both loud and predominantly low-frequency and, as a consequence, can travel over large distances underwater. While engine noise vibrating through the hull contributes to the overall noise that ships produce ship, the greatest contribution to vessel noise is propeller cavitation, when large numbers of vacuum bubbles created by the motion of propellers collapse.

The fact that propeller cavitation is such a significant factor in the noise generated by shipping may prove to be a boon in addressing that noise. Heavily cavitating propellers are inefficient, because cavitation is a form of turbulence that creates extra drag on the propeller blades, so that greater energy is required to drive the ships; meanwhile the constant implosion of air bubbles eats away at the propellers themselves. Reducing cavitation is therefore in the best interests of both marine life and the shipping industry.

Simple calculations suggest that the overall contribution to ambient noise from shipping is dominated by the noisiest 10 percent of vessels. These are also the vessels for which it is likely that noise-reduction measures will be the most effective. In April 2014, the International Maritime Organization adopted a set of guidelines for reducing shipping noise, noting that, for example: "Propellers should be designed and selected in order to reduce cavitation," such as by "optimizing propeller load, ensuring as uniform water flow as possible into propellers (which can be influenced by hull design), and careful selection of the propeller characteristics." Designing ships with more efficient propellers can not only lead to cost reductions, in terms of fuel use and maintenance costs for the shipping companies themselves, it can also result in significant reductions in shipping noise, theoretically making this an issue with a solution that is eminently desirable to all parties.

In addition to design of propellers and hull structures, vessel speed also plays a role in overall noise output. By slowing down, vessels can significantly reduce the noise they produce. With the slim profit margins and higher fuel costs in recent years, many shipping companies are already seeking ways in which to improve their energy and cost-efficiency. Through slow steaming and construction of larger ships that are more cost-effective they are able to transport more goods at a lower cost. This is a win-win for the industry and marine life, improving companies' bottom lines while reducing their contribution to ocean noise. Now is the time to take advantage of this desire to develop more energy-efficient vessels, by gaining commitments from major shipping companies to slow steaming; to retrofit and maintain older vessels; and to implement more efficient and quieter vessel design during construction of new fleets.



SEISMIC TESTING

Talk of the impacts of offshore oil development on marine life almost invariably conjures up images of seabirds and sea otters covered in tar-like goo, and rocky beaches painted black. But even without such disasters as the Exxon Valdez or Deepwater Horizon, long before platforms are constructed or drills driven deep into the seabed, oil and gas exploration has significant impacts on the marine environment.

Seismic exploration is driven by a global fleet of approximately 100 specialized vessels, roughly 20 percent of which are conducting field operations at any one time. Behind them, they tow arrays of as many as 48 guns of differently sized chambers: guns that fire not munitions, but air. That air, released under extremely high pressure, creates a powerful sound wave that penetrates miles beneath the seafloor and ricochets upward and outward; examination of the reflected sound waves allows industry to map ocean geology and determine the likeliest locations of oil and gas deposits.

To yield high acoustic intensities, multiple air guns are fired with precise timing to produce a coherent pulse of sound. During a survey, guns are fired at regular intervals—every 10 to 15 seconds, up to 24 hours per day, for weeks or months at a time—as the towing source vessel moves slowly ahead. To be on a ship in the vicinity of a seismic vessel is to be subjected to a repetitious "thunk thunk thunk" as the reverberating blasts, expanding outward, make contact with the hull. Underwater, the seismic blasts have an astonishing range. A number of studies have reported airgun surveys raising background levels of noise in the ocean from several thousand miles away; the noise is so significant, even from such a great distance, that it drowns out recordings of whales and other naturally ambient sounds.

Unsurprisingly, the scientific record shows that industrial airgun surveys have a large environmental footprint. In the areas of oil and gas development off Russia's Sakhalin Island, whales were recorded leaving their feeding areas during surveys only to return days after the surveys stopped—a clear indicator of habitat displacement. Many types of marine mammals have reacted strongly to the intense sound of seismic surveys, including harbor porpoises, sperm whales, and foraging, breeding, and migrating baleen whales, with silencing and habitat abandonment seen over enormous areas of ocean. Effects can be severe. Researchers have expressed concern that, in Arctic Canada, the noise from seismic testing has prompted narwhals to remain in coastal summering waters until well into fall and early winter, leaving them vulnerable to entrapment by encroaching ice. More than 1,000 narwhals are believed to have died in three such incidents around Baffin Bay, Canada, from 2008 through 2010.

Nor are marine mammals the only concern. Airguns have been shown to dramatically depress catch rates of various commercial species (by 40 to 80 percent) over thousands of square miles around a single array, leading fishermen in some parts of the world to seek industry compensation for their losses. Other impacts on commercially harvested fish include habitat abandonment—a likely explanation for the fallen catch rates—reduced reproductive performance, and hearing loss.

