
Jennifer Stock: You're listening to Ocean Currents, a podcast brought to you by NOAA's Cordell Bank National Marine Sanctuary. This radio program was originally broadcast on KWMR in Point Reyes Station, California. Thanks for listening!

Jennifer Stock: Welcome to a special edition of Ocean Currents, a show where we talk about the blue part of our planet, the ocean. We focus on research, conservation, natural history, management, expeditions, and ways for us land-based folks to get involved and learn more about what covers three quarters of the earth's surface. So, thanks for joining me today. My name is Jennifer Stock and I bring this show to KWMR from NOAA's Cordell Bank National Marine Sanctuary, one of three spectacular National Marine Sanctuaries off the central California coast and my hope is to build interest and knowledge about our ocean through this show.

So, today as we talk about ocean noise, I hope we can learn a little bit more about how we might be able to get involved, but we have some compelling sounds to share with you and the ocean's health is suffering from multiple issues like pollution, over harvesting, ship traffic, ocean acidification, and one that is harder for most of us to imagine in our everyday lives is ocean noise. The ocean was once referred to as the silent world by Jacques Cousteau, but now it's become an increasingly noisy place since the industrial age. It is estimated that the ambient ocean noise has increased 10 decibels, that's 10 times increase in sound levels, between 1950 and 1975 and probably after that even moreso. So, when I think about the ocean myself, I think of sounds like this.

(Ocean Sounds)

Jennifer Stock: ...because when I am in the ocean, I'm usually scuba diving. Here are some fish making some sounds in a coral reef area.

(Ocean Sounds)

Jennifer Stock: Very nice and peaceful sounds breathing underwater, but in reality, what we're experiencing now, or at least the larger mammals in the ocean and everything see in the ocean as well, they hear different wavelengths than us and they are hearing much different sounds and we're going to try to play this here.

(Ocean Sounds)

Jennifer Stock: ...and which would you prefer to listen to? I think that's pretty clear. There's increasing attention being drawn to this issue and identifying the sources of it to explore this issue today, I have Michael Stocker here in the KWMR studio. Welcome back, Michael. You've been on the air here a couple of times on KWMR shows. So, welcome back.

Michael Stocker: Thanks, Jennifer. It really is an honor to be here again.

Jennifer Stock: Michael is an acoustician and naturalist by trade and also a musician. He has been working on ocean bioacoustic issues since 1992. His understanding of both physics and biology has proven invaluable in court testimony and legal briefs defending the environment against the dangers of human-generated noise in the sea. So, Michael, with this background of yours, when did you first learn about ocean noise as an issue for animals in the ocean?

Michael Stocker: Well, it kind of goes back a long way. Actually, when I was a child, I had aquariums all over the house. My mother tolerated that and then actually supported it. We had saltwater aquariums, which at that time, you had to kind of mix the salt. There was an aquarium at Morrow Bay and they had hydrophones in one of the tanks that played the sounds of the rockfish and I was completely fascinated with that and I thought, "Wow. I've got to do that," and my mom said, "No. Your little fish don't make that kind of sound." Little did she know that some of the fish that I had, some of the corydoras and what have you are actually sound specialists and they make an interesting array of clicks and chortles. I don't know if it would have been something that would have been able to be heard over the sounds of the bubbling pumps and things like that, which seem to...they tolerate, but in any event, I was kind of on the track when I was a youngster and wanting to be a marine biologist as a kid was only thwarted in my high school years by a biology teacher who was incredibly tedious and I thought if biology is like that, I don't want to do it. So, I ended up getting involved with sound because it was my fallback position as a musician and that took me through signal processing, acoustics work, and what have you over the years and, kind of, it came altogether in 1992 when the Navy was proposing deep sea communications system and sniffing the entire Pacific basin with sounds and I didn't think it was a good idea.

So, I started presenting with my understanding about biology and physics at hearing with the California Coastal Commission, National Marine Fisheries Service, and other hearings where they

were kind of discussion whether or not this was something that would float and they did the program and, in fact, acoustic thermography of ocean climates, which was the first program, had that been really the only noise in the ocean, I wouldn't be doing what I'm doing now, but I saw that as a harbinger of things to come that they were, in fact, going to be bringing a lot more communications systems into the ocean and other stuff and that started this little, kind of detour.

