

Listening in on Animals

Liv Slaby: [00:00:00] Welcome to *Story+World: Changing Stories for a Changing Planet*. This season is a series of conversations between LENS scholars and writers, artists, scientists, activists, and others whose work relates to LENS's goal of understanding how today's environmental challenges connect to longer histories of imagining the natural world.

Today's episode is an interview with Grace Miller, a fourth-year environmental science undergraduate at UCLA who conducts research in bioacoustics. We discuss animal vocalizations and why humans should listen. I'm Liv Slaby, LENS podcast producer and PhD student in English at UCLA. Thank you for listening, and we hope you enjoy the conversation.

Grace, welcome to *Story+World*.

Grace Miller: Thank you for having me. I'm really excited to chat with you today and tell you a little bit about bioacoustics.

Liv Slaby: Tell us about your experiences listening in on animals. What's [00:01:00] it like to be doing this kind of field work?

Grace Miller: Yeah. I think surprising is the first word that comes to mind in the sense that whenever I am listening to a new soundscape, it is surprising and really interesting.

As you'll hear later in the podcast, there are so many different sounds that animals are making, and I'm just always surprised and intrigued by the complexity. It's a really exciting discipline.

Liv Slaby: What kinds of ecosystems and soundscapes have you researched?

Grace Miller: So the first bioacoustic research I ever did was with audio from the Yahuaraca Lakes in Colombia, and these lakes are part of the Amazon River basin, so the lakes and the surrounding ecosystem have all of the unique Amazonian wildlife, like sloths, pink river dolphins, and the world's largest lotus flowers.

But the project I was working on was with Marisol Valverde Montellano, a PhD candidate who studies bioacoustics, and so her work focused on fish vocalizations. She was looking at, are the fish vocalizing? Do they have distinct

vocalizations? Can certain sounds be attributed to certain species? And the answer to all these questions [00:02:00] is yes.

When you listen to these soundscapes, they are, as I mentioned, really complex. You can hear water trickling, insects whirring, and some scientists even think that plants are making clicking noises. But there are also these unique fish sounds that pop up, and they can be anything from, like, growls to purrs to knocks to gulps.

It is really diverse, and just listening while I was doing my research, there were over 50 different fish vocalizations. So here's a clip of what that ecosystem sounds like.

Some of the sounds are more faint than others, but you're hearing a lot of water gurgling. The chirring noises, those are insects. You can hear little gulps, and those are actually the fish sometimes gulping in water or food. And if you are listening to a certain soundscape for an extended period of time like that, you can get a lot of complexity and learn a lot about the ecosystem just from tuning into it.

Liv Slaby: That's incredible that fish can vocalize, and also I had no idea that plants were [00:03:00] sort of vocalizing as well.

Grace Miller: Yeah, it's really cool. And I remember when I first started analyzing that soundscape, I would sometimes confuse the two, which was funny. And then some of my other work surrounded the Arctic soundscape, and the Arctic sounds completely different from the Amazon, which makes sense because they're two different ecosystems.

But in the Arctic, in the winter, sea ice creates a layer over the ocean, which will amplify the sounds produced underwater, and it also minimizes wind-driven surface noise. And in the Arctic, you get narwhals, belugas, walruses, bowhead whales, and bearded seals at different times of the year. And it is very chaotic and mesmerizing that animals are producing these sounds.

For example, let's listen in to this sound clip, which is taken from a hydrophone submerged off the Chukchi Sea in the Arctic.[00:04:00]

Liv Slaby: That is such a rich soundscape

Grace Miller: Yeah, there's a lot going on there, and such diversity in the vocalizations, as you could probably hear. And so all of those different sounds

are being produced by different animals for different meanings, which we'll talk about a little bit later. And then moving forward into some of my other work, I've also done work in Costa Rica doing playback experiments with crocodiles, and that's a slightly different type of research than bioacoustics because you're assessing an animal's response to certain vocalizations rather than just passively recording the sounds that they're making.

But I figured it fits sort of into this category enough to mention. And [00:05:00] so some of the work I was doing in Costa Rica was looking at how crocodiles respond to the calls of their own babies as well as babies of different crocodilian species. And for my next step, I'm heading to Panama to research manatee acoustics in Rio Changuinola, which is a freshwater river and riparian ecosystem.

I haven't been able to listen to that soundscape yet, so I don't know quite what to expect. But we do know that manatees produce chirps and other sounds very frequently, and that these are used for social communication, which is what I'll be studying.

