

Science AMA Series: Hi, we're NOAA scientists Leila Hatch, Jason Gedamke, and Jenni Stanley. We're here to talk about ocean noise and what NOAA is doing to reduce this threat in our national marine sanctuaries and beyond. Ask us anything!

NOAAgov ¹ and r/Science AMAs¹

¹Affiliation not available

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Hi guys and thanks for taking the time to answer questions. I have a few about noise and oceanic sanctuaries in general:

1. In your research so far, what species seem to suffer the most obvious impact of increased noise?
2. When designating a sanctuary site, is there any pushback from local communities or are they generally welcome.
3. Where are some current sanctuaries and how were they chosen?
4. Assuming there are any, what are some proposed solutions to reducing anthropogenic noise?
5. Do you think the that there will be any way to incentives noise reduction? (E.g. some kind tax incentives for companies employing quieter engines)
6. What are your favorite sea creatures?

Thanks again!

[Yertoo](#)

Leila: Not many effects of noise are "obvious" unfortunately. I'm not picking on your word choice, but to be obvious in the ocean you have to be seen by people...which is a very slim slice of what is actually happening out there. For that reason, the most obvious are the most extreme and thus have received the most attention, like the stranding of whales on beaches linked to aversive responses (like going to surface to quickly) from specific noise sources, such as sonar. Such extreme responses of big, charismatic animals represent neither the most prolific types of noise exposure nor necessarily the primary types of marine animals that are being affected by noise. If we change the question to what species are likely most vulnerable to noise effects, then we start to include fish and invertebrates that make and hear sounds. That also lets us consider types of effects that are much more difficult to document, including loss of opportunity to hear food or greater risk of being eaten yourself because

you can't hear your predator.

Sanctuary designation processes engage a wide range of constituencies with differing opinions about what they are seeking to protect and why. The National Marine Sanctuary System currently includes 13 national marine sanctuaries and Papahānaumokuākea and Rose Atoll marine national monuments (see <http://sanctuaries.noaa.gov/> for more information and a map). You can learn about the [nomination process for new sanctuaries](#). It's a community-driven process where a group of people who care passionately about protecting an area come together to develop a nomination, and then submit the nomination to NOAA.

There are many solutions to ocean noise, from reducing the amount of noise we put into the oceans (e.g., through quieter alternative technologies) to reducing noise impacts to marine life (e.g., by conducting noise activities in places and during time periods with less risk for acoustically sensitive species, and by conducting monitoring during noisy activities to shut down operations when animals are close by, etc.). There is a great deal of discussion about incentive building to reduce noise, especially related to the building and operating of quieter ships. The Port of Vancouver, for example, is developing a program that does not penalize louder ships, but highlights, holistically but including noise, ships with less harmful environmental effects.

I like fin whales and otters and oostrocods and bluefish and...I'll stop.

What are the noisiest things and how do you tell them to shut up?

[Meanian](#)

Leila: I have little kids and the answer to your question is the same for them: it depends and "use your words" :). It depends because where you are, when you listen, and what specific frequencies you listen to all change the answer. It can get as complex as the same place we listen to during different seasons may be dominated by calling whales vs. by any human activity. Or in some places for three months the sounds of pile driving dominate because something is being built offshore,, but longer term it's the sound of a nearby shipping lane that's a steady, though less intense, contributor. We work with industries and federal agencies that produce sounds or permit activities that produce sounds to design methods that reduce their effects on marine species and places. These can include not doing noisy things in particular places or during particular time periods, or using equipment to reduce the amount of sound animals are exposed to, among other methods.

Hi NOAA! I'm a senior in high school, and have known my whole life marine biology and conservation was my goal. I'm about to enter into college, and I keep getting told it is hard to find jobs unless you have a Ph.D. How true is this?

As a follow up, are research "teams" assigned to key issues?

Finally regarding Noise pollution, is there a microscopic affect? Are the bacterial and algae communities directly affected by the sound?

[OverworldGamer](#)

Leila: First off--yeah! That's great that you are interested in these issues! Today you are talking to 3 people who went the route of getting PhDs because all of us had phases of our careers in which we were heavily and directly engaged in research, and were interested in developing skills to lead research efforts. Having that training helps Jason and I integrate ongoing research findings into NOAA's decision making, though we have less time actively doing research than Jenni does. That said, there are many jobs both at [NOAA](#) and in conservation science and marine biology in general

that do not require a PhD. Many jobs benefit from graduate training of some sort, a master's in environmental science or policy or education or communications and many lawyers also support what we do. Yes, we do have teams of people working together on issues like ocean noise in NOAA, and their training includes all of the types I just mentioned: lawyers, communication specialists, scientists with PhDs, policy leaders with Masters and many years of working in government etc. Teams is the best part!