Jennifer Stock:

Was that the ATOC you were talking about that thermal stuff?
Michael Stocker: Yeah, you know, originally, actually I'd been following the work of Walter Munk who is really a kind of brilliant oceanographer, physical oceanographer and brilliant, but also kind of not necessarily focused on, he wasn't a biologist. He didn't really think about the ocean as a vessel for life. They did a program back in '90, '89, '90 called the Heard Islands Feasibility Test and it was literally the first sound that was heard around the world. They heard that sound in...they generated down in Oceania on Heard Island and they heard it both sides of Cape Good Hope in South Africa and so, it was heard around the world.

Jennifer Stock:

Interesting. The Heard Island, that's....

Michael Stocker:

Yeah.

Jennifer Stock:

...discussed that way. That's amazing. It traveled around the entire planet.

Michael Stocker:

Correct.

Jennifer Stock:

Under the ocean? This one sound.

Michael Stocker:

One sound.

Jennifer Stock:

Amazing. So, it really kind of puts it on the plate of what we're looking at here in terms of a global issue with marine life and ecosystems at risk. So, with all that experience, tell us a little bit about ocean conservation research. This is an organization that you founded and you're now working under to work on these issues. What are you up to?

Michael Stocker:

Yeah. Well, I started working on it as an independent for quite a few years and then I started working with other non profit groups kind of as a science advisor and doing work with, a little bit with NRDC, but more with Earth Island and Greenpeace and Animal Welfare Institute, kind of advising them on some of the more, kind

of, arcane aspects of ocean physics and ocean acoustics. It became clear to me in 2006, I was at a conference in Hawaii and I was in an acoustics conference and I was in a bioacoustics section and I noticed that probably 90 percent of the papers that were being presented that day were being funded by the Office of Naval Research and while it was good science, it was not necessarily conservation-prioritized.

They would look at things like recoverable thresholds or maximum sustainable exposures and things that...they don't really have a conservation ring to them. What I would like to know is at what point in time do you start compromising the system? So, I realized the only that we were going to be able to get any kind of progress towards mitigation on this was to actually drive the research myself. So, I started Ocean Conservation Research a few years back and we have been, a bit at a time, growing and delivering papers and doing research, doing some mathematical modeling, and every year we get a little bit bigger and a little bit more successful.

Jennifer Stock:

That's great. That's good to have an independent strain there for looking at certain questions. What are...where are we at collectively? The whole ocean noise issue is somewhat recent compared to other things like pollution and marine debris, but where are we at collectively with knowledge about the impacts of sound on marine life?

Michael Stocker:

Well, this is actually a fairly new field. I mean, there were people kind of doing studies, mostly Navy people, doing studies on packs of various types of sounds and animals and into the past decade there have actually been people trying to come up with systems to, for example, acoustic harassment devices that keep net predatory harbor porpoises and seals and whatever away from aquaculture operations, but we really know very little about it. I mean, the animals that we do know what their hearing thresholds are, we're testing them, oftentimes in the context of human time domain priorities, you know?

Dolphins can hear certain frequencies, but what happens when they are more set in a complex biological setting and I'd like to back up a little bit. You know, you mentioned that the ocean, the silent ocean paradigm that was kind of the misnomer that Jacques Cousteau put out. Actually, the ocean was a lot quieter in 1957 than it is now, certainly, but we just published a paper and hopefully, it's in peer review right now, but we modeled the ocean noise prior to industrialized whaling and just with the five species

that we had noise models on and also able to kind of model the quantities of animals that were pulled out of the ocean, millions of whales that were pulled out of the ocean, we find that in 1820, the ocean was actually louder than it is now.

Jennifer Stock: How did we know though in 1820? What type of stations did we have out?

Michael Stocker: Well, I mean, this is what the paper is about. Essentially, what I do is I look at the animals that we have sound profiles for and we try to figure out how many animals were pulled out and there was a couple of different ways of handling that, taking whaling records, taking biological records, DNA records, and what have you and we found, for example, that the whalers were not necessarily inclined to report accurately what they were pulling out of the water because they were getting taxed on the quantities of whale oil that were selling on the heavy...we found in some cases the underreporting was stunning. Phil Clapum and Julie Shivishinko came out with a paper that was unpublished information that was gathered by biologists who were on Soviet whaling fleets as it was kind of mandated by the National Whaling Commission and while they were reporting, for example, that between 1957 and 1963, that they only pulled 45,000 humpback whales out of the water, the actual records that were taken by this biologist were 750,000 of that just one species.