Liv Slaby: I'm curious to hear a little bit more about how these different soundscapes that you've studied differ from one another.

Grace Miller: Yeah, of course. So soundscapes are defined both by the animals that make the vocalizations as well as the abiotic features. So in the Arctic, the main feature is the sea ice, and sea ice sort of acts like a cover on the ocean. It can amplify the sounds produced below and keep the sounds out from above.

And I talked to Kate Stafford about this. She is an associate professor at Oregon State [00:06:00] University in the Marine Mammal Institute, and she has done a lot of work on the Arctic, and this is what she had to say about sea ice.

Kate Stafford: When there's not much wind, and it's really, really cold, and the ice is frozen, you can think of the sea ice as a cap on the ocean, and that means that ambient noise levels in the Arctic are some of the quietest on the planet.

So you don't have any ships. You don't have any wind noise. Really, the greatest sources of noise are ice and animals. When the ice is moving, it produces creaks and cracks and groans and pops, and it is incredibly noisy and incredibly variable.

Liv Slaby: So what do animals use vocalizations for?

Grace Miller: Yeah, that is definitely a loaded question because animals use vocalizations for all sorts of things.

So for example, the Amazon river dolphin has really poor eyesight, and on top of that, the water in the Amazon's pretty murky. There's a lot of sediment. And so without this strong eyesight, they use clicks for [00:07:00] echolocation. And they'll emit high-frequency clicks, and the echoes are received in this specialized fatty tissue in their lower jaw and then transmitted up to their ears, and it sort of allows them to see the river without actually seeing it with their eyes, but with their vocalizations.

And in this recording, you can hear a river dolphin making these clicks.

So that was the river dolphin, and those clicks are basically used to help them navigate to find prey. In the Amazon, a lot of the tree roots go down into the river, so they'll be able to sort of sneak through all these tree roots just by using echolocation. So that's one example of what animals are using vocalizations for.

But for other animals, the vocalizations can be more social. For example, with my manatee work, we know that manatees are using these vocalizations socially. [00:08:00] They use them for mother-calf communication. They use them in groups. We don't yet know what these vocalizations mean. That's part of my research. But we know that they're social.

And when you look at bowhead whales, which we have a better understanding of, they sing these wonderfully complex songs, and these songs even differ between individuals and between years. And so these songs are used to attract mates, and you can hear a bowhead whale calling in this sound clip[00:09:00]

It's very first complex, and that's bowhead whale singing its mating song. But you can also, if you listen carefully, sort of hear it almost echo into the void, and that is because there's, again, that ice acting as a cover that really amplifies the song. It's very different from the Amazon where there's a lot of sounds coming in.

Animals are making all sorts of vocalizations, as we heard in the Colombian Amazon. Even insects are calling. They could be calling for mates or to establish territory. And we definitely have different levels of understanding of what vocalizations mean for each animal. But if you wanted to hear an aquatic insect, we have a clip of that as well.[00:10:00]

Liv Slaby: So you mentioned the social function of the bowhead whale song and the fascinating question of what these songs and vocalizations mean, as well as the way in which echolocation allows us to think of sound as this really spatial phenomenon, which it always is, but it becomes especially evident when thinking about the river dolphin.

So I'm curious to know more about why an animal's ability to vocalize is so important.

Grace Miller: Yeah, especially with marine animals, sound is vital because often in the sea, it's dark, it's hard to navigate. And I'll let Kate Stafford talk a bit about why sound is so important to marine mammals.

Kate Stafford: If you live underwater where light doesn't transmit very far, and smells don't either, and you're not really terribly tactile, sound is the sense you have to use, right?

You use sound to find food, to navigate, to find mates, to communicate, to stay in contact. Marine animals rely on [00:11:00] their sense of sound to navigate their world.

Grace Miller: And some animals also use vocalizations for protection. That's another reason it's important. When I was studying American crocodiles, I was looking about how adult crocodiles respond to specifically the distress calls of juveniles.

And what I found was that crocodiles would sometimes respond in a protective manner to the calls of juvenile baby crocodiles. And during the time of my study, it wasn't breeding season, it wasn't nesting season, so these crocodiles, they didn't have babies of their own. So the calls they were responding to weren't even their own juveniles, and they sort of had this innate response to protect based on the calls they were hearing.

And so sound can very much be a protective factor, and crocodiles also use vocalizations to aid predation. That's another important aspect. When I was doing my experiments, I also played the calls of spectacled caimans, which they're not crocodiles, but they are very similar, and they had a much more predatory response to those calls.