Thanks for taking the time to do this AMA. I had 2 questions for you guys:

- 1) I was wondering if you could give an example of how noise can cause direct physical injury?
- 2) Is the noise level more important in reef ecosystems versus the ecosystems that dominate America's east coast?

[blind1993](#)

Leila: Just like we wear protective gear to protect our ears when operating a jackhammer, noise can damage the ears of wildlife directly leading to temporary and permanent hearing loss. In extreme cases, noise pressure can cause direct damage to other tissues as well, and even be lethal. So noise can be a lethal stressor, but in far more cases it has sublethal consequences. These consequences are more difficult to track, and they need to be considered holistically in trying to figure out how meaningful they are to the ability of animals to prosper in a location. To consider what environments and species are at higher risk, we evaluate several things: what is the status of the area/species in general? what do we know about how important sound is to the ecosystem/species, as well as how they are affected by noise? How [noisy](#) is it in that environment? What are the other stressors experienced by the ecosystem/species, and how does noise interact with those stressors? These are difficult questions to ask but we build towards understanding them to prioritize our protective activities.

Hi NOAA!

This seems like a very interesting topic of research to do, never thought about noise pollution in oceans!

Just a few questions: 1) How did you guys get into this field of research?

- 2) What strategies have you developed to reduce man made noise? (can't imagine that is an easy task!) Do you focus on fresh water areas or marine only?
- 3) What is your favourite aquatic animal?

[electricmojo](#)

Jason: 1) Practice, practice, practice!! Seriously though, getting experience in your field of interest any way you can is the most valuable thing you can do (internships, summer jobs, etc). For me at least, a summer internship studying dolphin cognition was the first experience I had and really did lead to everything else I've done in the field. 2) No it's certainly not an easy task, but there are things we can do to reduce the impacts of man-made noise. See the recently released [Ocean Noise Strategy](#) for more on what we're doing. 3) probably spotted eagle rays that you can watch as they fly by! (I remember being amazed by this as a kid, and just recently brought my own kids snorkeling and they had the same sense of wonder!)

Good morning, NOAA scientists! As a future PhD student I truly admire the work you all do.

My question is pretty basic: how does noise pollution in the ocean compare to noise pollution in land ecosystems (in terms of impact, or anything else)?

Also, what advice would you give to a young scientist who aims to work for an institute like NOAA?

Thank you so much! Have an awesome day :).

[lizard_cakes](#)

Leila: Comparing levels of noise in air vs. noise underwater, the first thing to remember is that they have different references--so you can't compare numbers directly, they need to be converted. That said, there are similarities and differences. Similarities: transportation can dominate background noise levels in many environments on land and in air---airports, fly-ways, roads concentrate noise patterns in air just as harbors/ports and shipping lanes do so underwater. Similarly, other sources of noise in air and underwater are very loud, but for short periods of time. Some of these we recognize as damaging to people's ears, and we have standards to protect people from exposure to sounds like this, especially in workplaces. We have similar standards for some marine animals, most notable marine mammals. There are differences, however too: sound travels faster underwater and low frequencies (things with very low tones) also experience less attenuation (that's less loss of energy). Thus, low frequencies can be heard over very great distances underwater, much further than in air. This has benefits for animals that need to communicate over very large ocean basins, but it also means that that some of the things humans do that have low frequencies have wide ranging effects. As for career advice, [NOAA's career page](#) is a good place to learn more about the qualifications needed for the different types of job available at the agency.

Could you say something about purposeful underwater noise for the sake of scientific research, like ocean tomography for locating floats and determining water properties? Will these be allowed in sanctuaries?

Oceanographers already have a lot of trouble convincing environmentalists and the public that we need anthropogenic sound sources in the ocean to do our research. I know there are efforts to use natural noises to do things like locate acoustically located floats, but it's really difficult and much easier to have a controlled source.