Jennifer Stock: Amazing.

Michael Stocker: So, and what we did...take humpback whales and you do the noise profile. We know what kinds of noises it makes during certain times of the year and you basically just do the integrations and figure out...I modeled the ocean as if it was a big resonant chamber. It's kind of very simplistic stuff, but just the acoustic energy from the various species we had was fairly stunning.

Jennifer Stock: So, would you say, at this point, our focus is mainly on marine mammal impacts? Or, has it broadened to other animals? I know that there's been concern of, locally here at Cordell Bank, there was interest in mapping, ocean mapping, and there was concern that those are sound waves that are being sent down to map the bathymetry of the sea floor and what impact might that have on fauna on the sea floor, invertebrates and what not? So, it's mainly focused on marine mammals because we've seen these impacts of mass strandings and what not, but where else has, the studies, where else have they led us?

Michael Stocker: Well, we do see obvious impacts on marine mammals and there's also a lot more legislation on protecting of marine mammals, but we're seeing compromised fisheries after certain types of assaults, mostly seismic air gun work and what have you. In terms of the mapping, a lot of that would depend on what frequencies are being used. We tend to think that fish don't hear...have a very broad band hearing, except now we're realizing that some fish, for example, the natural prey of dolphins and porpoises, actually can hear their main predator.

So, they don't just hear up to 5 kilohertz, they can hear up to 40 to 80 kilohertz. Well, if you're doing your mapping with that type...scan sonar, for example, 45 to 80 kilohertz is not an uncommon frequency, they may have some impact. What is it? We don't know. Fish behave differently, you know, mammals when they are in threat mode, their heart rate will rise, the cortisol levels will rise up, getting into this kind of flight or flight routine. Fish, most fish, when they get into a fear mode, their heartbeat slows down. Their metabolism slows down.

There is speculation as to why that is. Maybe it's they don't want to create such a strong acoustical signal for their predators, but in any event, they behave differently. They don't flee the site. They may shelter in place, if you will.

Jennifer Stock: Interesting. For those just tuning in, you're listening to Ocean Currents, and I have Michael Stocker here in the studio and we're talking about ocean noise. I just heard something today and I'm wondering if you've heard this story. My superintendent at my office was...I told him I was going to be interviewing you about noise and he said, "Ask him about these sperm whales in Alaska."

There's these good whales and these bad whales that are...that's of course in quotes, that are hanging out with the sable fish fishery and the good whales, they are hanging way back and waiting from discard from the sable fish after the haul has been pulled up on deck, but the bad whales are going after the bait on the line and so, they called them the good whales and the bad whales, but what they're trying to do, there's research looking into hanging down these beads of sound mimickers to mimic the sound of sable fish so that the whales will get confused and not know where to go after the bait on the line. Have you heard about this study?

Michael Stocker: Yeah. Actually, Aaron Thode is the guy who, we were going to try to do some work with him down in Baja, California, really sweet guy, amazing photographs that he was able to take. They had these

predatory sperm whales and so he hung a camera down on a line and was baited with this case of black cod and these giant animals ever so delicately pluck the fish off the line. It's very funny to see.

Jennifer Stock: Those are the bad whales.

Michael Stocker: Those are the bad whales and, you know, I mean, it is. They're making quite a dent in the fisheries, I mean, the fishermen's catch. So, you want to do something about it, but what do you do when you have a clever animal like that? I haven't heard of the sending sound mimics down there, but it'll be interesting to see what happens.

Jennifer Stock: Well, especially because they echolocate. So, I guess they're trying to mimic what the sable fish sounds are so that the whales will be echolocating on these sound balls instead of the fish.

Michael Stocker: Oh, I see what you're talking about. Interesting. So, they're actually physical decoys, not sound-making decoys. Interesting.

Jennifer Stock: Well, physical, sound-making...

Michael Stocker: Sounds as well?

Jennifer Stock: Yeah. So, I just thought it was an interesting, somewhat bio-mimicry kind of impact with the fishery and I liked the idea of the good whales and the bad whales. It sounded funny to me. So, as far as noises go, it sounds like a lot of the noise is coming from shipping traffic and that's increasing as we are transporting goods around the world.