So vocalizations factor in in all sorts of ways.

Here are the two calls played for you. First, the American crocodile [00:12:00] vocalization, followed by the spectacled caiman vocalization.

Wildlife ecologist Todd Brinkman also notes that vocalizations and changes in soundscape can directly impact entire populations of animals

Todd Brinkman: know that different sounds, they absolutely disturb wildlife in some situations, in some circumstances. And one of the big concerns is if that sound moves wildlife off of what is considered higher quality habitat to say lower quality habitat, that can of course have a population level effect if it's a severe enough displacement to a lower quality habitat.

Liv Slaby: So going back to that question about the bowhead whales, is it possible to understand what animals are saying to each other?

Grace Miller: Yeah, for most species we haven't gotten [00:13:00] there yet, but there is research going on that is focused on understanding social communications. That's what I'm doing with my manatee research.

And it can be important for conservation because if you're listening to a manatee vocalizing and it's making these sounds again and again and you realize that those sounds are related to a mother talking to its calf, or maybe that's the sound it makes when it's eating, you know that when they're making those sounds, they're doing really important activities for their survival.

They're either taking care of their calf or they're feeding, or maybe they're doing something important socially. So by understanding what they're sort of talking about, you can understand, okay, when they're making these vocalizations, they're doing something really important, or they're in an important area that is necessary for feeding or breeding.

And so those vocalizations can actually be linked to specific areas we need to help conserve, or specific time periods we need to help protect them during breeding season or something. And so it's not yet possible to understand what they're saying for a lot of animals, but it [00:14:00] is important research and it's definitely a growing field in that regard.

Liv Slaby: What do your recording devices hear that you can't?

Grace Miller: Acoustic recorders are really good at capturing audio from places that are difficult for us to monitor or access. So one example is

hydrophones, which are just underwater microphones, and they allow us to basically listen in on animals that live underwater.

So for example, here is a piranha vocalization from the Amazon.

That's a piranha. It almost sounds more like a cat to me. But hydrophones really allow us to get down there into the, the river, the lake, and understand how these animals are vocalizing. So that is one really strong benefit of using bioacoustics to understand the environment. And another vocalization from the Amazon is the *Potamorhina altamazonica*.

And as we'll hear in a second, this is a very noisy fish, and we wouldn't really know any of this [00:15:00] without being able to place these acoustic recorders in the water.

Liv Slaby: I think maybe there's a notion of fish as somewhat voiceless, or at least I had that idea. And hearing these vocalizations is really surprising to me, as you mentioned at the very beginning of the episode.

Grace Miller: Yeah, it's really special to be able to gain that insight into sort of fish in that underwater realm because I think, yeah, when you're looking at fish from the surface, of course you can't hear any of the noises they're making.

But as soon as you put that hydrophone underwater, it opens up a whole new world. And it's very similar in the Arctic. I know we've talked a little bit about sea ice, but by placing hydrophones in the Arctic Ocean, researchers can record all of the vocalizations [00:16:00] that happen once the ocean freezes over.

So they could put a recorder up there in early fall before everything freezes over, and then record that soundscape for the entire winter and retrieve it in early spring. And so in that case, you're accessing this world that you cannot hear from above because it's completely closed off by sea ice. And for example, here is a gray whale vocalization that was taken from under the Arctic ice in the Chukchi Sea.

Liv Slaby: Beyond these spatial and logistical limitations on what we can hear, are your tools picking up frequencies that aren't audible to humans?

Grace Miller: Yeah. So humans can typically hear frequencies between 20 hertz and 20,000 hertz, which go from low pitches to high pitches. But there are animals that produce really high frequencies or really low frequencies, [00:17:00] and we as humans cannot hear those.

Acoustic recorders, however, can record these sounds, and when you analyze that data, you have both the vocalization but also a visual representation of the vocalization, and that's called a spectrogram, and it basically lets you see any sound even if you can't hear it. Morgan Ziegenhorn, who has done a lot of acoustic work in the Arctic, has thoughts about this as well.

Morgan Ziegenhorn: The human hearing range goes up to about 20 kilohertz. The instruments I worked on in grad school, we recorded at 200 kilohertz, so 1 to 100 kilohertz. Yeah. So way, way beyond human hearing. And that's because almost all dolphin echolocation clicks are produced above the human hearing range.

Liv Slaby: What sorts of specific technologies and methods do you use for bioacoustic monitoring and data collection?