Thanks, Henri

[HenriDrake](#)

Jason and Leila: The same properties (distant traveling) that make sound such a valuable sense for animals, and lead to concerns over impacts of noise from human activities, also make acoustic techniques incredibly valuable tools for things like studying the oceans and marine life, safe navigation for ship, and underwater communication for scientific and industrial instrumentation. So yes, there are very important and valuable uses of intentionally produced sound underwater. The key is ensuring that any potential impacts from these techniques are minimized and acceptable. Sanctuaries do not prohibit noise energy associated with research and industrial sources, but if the research activity that produces noise, for example, would result in contact with the seafloor in a sanctuary, then a permit would be required. In addition, if a federal agency is involved in any oversight or finances of the activity that produces noise that is likely to impact sanctuary resources, consultation can work to identify ways to address those impacts. In general, sanctuaries serve as active partnership sites for research collaboration. Potential impacts are evaluated, minimized and monitored, but research is key to managing these special places.

Hi. I live in Woods Hole, close to the administration building and the aquarium. Here we have a lot of

natural ocean noise from currents, tides, and other sources.

What is the difference between natural and artificial noise and why is artificial noise worse? Which species does it affect the most?

[DuoDex](#)

Jason: The ocean has never been a quiet place...at times it's filled with a cacophony of sounds from marine life (fish, marine mammals, invertebrates), weather (wind, rain), geologic processes (volcanic eruptions, earthquakes) and many more. While the ocean has always had a range of noise sources, most marine life has had millions of years to evolve in the natural acoustic conditions in the ocean. And they've evolved to use sound as a primary sense (e.g., avoiding predators, navigating, finding food). But, just in the last century or so, since the beginning of the industrial age, human activities have increasingly added various new sources of noise to the oceans (shipping, oil and gas exploration, construction, etc). Because sound travels so well underwater, in many places these human activities have dramatically altered the soundscapes (acoustic environment) in many places, or led to long term increases in the background noise, which can impact species and habitats in complex ways.

As a recent graduate with a bachelor's in Marine Biology can you tell me about your experiences in finding a career with NOAA? I am currently looking at observer positions in fisheries through NOAA Contractors.

Thank you and keep up the good work!

[MTGothmog](#)

Jason: My first job after getting my bachelor's was to work as a fisheries observer in Alaska! So that's a good start. For me at least, the most important thing you can do is getting experience in your field of interest. So take internships in labs or with organizations that do work that you're interested in. One thing typically leads to another, and once you build up a resume/CV with some relevant experience (and hopefully good references to back them up) you should have a solid foundation to start applying for jobs. Keep an eye on [USAjobs.gov](#) for NOAA openings! I'm happy to hear you're looking into the [Observer Program](#). The work observers do is critical to managing our nation's fisheries.

Hi NOAA!

Does sound affect Cnidarians as much as other animals? How do you measure that kind of impact?

[OneAviatrix](#)

Jenni: That is a great question and one that I unfortunately cannot answer completely. To my knowledge there have not been any studies looking at the effects of ocean noise on cnidarians. Although the majority marine invertebrates do not "hear" in the same way as some vertebrates (pressure detection), they are capable of sensing vibration and the movements of particles associated with sound production. They do this via both external and internal sensory hair structures that detected changes in the acceleration of particles. To answer your question we would first have to know whether cnidarians have the types of hair cells needed to detect particle acceleration. To my knowledge they do possess small sensory hairs near the nematocysts (stinging cells) that are sensitive to water borne vibrations — the job of this cell is to trigger a response in the nematocysts to capture prey. Therefore, they may well be able to detect underwater sound in the form of particle movements and may show responses to ocean noise.

As a long time oceanic, and specifically sharks, enthusiast I'm wondering if this is something that could be mitigated through both innovation in engine/prop noise and/or some kind of sound wave dampening barrier around high noise areas (obviously nothing intrusive to marine life itself)?

Also, have you found any evidence of noise "pollution" in the water sourcing from on land?

[StylesB21](#)

Leila: Barriers to prevent noise from an activity from propagating too far is a big business in marine engineering--there are several types of bubble "curtains" that are created to do things like you suggest: allow movement but not sound. However, they aren't for a big area like a national marine sanctuary, more for directly around a pile that's being driven into the ground. And yes! In nearshore monitoring we hear traffic on bridges and coastal roadways for sure: not the same way you do through the air, but through the energy that is transmitted through the ground and into the water.

Hi, NOAA! I very much admire the work you do. I was wondering about whales and other marine mammals that use sound to communicate. Has human noise pollution affected their communication negatively in any way?