What are some of the other noises? You mentioned about you were at a conference recently about oil drilling and exploration offshore work and that you were learning a little bit more about the types of sounds involved in that and I'm wondering if you have some thoughts on that as well as do you have any sounds to maybe share with us? The shipping or the oil drilling?

Michael Stocker: I have some stuff, unfortunately, a lot of the stuff that I'm really concerned about is not easy to get a hold of, but just to kind of lay the scenario out, when they go out and find oil, the first thing they have to do is seismic surveys and these surveys use these air guns, which explode, and create this kind of impulse that they then kind of reflect down into the substrate below the ocean bottom and back up to the surface and then they can read through any kind of distortions that happen once there and it's amazing the pictures, the

very stunning 3D pictures of what happens down there, you know, kilometers below the ocean surface.

They have to continuously monitor the state of the deposit as they suck it out. So, they constantly are having these surveys going on. That's pretty noisy. You can hear those explosions thousands of miles away in the ocean, but once they find a deposit, they will then drill and they drill from a platform, these deeper-water platforms. They can't just build up an arbor and stick a platform on top of it. We're talking about something that's 5,000 feet deep. It doesn't make any physical sense.

So, they have these stabilized platforms that are stabilized with these thrusters and these thrusters are these propellers, depending upon the size of a platform, that may be two, three and half, four meters in diameter, these giant propellers, well just a couple of propellers would sound...let's play a cargo ship, here. Let's see and get a noisy ship. Oh, that's the other noisy ship. This is the cargo ship.

(Cargo Ship Noise)

Michael Stocker: That's just one propeller, but that's probably a propeller that's about a meter and a half in diameter. They would have six to eight of those on board these ships constantly stabilizing because they have to stabilize it with an x, y, z axis within a meter so that they can poke a pipe down there. The technology used in oil and gas is really the gee whiz factor. It's really high.

Jennifer Stock: The sky's the limit, right?

Michael Stocker: It's really...yeah, there's a lot of money there. This conference, by the way, there was 90,000 people attending the conference. That's a lot of people.

Jennifer Stock: Wow, that's a big industry in this country.

Michael Stocker: Yeah, but the other noises that come...so, once they've got the exploratory drilling, they figured out, "Ok, we got the oil," they tapped into the thing, they will have stabilized platforms running around the clock, basically, sucking the oil out, processing the stuff. So, those propellers don't go away.

Jennifer Stock: It's a similar sound to just the ships that are moving up and down the coast, though. I mean, if there's thousands of ships coming in

and out of San Francisco Bay, we're hearing those propellers over and over in and out all day long.

Michael Stocker: These are particularly large, though.

Jennifer Stock: Oh, bigger.

Michael Stocker: Yeah and a lot more turbulence is being generated because they're essentially kind of shifting back and forth and grinding in and out and then there's the sea floor processing equipment. They don't necessarily just suck the oil up like a milkshake. There's actually a lot of different substances in that. There's brine, there's gas, there's sand, you know, solids, oil, and so they have to separate that out and what do they do with the stuff that they separate out.

Well, they re-inject it. So, you have pumps that suck it out, or actually pumps don't suck it out, pumps that mediate it, push it through the separating equipment, and then re-inject it back into the sea and often times it's going to be high pressure. For example, the BP oil disaster, the well head pressure was 13,000 PSI. When you have triple state materials going at that...it's not quiet. So, that's part and then there's more noise. It looks like you're looking at a station identification mark here.

Jennifer Stock: No, I'm just nodding along thinking of these massive cities on the sea floor of equipment and the pressure and it's just...it's so non-native.

Michael Stocker: Yeah, definitely that and then, of course, now that they have a lot of autonomous vehicles that are tending these things, they have these multi-nodal communication networks which send out these signals that are anywhere from lower frequency, you know, 1 to 3 kilohertz, just kind of identification navigation signals, to higher frequency signals that actually kick out data and just to give you an idea of how some of these signals sound, this is some, let's get into the digital modem signals. That's high frequency. Can't really hear that one.

(Modem sound)

Michael Stocker: Yeah. That's a frequency shift key, fairly common.