Grace Miller: So there are certainly different methods for both underwater recording and terrestrial recording. I'm going to hand that over to the experts on this one about the different ways that [00:18:00] they set up their bioacoustic monitoring technologies in the wild. So first we'll hear from Kate Stafford.

Kate Stafford: A lot of the, like the overwinter data, year-round data we use, we deploy a recording package on a mooring.

So you'll have a giant anchor, which is often an old train wheel, a string of instruments that measure temperature, salinity, current speed and direction, and then a hydrophone. And the hydrophone just sits and records, usually on a duty cycle. It's not continuous so that the batteries will last, say, 15 minutes every hour for a year.

And the data are archived on the instrument. So to get the data, we've got to get that whole mooring line back, which means going out in a research vessel, sending a signal to release from the anchor so everything floats to the surface, open your instrument up, hope it worked, hope it didn't flood, hope the batteries lasted, and then downloading the data.

You make a spectrogram and look for the patterns that you know are bowheads, belugas, fin [00:19:00] whales, humpback whales, and identify those.

Grace Miller: And Morgan, who specializes in terrestrial acoustic monitoring of birds, also provided input on how she sets up in the field.

Morgan Ziegenhorn: The microphones that we use are called AudioMoths.

We basically, you get them and you program them ahead of time before you go out into the field. They don't really have like an interface or buttons. You can pick what frequency range you want to record. Uh, you can pick how long you want to record for. You can set a duty cycle, which is something that we do where you record...

In our case, we record the first five minutes out of every half hour. But once you've made all of those specifications You take the instrument out with you into the field, and we set ours up in these little cases and on rebar. They're set, like, about a foot off of the ground.

We also face all of ours in the same direction [00:20:00] because the microphone is supposed to pick up sound from every direction, but generally once it's in the case, it doesn't really do that as well.

And kind of set it up at an angle to the wind, and we do that the same on all of our plots because generally the prevailing wind direction on the north slope is the same across the slope. Then we leave it out there for a month, sometimes two months. For the most part, they stay relatively intact, and then someone will go back and pick them up.

Liv Slaby: What inspired you to pursue this research?

Grace Miller: I first got into bioacoustics about two years ago when I was working on that Amazon fish project, and I was just floored by how much was going on underwater acoustically. I found it so interesting that sounds could reveal so much about the ecosystem. And once you listen in on a soundscape, you realize that not only are you hearing these different species communicate, but it can tell you so much about the health of the ecosystem and how the ecosystem [00:21:00] is functioning.

Liv Slaby: Tell me a bit more about the state of the field. Is this a new area of study? Is it a growing area of study?

Grace Miller: It's definitely an emerging field, but it's rapidly growing and evolving, which I think is amazing. I've been seeing more and more projects that are incorporating acoustic monitoring. Some projects where acoustic monitoring is the main goal, and other projects where somebody is maybe tracking a marine mammal and decides to add a hydrophone so they can also have that acoustic data.

Sometimes people will monitor the health of an ecosystem, and if they decide to throw in an acoustic recorder, they can assess how the soundscape is changing over time. And it's really exciting to see acoustics getting incorporated into this larger view of ecosystem health, population dynamics, and species conservation.

Liv Slaby: How has your work changed the way you think about and relate to other than human species?

Grace Miller: I think in general, humans have this view that we are unique because we have complex language and communication, but when you start listening to all of these soundscapes, you realize that so many species [00:22:00] have complex communication and vocalizations.

And we as humans are maybe just unaware because we haven't been able to listen in and understand that aspect of different ecosystems. But there is so much going on acoustically, whether it is below the Arctic ice, or in these lush Amazon ecosystems, or in the mangroves of Costa Rica, and it can tell us a lot about these animals and how they function.

I think for me, having spent time listening to all these ecosystems, it's been really eye-opening in the sense that I truly understand how much communication and vocalization is going on, and a lot of it we don't even yet understand.

Liv Slaby: When people look at sea ice, they might think it's a dead void. But as you've shown, when you listen, you can hear how much abundance there is and how much life there is.

Why is it important to de-center visuality as the primary way of coming to know the world around us?

Grace Miller: If you think about it, a lot of the ecosystems we've talked about today, sight is not [00:23:00] the main sense or the primary sense for a lot of these animals. As we talked about in the Arctic, it is dark, and the ice makes a cover, and the animals use sound over sight because it's really hard to see, but they can hear one another.

So it's really important to de-center visuality because visuality isn't the main sense that a lot of these animals are using to interact with each other and interact with the environment. And so by listening to environments, you can gain a

much clearer and accurate understanding of the biodiversity and how the ecosystem functions.