In an attempt to reduce the impact of seismic blasts on cetaceans and other marine life, U.S. regulations require visual observers to examine the area for marine mammals for a period of at least 30 minutes before a seismic survey can begin. Then it must ramp up slowly by firing first one seismic gun and then others over a period of 20 to 40 minutes, slowly increasing the volume level in the hope that marine animals will leave. Should a whale or other marine mammal appear within an exclusion zone of about 500 meters from the center of the seismic array, the operation must shut down, and visual examination must resume for 30 minutes.

Yet as numerous biologists have recognized, this approach is inadequate at preventing severe acute effects. Seismic surveys take place around the clock, in all weather conditions, and marine mammals are difficult to spot under the best of circumstances. No matter how professional the monitoring, a large number of protected species will simply escape detection, leaving them unprotected from the acute impacts of airgun blasting. In addition, shutting down a source in response to animals often means a line is repeated resulting in more overall noise and higher risk. And maintaining a small safety zone is completely ineffective at tempering impacts from a sound that reverberates over distances of hundreds or even thousands of miles.

A more effective approach is to address the location, duration and intensity of seismic surveys. As the U.S. Marine Mammal Commission has explained, avoiding "repetitious seismic surveys of the same area when a single survey would suffice"—by, for example, having one entity conduct a thorough survey and then other companies use that survey's data—could drastically reduce the impact while providing the same results. Surveys should be conducted only in areas and at times when whale density is known to be low; some habitat is simply too important to be subjected to the transformative impacts of seismic. More fundamentally, various technological alternatives are being developed that may be at least as effective as airguns in oil and gas exploration, without as significantly deleterious effects on marine life. Most notable of these is vibroseis, which generates sounds through vibrations rather than airgun explosions; the technique is more commonly used on land, but commercial marine vibroseis techniques exist only in prototype. Marine vibroseis and other "quieting" technologies lack the funding, support and, perhaps most importantly, the regulatory mandate needed to expedite their development and commercial adoption, despite the fact that oil companies clearly have the resources to devote to such research. "Shoot first and ask questions later" is not a sustainable approach.

"If you put the ocean at risk, you're putting all of us at risk."

— Sylvia Earle

NAVY SONAR

When 12 Cuvier's beaked whales came ashore along the coast of Greece in 1996, the event raised alarm bells among scientists. Cuvier's beaked whales, like other beaked and bottlenose whales (not be confused with the more familiar bottlenose dolphins), are deep-diving, open-ocean animals that rarely strand en masse; prior to the 1996 event, only seven strandings of more than four individuals had been recorded since 1963. Two of those had occurred the decade before, in 1988 and 1989, both times in the Canary Islands. But more followed: in the Bahamas in 2000, in Madeira that same year, twice more in the Canary Islands, in 2002 and 2004, off Spain, Greece, Italy, and other locations—all involving one or more species of beaked whales, with several featuring other cetacean species as well.

The common factor? As far back as 1991, an article in the scientific journal *Nature* had suggested that cetaceans might be at risk from certain military activities, and another article in the same journal following the Greek strandings pointed an accusatory finger specifically at nearby naval exercises testing a form of 'active sonar' for the detection of submarines.22 Subsequent studies delved into the link in greater depth, and by 2004 the Scientific Committee of the International Whaling Commission agreed that "there is now compelling evidence implicating military sonar as a direct impact on beaked whales in particular." The primary culprit was mid-frequency active sonar, one of the Navy's primary means of submarine detection, which puts out high-intensity sound that is acutely alarming to marine life. Often used during the Cold War to track a deep-sea submarine threat, mid-frequency sonar is increasingly used to scan shallower environments for submarines that are able to operate in most coastal waters.

Necropsies of beaked whales stranded in the Bahamas in 2000 clearly revealed that the animals had suffered acoustic trauma resulting in hemorrhaging around the brain, in the inner ears, and in the acoustic fats located in the head that are involved in sound transmission. Analysis of beaked whales that stranded during the 2002 Canary Islands episode found acute systemic micro-hemorrhages and gas and fat emboli. These findings are consistent with a scenario in which the whales experience such stress from the sonar blasts that they rapidly change their diving to escape them—too rapidly, in fact, to the extent that they suffer hemorrhaging and physical trauma akin to 'the bends,' or decompression sickness. Subsequent studies have only underscored this conclusion.