Jennifer Stock: How far would that transmit?

Michael Stocker: They usually, their operating range for these multi-nodal networks operating at 20 to 40 kilohertz or 10 kilometers.

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- Jennifer Stock:* So, 10 kilometers. So, some miles?
- Michael Stocker:* That's, what, three and a half, four miles? But, there are all these...
(Signal Sounds)
- Michael Stocker:* ...all these delightful sounds.
- Jennifer Stock:* It causes stress. I'm feeling stressed.
- Michael Stocker:* Yeah, and these signals, by the way, they go on and on and on and on. I mean, there are certain times where they have basically a call-response situation that'll have something they need to do a release, do a signal line with them that's just a beep or two, but all these pieces of equipment will have other times where they're just kind of kicking out signals forever.
- Jennifer Stock:* Wow. Lots and lots of noise. Well, for those of you tuning in, you are listening to KWMR, 90.5 Point Reyes Station and 89.9 Bolinas or on the web at www.kwmr.org. My name is Jennifer Stock. This is Ocean Currents and we're talking with Michael Stocker about ocean noise.

(Music)
- Jennifer Stock:* You're listening to Ocean Currents and I have Michael Stocker here in the studio and we're talking about ocean noise. What's happening right now with oil drilling on the coast of California and I'd like you to also talk about the arctic work that you've been talking about. There's a lot of whales that go up to the arctic to feed, especially in the summer months, many of them come from down here, but can you give us an update on what's happening with oil drilling? This moratorium expired here in 2008, where we had no oil drilling on the coast and then that was not renewed and it's a new administration now and what's happening?
- Michael Stocker:* There are a lot of people who are pretty amped up about trying to get as much oil out of the ground as possible right now and this house just passed a kind of a trio of bills that were all fairly favorable to the oil and gas industry. One of them was basically, lifting the moratorium, it was designed to speed up the approval of leases and another one basically has lifted the moratorium on the east and west coasts, will...I don't think we're going to see these pass necessarily because there is a lot of people that live in California and we can put up a lot of resistance, but you can see

which way the tide is turning on this stuff as the oil men are really, you know?

This is going to be slightly different tangent here, but I was at a conference last summer in Cork, Ireland and it was a bioacoustics conference and pretty much most of the people who were in the field, there's not a lot of us, there's maybe 150 to 200 people, people from Navy, people from oil and gas, and seismic, geophysical stuff, bioacousticians, academics, what have you and it was a pretty good week all and all.

Everybody was nice to each other, but at the end of the week one of the guys stood up from the Navy and he basically was wagging his finger at the regulators saying that, "The scientists are doing the work and the environmentalists are going to push us to be honest about this stuff and we're getting all this stuff together, but we're not getting regulations we need. We need regulators to step up to the plate and do their job."

And regulators stood up and said, "Well, it doesn't actually work that way. We don't get to regulate unless we are asked by legislators to draft regulations." It was clear as a bell at that point to me is that our legislation is choked up by oil and gas people and military and they're not going to get any kind of mitigative legislation if who...if the people who are feeding the trough are basically fed by oil and gas people. So, regulations are not forthcoming.

Jennifer Stock: Because there's no one to make the legislation...there's no legislation.

Michael Stocker: ..to ask for the legislation, right, and instead they're asking for fast tracking of oil leases. So, it's kind of where we are right now. It's a sad reality.

Jennifer Stock: Is that the situation in the arctic too? There's an opening up there?

Michael Stocker: Yeah, this opening up and the moratorium also includes leasing the arctic. So, what we're asking people to do is we're asking them to let Michael Bromich know that we should not open up these areas to leasing until we understand the full scope of all the impacts of the noises that are going to be brought into that, particularly in the arctic.

We have icebreakers, all kinds of different technologies to stabilize platforms in ice pack and ice flow: Acoustical modems, seismic air

guns, and stuff and until we really know what the impact of these noises are on our fisheries, we shouldn't just burst ahead and particularly up in the arctic because 40 percent of the fish ends up on the table in the southern 48. 40 percent of that comes from the arctic. So, we can really mess with our food supply if we don't do this thoughtfully.