[kilkatzen](#)

Leila: This is a very active area of research. In many cases, such as with the largest animals in the world, the baleen whales, the scale over which communication takes place (many tens of kilometers) makes it very difficult for researchers to evaluate whether information exchange has occurred, and if so, how noise might be interfering with that exchange. What we can do is quantify how much other noise might interfere with the animals' sounds during certain time periods, in certain areas, and in frequencies that humans are producing noise. This is similar to quantifying what happens to you when you are at a cocktail party and the room fills up -- we can evaluate how much less you hear than you did when the room was emptier. You can learn more about NOAA's research on ocean noise at cetsound.noaa.gov.

What sort of decibel levels do some of the different sources of marine noise generate at their sources? OSHA has published safe noise levels (durations of exposure dependent on decibel level) for humans. Is it plausible that man is causing literal hearing loss in marine species?

[despicable_secret](#)

Jenni: Here is a great website that answers the first part of your [question](#). There are a number of studies published in scientific journals that conclude that certain man-made sounds can cause hearing loss, temporary and permanent hearing threshold shifts, and behavioral responses in marine fishes. (This is similar to humans, as the effects are duration and intensity dependent.)

Is it correct to assume big Cruise Ships make the most ocean noise? I've never been on a cruise, partly because I heard it messed with whale's communicating with one another.

[PrdFthr84](#)

Leila: Cruise ships do make sounds, and in some very specific situations they might be the dominant contributors to noise in lower frequency bandwidths (like in a port area dominated by that tourist industry but without traffic from the often more prolific vessel types that make up world shipping, such as cargo ships and tankers). Ranking noise sources, to call one type the "loudest" rarely provides universal answers. There are places where noise from cruise ships has been identified as specifically

of concern, such as the Glacier Bay National Park in Alaska, where their presence is closely regulated.

Can you tell us some good news? This is going to seem like a frivolous question in a science AMA, but well being of marine mammals is up there with elephants in the category of "nothing I can do about it and most everything I hear makes me sad." I remember there being a moratorium on high intensity sonar, but I haven't heard any other good news since then (c. 2013).

[dirtygremlin](#)

Leila: No, it isn't all bad. There are a lot of people that care a great deal about marine life and are working very hard. It isn't easy science to do, and the answers to how it make it better take new ideas. But the tools are coming, and the knowledge to support them is coming. You actually inadvertently gave me the in to an example: many people get their introduction to noise effects through well-publicized information about the effects of sonar on whales. The millions of dollars of funding that resulted from that heightened awareness has resulted in a far greater understanding of the specific species that are most vulnerable and in what contexts. But of far greater importance, we came to realize that noise sources other than sonar and species other than marine mammals need more attention, and more focused science. That awareness is driving a whole new phase of science, which in turn will give us the opportunity to better manage what we do to reduce impacts. You can learn about NOAA's approach to understanding and responding to ocean noise at <http://cetsound.noaa.gov/>.

Hi! Longshot question - As a High-schooler back in like 1992 I participated in gathering ambient sound data on the Stellwagen Bank. (under Dr. Peter Schiefle?) Just curious if this data is still used/part of the model. Always was rather proud of the work we did (though debugging a water column equation on a laptop in MS Excel in the cabin of a rolling boat did leave a bad taste.)

[jebediah999](#)

Leila: Hello! Thanks for tuning in! Yes, you were a part of very important work that got our site started down this research path! See [here](#), where we have a little write-up about what you did, and how it relates to how the program developed further. We are proud of you too!

Hi, thank you for sharing with the community!

My question is whether we would expect noise pollution to have an effect on migratory organisms. I've heard of extreme cases of fish migration (especially salmon) where it is unknown how they can find their "original stream." I could imagine tracking fish that move through noisy areas, and perhaps a greater percentage of those fish get "lost" compared to fish who are not affected by noise pollution. Is this a viable theory?

[Harpologist](#)

Jenni: Research has suggested that natural underwater ambient sound is used in settlement and orientation decisions of many species of marine larvae. It has also suggested the addition of anthropogenic noise in this environment can influence these decisions, increase stress, increase chance of predation, and in some cases increase mortality. So in part, yes, I think your theory is viable. If we know an animal travels from point A to point B and there is a loud noise source introduced in the middle, you could theoretically observe whether this causes an avoidance behavior, a change in route, or a reduction in animals completing the journey.

Are there any implications for the productivity of fisheries, or any impacts on organisms that might be proxy indicators of fishery health/ productivity?

[DirectsTenYeti](#)

Leila: There is a lot of research thinking about this. Internationally, there has been a focus on the effect of some noise sources on catch rates in fisheries with significant effects (not always as simple as less fish caught). Most of these studies are too short term to evaluate how long lasting implications are exactly how noise effects are translating to lower productivity in fisheries. A growing body of research is looking at broader habitat implications of noise for fishes, and is often prioritizing commercially important species as well as species that use sound during important life history phases. Laboratory studies are showing changes in larval development and growth rates in noisy conditions, but little is known regarding how this related to what stocks are experiencing in the wild.