For example, let's listen to these three recordings of a walrus, a beluga, and a bearded seal, and you can see how complex their vocalizations are. And it's because they're using vocalizations as their main forms of interaction and communication.[00:24:00]

Liv Slaby: The beluga's making all of those noises?

Grace Miller: Yeah, that's only a beluga. And so just between those two already, you can see there's such diversity in the sounds they're making, even though they're both marine mammals. And it really just emphasizes the idea that their vocalizations are so specified because that is how they're navigating the environment first and foremost.[00:25:00]

And that is a bearded seal, as you can see, very different than the other two as well. So there's a lot of vocalizations going on underneath the water, and so sea ice is definitely not a dead void. There's a lot going on, we just can't see it.

Liv Slaby: Why is bioacoustic study valuable for our understanding of these hard to access ecosystems?

Grace Miller: Bioacoustics allow us to study environments continuously over many months and in a non-invasive way. So we know that the animals are not reacting to any human presence, and we can sort of control for that, which is really important. As Morgan says:

Morgan Ziegenhorn: The other cool thing about the acoustic recorders is that they can record data.

Instead of just being there for a little bit, they're able to record data from a whole summer. You're looking at hundreds of thousands of hours of data

Grace Miller: And so thinking about the ecosystems I'm familiar with, for example, [00:26:00] the Amazon recordings, I know that Marisol, who is leading the project, went down to the Amazon for a couple of weeks and placed recorders there, and then allowed them to record those lakes over the summer.

And then she came back and collected them and had months of data that she could analyze. Acoustic recorders provide a lot of insight because she didn't have to be in the Amazon for those summer months, and when she pulled the

recorders out, she had all the months of data without actually having to physically be there.

Liv Slaby: So once you have this data, what sort of information does it give scientists?

Grace Miller: I spoke to Todd Brinkman about this, and we discussed a study that was conducted over a couple decades where a researcher went to a forest before any logging had happened, and he recorded what that forest sound like. And then the logging company came in and thinned the forest, and they hadn't been intrusive enough to the point where visually you could really notice a big difference.

It didn't look like there was significant damage. But this researcher came back and he recorded that ecosystem [00:27:00] again, and this time there were far fewer vocalizations and far less diversity in vocalizations just with that primary thinning of the forest. And so it's really important to understand that even if something visually does not look as if it's been affected, sound can provide really important insight into the ecosystem to let people know if it's healthy or if it's being impacted by anything.

And so vocalizations can tell us all sorts of things. They can tell us what species are present, if species are interacting with one another, if species are coming in seasonally, or if they're more permanent, and if populations are increasing or declining. And it can even give us information about species mating and producing reproductive calls.

So overall, vocalizations give us a ton of intel about animal behavior, abundance, and diversity.

Liv Slaby: So this brings us to kind of a sad part of the conversation, but one that emphasizes the importance of bioacoustics. So how do human activities impact these soundscapes?

Grace Miller: Yes. As always, [00:28:00] human activity is impacting the environment, and one anthropogenic activity that has a large impact on soundscapes, specifically marine soundscapes, is boat noise. And in all the ecosystems I've studied, boat noise has made a significant impact on the soundscape.

Even a small motorboat can be very disruptive and can completely take over the entire soundscape. For example, let's listen to this motorboat noise from the Yahuarcaca Lakes. [00:29:00]

Listening to that motorboat noise, you can hear it's pretty disruptive, and it definitely sort of takes over the soundscape in a way. You're not hearing those more subtle clicks or fish noises anymore. And just as somebody who's done research in, on that soundscape, I even noticed that when I was trying to analyze the different noises and pull out those fish vocalizations, anytime a boat would come into the scene, it was almost impossible to hear all those different species' vocalizations.

So it's very intrusive, and even a small motorboat can do something like that. And as Kate Stafford notes, increased anthropogenic noise can affect whale stress levels.

Kate Stafford: Uh, there was a really interesting study that happened right after 9/11 when researchers studying North Atlantic right whales were on the water, and nobody else was on the water, obviously, 'cause the world ground to a halt.

And they were [00:30:00] measuring levels of stress hormone in feces, and they found a statistically significant correlation between stress levels and ambient noise. So just post 9/11, when the oceans were very quiet Stress levels in right whale feces went down. And when they looked at ambient noise levels after the fact over time, they found a clear correlation that noise increases stress levels.