Stranded whales represent the most visible impacts of naval sonar, but on the Navy's ranges the cumulative effects of repeated disruptions of foraging and other vital behaviors may be of greater concern. Recent studies have shown that sonar suppresses blue whale foraging calls and could drive these ocean giants from their krill patches. Another line of study shows that sonar causes beaked whales to stop feeding, go silent, and abandon their habitat—again and again—on exposure to sonar. Compared with their beaked whale neighbors, the population of Blainville's beaked whale that lives on the Navy's Bahamas range is much smaller in abundance and has remarkably few juveniles and calves: a sign that the range has become a population sink, allowing the whales enough food to survive but not to effectively reproduce. Analysis by the U.S. Navy itself has acknowledged that testing of their active sonar can, over periods of several years, affect marine mammals millions of times.

It is worth noting that none of the cases mentioned involve naval confrontations with submarines. They are all training exercises and at-sea equipment tests, refining equipment and readying sailors for such events. Neither NRDC nor IFAW, nor other partners involved in legal action, wishes to compromise national security. But the Navy should follow the advice of scientists and not conduct its training and testing activities in or near sensitive habitat for vulnerable whales and other marine mammals during periods when these species are present. In 2015, in the wake of legal action, the Navy and conservation groups hammered out an agreement that would safeguard important marine mammal habitat without compromising military readiness off Southern California and Hawaii, in two of the Navy's most intensively used ranges. Protecting habitat is a common-sense measure that will allow the Navy to continue securing its sailors at sea, without sacrificing the marine life that lives beneath the waves they patrol.

OUR PAST, OUR PRESENT AND WHATEVER REMAINS OF OUR FUTURE, ABSOLUTELY DEPEND ON WHAT WE DO NOW.

-SYLVIA EARLE

AN OCEAN OF NOISE: OTHER HUMAN IMPACTS

The rise of ambient noise in the ocean has been described by eminent oceanographer Dr. Sylvia Earle as being like a "death by a thousand cuts." Almost everywhere, particularly in coastal regions but also in the open ocean, humanity has introduced an industrial chorus of bangs, clanks, and thuds across the sea, transforming large swaths of the ocean into a horn-honking, traffic-choked Manhattan. From almost every corner, the noises grow and continue.

Pile driving is used for harbor works, bridge construction, oil and gas platform installations, and the construction of offshore wind farm foundations; the noise produced not only enters the water column directly, it also travels through the seabed. Dredging and digging are undertaken to maintain shipping lanes, extract geological resources such as sand and gravel, and to route seafloor pipelines. Offshore wind farms produce not only high levels of low-frequency noise during their construction, but also more moderate levels during their operation.

Underwater explosions—in the course of construction or as a result of detonation of marine ammunition dumps—can cause not only injury or death from shock waves, but hearing damage from the sound. Likewise, the contributions of the oil and gas industry to the sonic din do not end with seismic testing: once deposits are found, the drilling or extraction phase adds even more noise into the underwater environment.

Reducing noise outputs is theoretically more feasible for some of these activities than for others. Oil platforms, by their very size and nature, do not easily lend themselves to quietening measures; the noise from pile driving, however, may be reduced at the source by using continuous pressure or suction rather than a hammer action to place the pile into the sea bed. Noise propagation may also be reduced by fixed screens or bubble curtains around the piles, although some of these measures are practical only in low tidal currents and relatively shallow water. Deploying bubble curtains may also be a practical solution for reducing the impact of detonations and explosions.

Yet so great is the scope and variety of the noise sources with which we are bombarding the marine environment that ultimately a more comprehensive approach—one that, for example, seeks to reduce or limit the total amount of anthropogenic noise in the ocean—may prove essential. Already the European Union has taken the first steps towards holistic, multi-sector regulation of ocean noise. Meanwhile, with every day that ocean noise levels increase, the broader noise footprint worsens.

Seismic tests do not just create loud blasts that carry for hundreds of miles; they reveal oil and gas deposits which, when burned, cause carbon dioxide to enter the atmosphere. Some of that carbon dioxide returns to the ocean, sparking a process in which the pH of the ocean is becoming lower, a process known as ocean acidification. And, as is well-known, much of the carbon dioxide that is released from the burning of fossil fuels enters the atmosphere, warming it; the effects of planetary warming are especially pronounced in the Arctic, where diminishing sea ice seems destined to result in more ship traffic, more associated port construction, and yet more oil and gas exploration—all creating more ocean noise.

Increased levels of anthropogenic noise cause cetaceans to avoid areas they would normally inhabit, sometimes permanently. It provokes changes in diving and foraging behavior, leading to the expenditure of greater energy and the loss of feeding opportunities. It can cause temporary and permanent deafness, and in some cases lead to fatalities. It has the clear potential to induce a state of chronic stress. And it is creating an oceanic world in which species that have evolved over millions of years to talk and listen to each other across tens, hundreds and, for the great whales, even thousands of miles are no longer able to do so.

They are calling still, some effectively yelling to be heard above the din. As we are creating the ever increasing noise, it is up to us to hear them, and to turn down the noise in the ocean.