Hey NOAA! Do you have any data on the effects of ocean noise on more pelagic fish species, or was your research more focused in and around the reef?

[seaspirit331](#)

Jenni: Yes, we are investigating the effects of ocean noise on both pelagic and reef fishes. For example, we are currently conducting research in multiple U.S. national marine sanctuaries that are home to both pelagic and reef associated fishes. To me, one of the most interesting species we are focusing on is atlantic cod in Stellwagen Bank National Marine Sanctuary; we're looking at changes in their vocalization patterns and communication spaces over time and space. You can learn more about the research we're doing on [noise in national marine sanctuaries] (sanctuaries.noaa.gov/science/sentinel-site-program/noise.html). Information about the research we're doing specifically in Stellwagen Bank is [here](#).

Thanks for taking the time to do this!

With all the new tech coming out for renewable energy, I imagine some sort of aquatic turbine will be used. Do you foresee the noise of one of these machines as an issue? And if it is, is there anywhere in the ocean they could be placed where the noise doesn't have a negative impact?

[screwy_wabbit](#)

Leila: New technologies always necessitate more research--we don't know too much about noise generated by first installing and then long term operating underwater turbines yet. However, noise effects are a recognized part of environmental impact assessment for offshore energy development in many places in the world, particularly when people want to install them in places where they have heightened concern due to the presence of animals with known noise sensitivity. Aquatic environments, as you suggest, are not homogeneous: there are places (and time periods) that are more vs. less vulnerable to impacts and much of what we do at NOAA and with partner federal agencies is try to improve our characterizations of habitat and its value to species so that we can inform site decisions such as these.

Hello! How has ocean noise changed with climate change?

[gracethefishy](#)

Jason: Great question, and one that we're continuing to learn more about. As just one example, the changing ice conditions are already causing changes in Arctic soundscapes and altering the acoustic

environment. In addition, with the continued retreat of sea ice, the Arctic is likely to see increased human presence (shipping, development, oil and gas exploration) in the not too distant future, which will further accelerate the changes to the acoustic environment. The potential effects of these changes range widely. For example, belugas have very sensitive hearing that is easily masked by noise. That's troubling news for wild beluga populations, especially the endangered Cook Inlet stock, which faces a noisy environment due to increasing human noise from nearby ship traffic, construction projects, and military, oil, and gas activities. Successful implementation of the [Ocean Noise Strategy Roadmap](#) can help reduce impacts from these human activities.

Why are dolphins attracted to the seismic source when we soft start?

[j2598](#)

Jason: Interesting question. While animals all may react differently (e.g. some animals may move closer, others may move away) remember that sound travels far underwater, and many times these animals may be curious...just wanting to investigate what this 'strange' sound is nearby!

Oi, NOAA.

1. How do offshore wind farms affect marine noise levels?
2. Can i donate anywhere?

[ceropoint](#)

Leila: Wind farm construction has been a focus of noise assessment as has the design of methods to reduce the noise produced during the time period (days to weeks to months, depending on number of turbines) of their installation. You can see an example of a map made of the noise levels produced by installing a proposed wind farm off Massachusetts at <http://cetsound.noaa.gov/sound-index> (look at "Cape Cod Event"). There has also been attention to noise during their operation, though this is acknowledged to be far lower intensity.

Hi!! Thank you for doing this Ama: 1:What are the biggest noise sources ?

2: I once read that noise can cause physical harm to fish, is that real and if it is how?

3:And does noise affects also marine plants?

[Thecrew_of_flyngears](#)

Jenni: It totally depends on how you define "biggest." There are many ways to measure and classify a noise source: you can look at the intensity, duration, frequency range, and/or propagation capabilities of the noise. Each of these properties could change the effect the noise will have on something.

Certain noise can cause physical harm to fishes, but it is very dependent on the intensity and the duration of the signal. Noise can cause damage by destroying the hair cells on the sensory epithelium of the inner ear. Anthropogenic noise is not the only loud signal underwater; believe it or not a single snap from a snapping shrimp at the source can be as high as 189 dB @ 1 m! Also take a look at this [website](#) for further information on noise sources.

Hey NOAA folks! We had the pleasure of having NOAA research ship Ronald H. Brown with us in San

Diego a few weeks back. Fine ship!