Grace Miller: And Ben Sullender, a spatial ecologist at Audubon Alaska, adds onto this.

Ben Sullender: Really what it boils down to is people sort of drowning out animals' natural ability to communicate with each other, to track down food resources, and to navigate their way in this dark environment. And that's something that they have relied on throughout evolutionary time, is using sound to figure out where they are in their environment.

Grace Miller: But aside from boats, other anthropogenic activities can also alter the soundscape. For example, underwater as well, seismic air guns create these really loud blasts that can [00:31:00] sometimes even deafen whales or cause them to stop calling altogether because it's just so much noise, which can in turn cause them to become lost or disoriented, 'cause as we talked about, vocalizations are their way of navigation.

Even levels of just background noise, such as cars passing on a freeway or people talking, can disrupt the natural soundscape, and it can make animals less likely to call or cause them to spend more energy to call at a higher volume or higher frequency. And I actually read a study recently where researchers listened to birds before COVID and during COVID when everything sort of shut down and there wasn't a lot of anthropogenic noise.

And they noticed that once the soundscape became a lot quieter, these birds were calling at different frequencies and using far less energy to call. And it sort of showed that when there was a lot of anthropogenic noise present, the birds had to expend a lot more energy just to make the same vocalizations to be able to hear one another.

And so even something that doesn't really seem that loud to us, such as, like, a car going by, can really impact the soundscape.

Liv Slaby: That is fascinating. I had no [00:32:00] idea about that. Certainly I'd heard about seismic air guns, which are used for offshore exploration for oil and gas, and I've seen videos on YouTube taken by divers, and it's so shocking and so violent.

But I didn't know it was also affecting animals on such a small scale.

Grace Miller: Yeah. It can be something super minor. Even just walking through a forest, if you're hiking and you're talking out loud, it can cause animals to stop vocalizing or find somewhere else that's maybe quieter. And so sound is definitely something we as humans should definitely be thinking about because it can impact the environment as well.

Liv Slaby: What are the greatest anthropogenic threats to bioacoustic environments?

Grace Miller: So for marine environments, one of the biggest problem is boats, specifically boats with motors, because they can cause vocal masking. And vocal masking is when a sound such as a boat motor comes in and sort of masks or hides all these other smaller vocalizations that are less loud.

And [00:33:00] we heard that in the Amazon recording. When the boat came through, you couldn't hear the plants or the insects or the fish anymore. And one area where boats have been pretty harmful is with manatees in Panama because manatees use mother-calf communication to stay together. And with whales in

the Arctic, boats are also causing problems because, as we know, whales use their vocalizations to stick together in a pod and make sure nobody gets lost.

And so when you introduce ship noise into either of these soundscapes, you get a lot of vocal masking where the vocalizations can no longer be heard. And this can cause mother-calf pairs to separate. It can cause whales to get lost. I think in the past couple of years, I've heard of a whale up in San Francisco sort of getting lost on its migration, could have been because of ship noise.

And important mating calls can also get covered up by boat noise and can pose a really big threat to both the survival of these animals as well as the population dynamics. And you can hear this clip from Glacier Bay National Park, which is in Southeast Alaska, that a humpback whale song is being masked by an outboard engine.[00:34:00]

In that recording, you hear the engine sort of being consistent throughout, and you can hear the humpback whale song coming in and out. It was really hard for me to hear, and I know there's supposed to be a humpback whale there, but that's sort of what masking does. It covers those important vocalizations with that constant noise of the outboard engine or different ships.

Another human-induced threat is climate change, and this is specifically pertinent to the Arctic because as the climate warms, ice in the Arctic becomes less prominent, which opens up the sea to more ships, which we know that ships are not good for soundscapes. But also, these ice-free periods are becoming longer and more prominent, and so that cap on the ocean is not there anymore.

So all of the sounds from the surface are sort of coming in, and the calls beneath the surface are no longer amplified [00:35:00] as strongly. Ben Sullender adds to this.

Ben Sullender: So as that sea ice is receding, we're getting a lot more vessels that stay in the waters for a lot longer. So it's a higher magnitude of vessel interactions in these areas, as well as a lot longer duration.

So its exposure is really increasing for anthropogenic noise up there.

Grace Miller: While sometimes animals are able to avoid areas with high anthropogenic noise, in other cases, it just isn't possible.

Ben Sullender: The challenge is in really narrow bottlenecks like the Bering Strait. If you have a massive amount of marine noise in that area, that's also a migratory passage for these animals.