RECOMMENDATIONS

To date, much of the effort made to mitigate ocean noise has focused on safety: trying to spot marine mammals within a few hundred meters of a powerful piledriver or airgun array, and pause operations until they have gone and are no longer at risk of direct injury. But this approach fails to address the fundamental threat that ocean noise poses to marine ecology, systems, and habitat. Around the world the scientific community and policymakers have increasingly urged noise reduction and habitat conservation as the way forward in management of this global problem, and the National Oceanic and Atmospheric Administration (NOAA), the European Union (EU), the International Maritime Organization (IMO), and other authorities have begun to take up the call. On the industry side, noise-quieting technologies are gradually becoming available for offshore construction, oil and gas exploration, commercial shipping, and other activities, but require regulatory intervention to further develop and bring to market.

TAKING ACTION

Here are 10 critical actions that Congress and the Administration should take to meet the challenge of ocean noise pollution.

Leading the way in noise quieting

1. Using all authorities available to them under the Marine Mammal Protection Act, the Outer Continental Shelf Lands Act, and other statutes, NOAA, the Bureau of Ocean Energy Management, and other regulatory agencies should require as standard practice that industry use technology and methods with the smallest environmental footprint during seismic exploration, offshore construction, and other activities. Additionally, the agencies should use incentive measures and action-forcing mechanisms—an approach that has borne success in Europe—to accelerate development of new noise-quieting methods.

2. Congress should require implementation of IMO ship-quieting guidelines on all new U.S.-flag vessels, and should provide tax benefits for new and existing privately-owned U.S.-flag vessels to install ship-quieting technologies and to obtain quiet-ship notation from a member of the IACS, the International Association of Classification Societies.

3. The Administration should establish a program to advise and aid port authorities in establishing noise management plans. Such plans should include monitoring the noise output of individual commercial ships (which some North American ports have begun to undertake), in order to encourage quiet performance and, per IMO recommendation, to identify the noisiest ships for potential management action by shipping lines.

4. Federal agencies, such as the Bureau of Ocean Energy Management, should fund research aimed at improving noise reduction methods (e.g., for seismic exploration) and at assessing the environmental impacts of those methods. Additionally, agencies should utilize the National Oceanographic Partnership Program to fund cooperative public-private research on the cost, efficiency gains or losses, and noise-reduction benefits of ship-quieting technologies for

new and existing vessels. Congress should increase the funds available to agencies for such research.

5. The U.S. government should begin championing the amendment of MARPOL, the International Convention for the Prevention of Pollution from Ships, to include underwater noise or energyas a form of pollution. While a long-range goal, amendment ultimately is essential to close an historical gap in oceans law and achieve international regulation of this global problem.

Managing noise in important marine habitat

1. Congress should authorize and fund an ocean noise management program within the National Marine sanctuaries, and NOAA should incorporate noise management into its management plans and consultations for National Marine Sanctuaries and marine national monuments. In protecting these recognized areas, we are taking an important step in establishing acoustic refuges for marine life off our shores.

2. NOAA, in collaboration with other agencies, should conduct a review of ship traffic off the U.S. coast, synthesizing the available acoustic, species distribution, and ship-tracking data in order to determine how best to reduce and manage shipping noise impacts on our coastal and marine habitat. As part of this effort, the Administration should identify specific areas of importance for noise reduction and establish an interagency program to reduce noise in those areas, through routing measures, ship-speed reduction, and other means.

3. The President should direct NOAA to use its existing authorities to protect the acoustic habitat of marine species; and, in facilitating his effort, to dedicate a portion of its annual budget to the implementation of NOAA's new Ocean Noise Strategy, as a joint initiative between NMFS' Offices of Science and Technology and Protected Resources and the Office of National Marine Sanctuaries.

4. Much as the Department of Defense has done for hazardous activities on its land-based ranges, the U.S. Navy and NMFS should establish protected areas on the Navy's offshore ranges within habitat and at times of particular

importance to marine mammals. Within these areas, high-intensity sonar and underwater explosives activities should be restricted or limited.

5. The Administration should champion noise-management efforts within intergovernmental organizations, continuing its leadership on underwater noise at the IMO and International Whaling Commission and advancing noise management within other bodies, such as the Arctic Council, which the U.S. will chair through 2017.

Questions for Further Discussion

1. Why is it important to protect whales and other marine life?

2. What are some of the chronic (rather than acute) impacts of ocean noise discussed in the film?

3. In what ways do whales and other marine mammals depend on sound?

4. How do marine mammals use sonar?

5. What do you imagine ocean noise pollution is like? What can you compare it to in your own experience?

6. How do you think the Navy can both do its job *and* protect the natural environment? Do you think it's possible to do both?

7. What steps can individuals take in their own lives to reduce the amount of noise in the oceans? Are there things people can do that were not mentioned in the film?