My question is, do you work with the Navy to gather information about ocean noise, considering the sheer amount of SONAR platforms they have at sea at any given time? Does gathering sounds from multiple locations help triangulate the areas of the ocean most impacted by noise pollution?

[Navydevildoc](#)

Jason: Hello, glad you enjoyed having the Ronald H. Brown in town! Yes, we collaborate closely with Navy on many aspects of issues surrounding ocean noise. We're currently having conversations about the possibility of expanding our [Ocean Noise Reference Station Network](#) and developing a long-term Passive Acoustic data archive that will allow easier researcher and public access to passive acoustic data. Navy funds a huge amount of research into the potential impacts of noise on marine life and we're often communicating with them about research priorities and directions for upcoming work. And yes, if you can record the same sound at multiple locations (at least 3) you can triangulate where the sound was produced!

What kind of microphones are used to detect ocean noise? Have you had to improvise equipment to get results?

[pinegreenscent](#)

Jenni: The microphones we use to detect and record underwater sound/noise are called hydrophones. Most hydrophones are based on a piezoelectric transducer which generates electricity when it is exposed to the pressure change in the sound field. You can learn more about the hydrophones we use in sanctuaries [here](#).

I have definitely had to improvise equipment in the past to get results! During my early research we used DIY hydrophones units. We would repurpose housings for other equipment such as temperature loggers and build the recorders ourselves. There was often a lot of electrical tape and zip ties used!

Hey guys thanks for doing this! I operate a ferry service who's boats are in the 70 - 150 foot range. Are you aware of any technologies operators can implement to reduce the noise pollution from their vessels, be it propeller noise or vibration from the machinery within the hull? I realize we're a small part of the overall problem and would like to know how to reduce our impact

[mydogfrank](#)

Leila: Yes! There are technologies that address both the sources that you talk about -- propellers are particularly dominant contributors to low frequency noise from large ocean-going ships. But operational characteristics matter, and the way you operate your ferries is obviously very different than the way a cargo ship is run over an ocean basin. Mid-sized vessels like yours often can have significant energy in slightly higher frequencies, up to the 10s of kHz, and often noise increases with speed. Also, you have other drivers for considering your priorities in noise reduction: you care about how the passengers on your ferry feel, and how much noise they experience, and that can often track to vibrations and machinery noise, which as you say can be dampened. Dampening also can reduce maintenance costs. The first step usually is to have an assessment, which are increasingly common though they used to be really focused on military and fishery research vessels, and see what your biggest noise drivers are and what makes the most sense to your business. It's great that you are thinking about this, as, depending on where you operate, it could be of benefit to your operating environment.

I imagine that a lot of the noise is from boats. Is the boat noise produced primarily by the propeller, the motor, or something else? Which boats are worst? What kind of design measures can be implemented to reduce boat noise?

Thanks very much.

[30ftandayear](#)

Leila and Jenni: Yes, you are right; a lot of low-frequency noise in the ocean is due to vessel movements. A lot of the noise being created by moving vessels is due to the propeller and the associated cavitation. Large cargo ships and tankers can have louder noise profiles--but operation matters, with vessels operating at higher speeds often showing higher source levels. They produce noise levels that span a large frequency range, however, most of the energy is below 40 Hz. Some parts of the shipping industry are looking at this issue seriously and are exploring the technical options for reducing this noise. The most logical first step is redesigning a vessel propeller to reduce the propensity of cavitate (here a lot of noise is caused when many tiny air bubbles that form around the propeller blades burst). There can also be insulating surfaces added between noise machinery such as engines and generators that would limit the propagation of their operating noise through the hull.

HI NOAA, QUICK QUESTION. How often do you guys hear bizarre unexplainable ocean noises?

[Env136](#)

Jenni: Every hydrophone deployment I have ever been a part of has returned unexplained sounds, some extremely bizarre! This is one of the reasons I find this research so interesting and rewarding. We're constantly facing the unknown, making small discoveries, and hopefully leaving the field with more knowledge than we had previously.

Many marine organisms are affected by noise but would you be able to definitively specify a single organism who has been effected the most by the noise?