So if you have an enormous amount of cargo traffic or liquid natural gas tankers just buzzing back and forth in this really restricted forty-mile wide stretch of water, you might not be able to... If you're a whale, you have to get through it, and you might not want to because it's so noisy. So there's potential to interrupt migration patterns.

Grace Miller: And when you're looking at terrestrial [00:36:00] threats, one of these is the sounds of aircraft. And this can be very disruptive to terrestrial animals, especially migratory birds as well as caribou. And I know I've done work in the Arctic in Alaska, so I'm just using that as an example. But in Alaska, planes are really big forms of transport, and so you can be getting planes all day, and it really can disrupt the soundscape.

And any sort of infrastructure development can also be detrimental to the soundscape as well as the ecosystem because if you're building anything, you're having constant loud noise that can cover up breeding signals or territory signals. And any sort of machinery as well, whether that is a truck or a train or an ATV, all of these contribute to anthropogenic noise and can really impact fragile soundscapes.

And a final terrestrial challenge is oil drilling. That's a big one that can either mask important signals or cause animals to use a lot more energy to ensure they're being heard. And it's very disruptive to both the environment as we know, but the soundscape as well.

Liv Slaby: What challenges come with bioacoustic [00:37:00] analysis?

Grace Miller: The biggest challenge in the field of bioacoustics is the amount of data that you have, which I know is usually it's the opposite problem. Usually scientists don't have enough data, but after recording a soundscape for weeks or months or even a year, you have massive amounts of data. And especially if you are looking for specific acoustic signals of maybe a certain species or a certain type of animal, it takes a really long time to pull those vocalizations out.

For example, when I worked with fish bioacoustics, I would manually sort through hours and hours of audio recordings and annotate on screen every time I heard a fish vocalization, and it can be very time-consuming work.

Liv Slaby: What are the conservation implications of bioacoustic study?

Grace Miller: So bioacoustics gives scientists a really intimate view into the world of any animal that is producing vocalizations.

In terms of conservation, bioacoustics can be really helpful because a soundscape can show which species are present and what behaviors they're exhibiting. So for example, if a [00:38:00] specific ecosystem or area has a lot of breeding calls or migration cues or social vocalizations, and you can show that using acoustic data, then you'll have a much more solid argument for protecting that ecosystem.

Just by using vocalizations, if you're able to match a vocalization to a certain species, we can see, okay, are there invasive species in the area, or are we seeing significant declines in the populations of endangered or threatened species? And so in terms of conservation, it can provide really critical information over a longer period of time about population dynamics and potential threats to species in need of conservation.

Liv Slaby: How are bioacoustics then implemented into conservation plans?

Grace Miller: Bioacoustics offers a ton of insight into where ecosystems are being most impacted by anthropogenic activities because you can actually hear it happening. You can hear the ships creating noises that will mask signals, or you can hear trucks creating disruptions on land.

So I look at bioacoustics as a discipline that provides a ton of information about [00:39:00] how and where we need to conserve and what is most critical. And of course, as always with conservation, there has to be give and take. Kate Stafford weighs in on this.

Kate Stafford: Understanding what the signals mean gives us an understanding of where, what habitat might be really important and worth protecting, where animals are, when and why.

And that can tell us, okay, if we're gonna manage, say, shipping Maybe we don't blanket say, "Everybody has to slow down all the time." Maybe we say, 'cause there has to be give and take- Right ... to actually get something done, right? Maybe we say, "Okay, in the winter in Bering Strait, it's really important because you can't see," right?

You're not gonna have visual observers on the boat. It's too dark. There's too much ice. Let's slow down because we know this is critical in critical habitat in the winter. In July in Bering Strait, maybe we don't worry about that so much because there's not a critical mass of species in that region, so maybe then we, we relax a little [00:40:00] bit, like we don't let the ships go 20 knots, but we say, "Okay, this is a time and a location where we don't feel like we need speed restrictions."

Liv Slaby: Are there any current projects that utilize bioacoustics for conservation?

Grace Miller: One ongoing project that I've heard of that I find fascinating is the North Atlantic Right Whale Monitoring Program. So the National Oceanic and Atmospheric Administration, or NOAA as most people know it by, has set up a program where they leave passive acoustic detectors in areas where North Atlantic right whales may be.

And these whales are endangered. There are only about three hundred and seventy left, so conservation efforts are really critical. And when a passive acoustic detector picks up a right whale vocalization, this allows for near real-time monitoring, and alerts can be sent out to passing ships to steer clear of the area to avoid any ship strikes or vocal masking or anthropogenic harm.