[BillClinton](#)

Leila: I'm a scientist--we live in a continual appreciation for how little we know--so no. But I'm also a natural resource manager, and we have to make decisions every day based on the best of what we do know. If there is one rule that defines uncertainty it's that we are the most certain of the things we have studied the most. And we tend to study big charismatic things (like whales) that generously come up to the surface of the ocean where we can see them, and thus we know more about the effects of noise on them. However, we are learning more about more about noise impacts on the smaller but far more numerous species of fish and marine invertebrates because we can study them in laboratories. Time will tell! You can learn more about NOAA's approach to studying and responding to ocean noise at <http://cetsound.noaa.gov/>, and about research about noise in national marine sanctuaries at <http://sanctuaries.noaa.gov/science/sentinel-site-program/noise.html>.

Hey Leila and Jason,

This is interesting, I've heard of all the types of other pollution problems with our oceans but never noise pollution.

I wanted to know which are the biggest causes of this noise pollution today? Is it more from recreational or industrial?

Also I would assume that there has been more activity in the ocean than 100 years ago but are there any patters from marine life that have dramatically changed over the years that could be attributed to oceanic noise pollution?

[tmart016](#)

Leila: The kind of question you are asking is best addressed by developing a "noise budget" for an area. This is an evaluation for a specific place in the ocean of the relative contributions by different identifiable sources of noise to the total noise levels. Almost always there is a piece of the pie that includes noise made by unidentifiable sources. One of the key things to remember is that the noise budget and its answers will change if you change the area being described or the time period being covered, or the frequencies of noise being addressed. So the answer to your question depends greatly on where you look. Such techniques, again, address understanding of the human contributors to noise levels. Describing "soundscapes" is more inclusive, and relates noise contributions by humans to those sounds made by marine organisms and the physical environment. We don't have a lot of comparable recordings to closely track noise produced by increasing offshore industrialization. There are many dramatic trends in marine life over that time period, of course, but relating them specifically to noise is unlikely to be possible. You can learn about NOAA's approach to understanding and responding to ocean noise at <http://cetsound.noaa.gov/>.

So you're here to discuss what NOAA is doing to address the noise issue. What exactly is NOAA doing? Are any other countries doing anything to reduce the noise? What country is leading the way with this problem and what can we do to work with them (all depending if we are leading the cause or not)?

[BillClinton](#)

Leila: NOAA has recognized that we are the lead U.S. agency with mandates to address noise impacts to marine life, both through the science and management authorities we have, and through a diversity of programs that enable us to manage endangered species and protected populations, commercially important fishery stocks, and special places, like national marine sanctuaries. The [NOAA Ocean Noise Strategy](#) effort sets forth goals for standardizing and broadening our approach over the next decade. The strategy effort ensures that the work we do to design mitigations for marine mammals exposed to sound relates to the science we prioritize funding, for example, and also ensures that how we think about noise impacts in protected areas corresponds to how we think about impacts of noise to habitats that support fish. Our experts set out this thinking as a framework document, the [Ocean Noise Strategy Roadmap](#). We had a great deal of public comment before it was finalized in September. Take a look and let us know what you think. In several places we talk about what other countries are doing and discuss collaborations internationally as well as key partnerships between NOAA and other federal agencies.

Given that so much noise is from military or economic sources (ie shipping), what proposals would you put forth to reduce noise production without sacrificing power or speed? Do you have some new engine/propeller design in mind? I also assume that cavitation is as much a source of noise as the engines themselves.

[ACleverRedditorName](#)

Leila: You are correct, cavitation is a main driver particularly for the low frequency contribution of noise that affects noise levels at large spatial scales. From 2008-2014, NOAA and the U.S. Coast Guard worked to lead a group at the UN's International Maritime Organization to create guidelines to design quieter commercial ships. This effort lead to the successful ratification of these guidelines in 2014 by

the IMO (<http://www.nmfs.noaa.gov/pr/acoustics/shipnoise.htm>.) They identify and evaluate several means of addressing noise from ships through design, and though voluntary, several additional efforts are now targeting means for incentivizing their implementation.

Hi Leila, I was wondering if there are any laws regarding ocean noise in the US, and who would enforce these laws? Coast Guard, etc? Thanks!

[um420](#)

Leila: Hi! The laws that provide NOAA with jurisdiction address noise indirectly, as it impacts the marine life that we are mandated to protect: from species to ecosystems to special places, like national marine sanctuaries. These statutes provide a variety of responsibilities, from assessing those impacts, to determining allowable levels of impacts, to requiring or recommending things that can be done to eliminate or minimize these impacts. In addition, NOAA developed an [Ocean Noise Strategy](#) focused on improving agency actions to address ocean noise over the next decade. Other federal agencies assess noise produced by the activities they themselves conduct or that they permit/authorize more directly, and can therefore support programs to incentivize quieter technology if appropriate, as they too have mandates to reduce environmental consequences. Other types of legislation works more directly but quite specifically to places: National Parks are mandated to manage soundscapes within US Parks, and this can result in direct regulations of noise producing activities within parks. Internationally, mandates vary as well.