And so that's one project that's currently in place to help conserve these whales using bioacoustics. [00:41:00]

Liv Slaby: Can these projects then influence policy decisions?

Grace Miller: Absolutely. In a nutshell, bioacoustics can measure the biodiversity of an ecosystem. So if you're listening to an ecosystem and you're noticing a significant decline in the diversity and abundance of vocalizations over time, you know that there is something that is negatively impacting that environment.

And in terms of human action, it could be logging, it could be disruptive ship noise, it could be infrastructure. And so we have seen some conservation policy decisions that are influenced by acoustic data. For example, up in the Arctic, there are some zones where ships have to slow down or cut their motors so that they are less disruptive to the soundscape.

And as always with environmental decisions, it can be hard to get those implemented, but bioacoustics provides a lot of the information needed to support that decision.

Liv Slaby: What do you hope to accomplish with your planned research?

Grace Miller: So my planned research is a study that's looking specifically at West Indian manatee vocalizations in Panama, and that species is threatened there.

[00:42:00] And I'm trying to understand the social significance behind them. And essentially, I'm trying to figure out what the manatees are saying to each other. So the largest goal would just be able to understand what these vocalizations mean and why they're being produced. And there is a hope that this will inform conservation efforts because if you can link a certain vocalization to a vital behavior, such as this chirp means that the manatee is trying to breed, or that squeak means that they are feeding or protecting the calf, and then you can link that meaning and that vocalization with certain areas of the river, and you're hearing one call over and over in this specific area, that provides a really strong argument for conserving that section of the river or even decreasing the number of ships that are allowed through, which would then decrease the anthropogenic impact on this really important behavior.

So even though I'm looking at the social side of vocalizations, I hope that this could have a really large, strong conservation impact on manatee populations in the Bocas del Toro area I also hope that it will allow us to understand the species a little bit better because manatees are very [00:43:00] elusive, they're low in numbers, and they're quite hard to study, especially in Panama, because the rivers are really murky from all the sediment, and it's part of why we're using bioacoustics here, because it allows us to hear things that we can't really see.

Liv Slaby: That sounds really exciting and really generative. What do you want your audience to take away about how we listen to more-than-human beings?

Grace Miller: I'd love the audience to consider that there is so much that can be learned from just listening. I know that we, humans as a species, are incredibly visual, but if you just close your eyes and even listen to an ecosystem, you can learn so much and sometimes catch things you wouldn't notice if you were just looking.

And I think it's important to understand that so many species have complex communication. It's not just humans. And for a lot of species, sound is their main way of navigating the world, and I think just humans in general should think more about the vocalizations that are happening and listening into them.

Liv Slaby: How can humans prevent the loss of more-than-human soundscapes? [00:44:00]

Grace Miller: So for this, it's difficult to say that there's just one solution. A lot of the impacts come from major corporations or large-scale activities. One way that you can have an impact is through policy decisions, so supporting policies that don't enable oil drilling in very important areas, or policies that limit ship traffic to certain times of the year or certain times of the day.

You could also support policies that would limit construction of roads in areas that are really ecologically important. And anything that limits the amount of anthropogenic noise that is going into a certain soundscape is a fantastic way to protect it. On a more individual level, being mindful of your own noise when you are out hiking or in the natural environment is really important.

That could be something as simple as not playing music when you're on a hike or at the beach, or keeping your voice down in areas where there's lots of wildlife. And I know we also talked about cars. It's not always easy for people to, you know, not use their car, but if there's a way that you could bike to work or bike around town, it's producing a lot less noise than you would [00:45:00] be if you were using a car with an engine.

And all the noises we make can and do impact the soundscape, and it's not something that everyone always realizes, 'cause again, we're visual creatures. But being mindful of our noise is very helpful.

Liv Slaby: Grace, thank you for joining us and for telling us about this vital area of study, as well as how we can be more mindful members of our ecosystems.

We're very excited to hear about where your research takes you.

Grace Miller: Thank you for having me. I am really excited to dive into the bioacoustics of manatees, and hopefully I'll be able to give an update at some point as to what they're saying to each other.

Liv Slaby: This has been *Story+World: Changing Stories for a Changing Planet*, where we explore environmental art, activism, policy, and imagination in California and beyond. It's the podcast of the Laboratory for Environmental Narrative Strategies, or LENS, at [00:46:00] UCLA. Thank you for listening, and we hope you'll join us in our next story world.