Since scientists and engineers are now reasonably good at building systems to detect and do species level ID of cetaceans, I was quite excited to hear about the buoy that WHOI put in outside of the [NY Harbor](#)

(Wishfully) ignoring the sticky funding question, I see a natural extension of this work to create networks of such systems in busy harbors to actually localize the animals. The potential to prevent animal/ship collisions is, I think, decent, and at worst, would provide a neat window for the public into the too often opaque ocean and it's creatures.

From an engineering/systems standpoint, this is effectively prior art, so my question is:

- What hurdles/pitfalls would you foresee in such a system?

Things that cross my mind: noise floor issues, frequency of animal localization (time between successive localizations), getting said info in digestible manner to ship captains (AIS integration?).

[fenative](#)

Leila: It is always amazing when we start listening in a new place how much we start to understand, that we couldn't see, about what is there. Much of what you are thinking about we considered a great deal when we put 10 of the same system of real-time right whale detectors in a line coming into the port of Boston. For example: we have higher background noise in the shipping lane, and right whales call softly, but work out the math and we can hear them to about 5 nautical miles from the buoy--which means we can cover the full shipping lane width if we put the detectors down the middle of the road. In addition, both genders of right whale make the call type and its fairly stereotypical (that is, you can build an automatic detector that does pretty well). Plus, right whales are very endangered, so we needed a system that could recommend a management response (slow down, heighten awareness etc.) for every detection. We designed the system just as you noted: we transmit detections via AIS to ships receiving that signal in Massachusetts Bay. We've also developed a web app that integrates those data with more static ship strike management information for operators.

Still, none of those answers are the same for a different species in the same port area, much less a

different port area. You need to know a lot about acoustic behavior and account for the fact that for many baleen whale species prone to ship strike, for example, only males vocalize, and they vocalize very loudly (e.g., blue and fin whales) so they can be far away from the site where you are listening and where the ships are. To localize, as you suggest, you need an array of recorders that can all hear the same signals so that you triangulate where the source is. That's expensive, which, as you suggest is sticky :). We get a lot of benefit, however, from not focusing so much on localization, but keying in on detection, like in the NY Harbor, in a particularly vulnerable spot and for a particularly vulnerable species. And you are also correct that its a fabulous opportunity to give people a window into the ocean.

Has there been any studies produced on the effects of noise on deep sea life, directly or indirectly?

Will rising ocean temperatures, with the effects that temperature has on sound, be problematic in attempting to deal with the problem? Would it have any impact at all?

[thatsconelover](#)

Leila: Well, the jury is out on that. There is plenty of discussion of the interaction theoretically, suggesting a more acidic ocean would be more transparent to sound. But the effect of rising temperature is quite small and is difficult to line up against other drivers that impact both how far animals' signals travel and how far the noise we make travels.

How far can sound travel through the ocean?

[FruiterGnome](#)

Jason: Sound (low-frequency, or deep pitched sound in particular) can travel thousands of miles underwater if it's loud enough when it's produced. Studies have recorded seismic surveys across ocean basins, and similarly, the sounds of earthquakes and explosions, can be picked up literally halfway around the world. [Learn more](#) about sound propagation underwater and the SOFAR channel which helps funnel sound through the oceans over long distances.

Could the [52-hertz whale be singing at a higher register](#) to counter increased noise in the water?

[Aximill](#)

Jenni: There is a phenomenon known as the Lombard effect which is an involuntary increase in amplitude of a vocal response by a signaler in the presence of background noise. There is evidence that certain terrestrial and aquatic organisms use this in response to rising background noise levels e.g., blacktail shiner (a freshwater fish) and many species of birds. Certain species have also been shown to be able to alter other acoustic components of their vocalizations, such as the frequency and the duration. So getting back to your question, we don't really know what is really going on with the 52-hertz whale. However, there is evidence that species such as the blue and fin whale have altered their call frequency over time and one hypothesis for this is that it is due to increased ocean noise.

Do submarines have a bigger impact than those that are on the surface? And what sort of impacts do submarines have on marine life?

[Rhyers](#)

Leila: Most submarines are designed to be very quiet, as the majority are operated by international militaries for surveillance purposes. Just like in nature, things that are trying to both listen and be stealthy, have to be quiet! :)