Jennifer Stock: Well, especially with the massive changes we're seeing in the ocean already with fisheries and other parts of the world and that's such a strong support, strong place to get seafood. It seems like we really need to protect these areas that are the most abundant that are feeding the most amount of people and when we bring in another additional threat to that it makes it even more difficult. So, you're talking about getting involved writing letters. Where is a good source of information about this, the updated oil lease information and getting involved?

Michael Stocker: This is a little bit premature, but for the millions of people out here in West Marin, I'll just...

Jennifer Stock: Hey, we're on the web!

Michael Stocker: ...yeah. We...I've been working with World Wildlife Fund, Dave Aplen who is up in Homer, Alaska, and there's a really great group being created and we've been putting together this website. We've been spending the last nine months on it. They put a lot of energy and effort into it. It's called Don't Be a Buckethead dot org and basically, we're still, we haven't launched the video yet, but it's a fairly embellished site. It talks about all the different noise impacts.

We did a really thorough matrix in terms of the different technologies and the different animals. So, we have seals and sea lions, mostly seals up there, whales, beluga whales, the right whales, the fisheries, and the polar bears as being the representative groups of the impacted...

Jennifer Stock: ...some big megafauna.

Michael Stocker: ...and then substantiated by the scientific papers, what are the impacts that we know that these noises create? And then there's some we don't know. For example, we don't really know how noisy the sea floor processing equipment is. I'd like to drop a hydrophone down there. We've got a...nonprofits who are basically sending out grant proposals, a few grant proposals we have out on that, hopefully we can drop a hydrophone in the water then.

Jennifer Stock: Now, NOAA and the National Marine Fisheries Service, they regulate marine mammals under the endangered species act or the marine mammal protection act and they've been conducting analysis on impacts of oil and gas disturbance to marine mammals. Where are we at with those studies? I understand that there's assessments that start in 2007, but it had to stop and now it's going further again this year and now, more currently to learn more about this. Do you know much about where this is at or where this is taking place?

Michael Stocker: Yeah, there was some, what they called controlled exposure experiments done, Brandon Southhall, Peter Tyak, and some other people were doing this. It's a little bit contentious because people are concerned that we're harassing these animals. They're being very cautious about it. If you really look at how they're working it, they essentially go out and tag an animal, but most of the work in beaked whales because they seem to be the most sensitive. It's very difficult to tag a beaked whale anyways.

Jennifer Stock: It's hard to find a beaked whale.

Michael Stocker: Yeah, exactly. They spend probably 95 percent of their time underwater. So, you have to kind of see them come up by profile and then intercept them and they have these tags, which are basically data recorders that have suction cups on them and they stick on them because they have smooth skin, they stick on them for maybe a few hours, if they're lucky 4 or 5 hours, and during the course of that, what they hope to do is see what the swimming patterns and what have you and then they'll ramp up sounds and figure out if there's a behavioral modification as a consequence of the sound.

So, as I say, there's a lot of contention about it, there's a lot of people saying you shouldn't harass these animals in the first place, we should just shut the noise up. The problem is with the way that the legislation and regulation works, we have to have data. So, in the scale of things, you know, it's kind of like the tragedy of the whale jails. They have these orcas or had these orcas in places like marine land and the orcas were just...it was a pitiful sight to see these poor animals in these dinky little cages, essentially, but what ended up happening as a consequence, they were like, kind of the martyrs.

They introduced millions of people to the idea that these animals were not savage beasts and that they were sentient animals that they, in fact, were friendly and in some...it's said, "Well, it's a

horrible thing the humans need to try to get sense beat into them..."

Jennifer Stock: Well, historically, whales...it has hard to get whales on the radar for conservation until the music of the humpback whales was played and it really brought attention to humpback whales and this is during the era of whaling. It's harder to communicate the animals that we just can't see...a lot of us just don't see them. Some of us do get to and this is an animal, whales in general, that are hidden most of the time and it's pretty hard to bring that light to people in terms of their communication, the sounds. You had a couple sounds that I wanted to play. I figure, let's bring in some of the happier sounds.

Michael Stocker: The fun stuff.

Jennifer Stock: The good stuff that we're trying to protect to be around for a lot longer. You had some pilot whales. I wonder if you could play those?

Michael Stocker: The pilot whales that I have, which has got masking when the motors go through it, but I'm going to play some belugas. The belugas...I'll play that in a second. The belugas are called the canaries of the sea and it's kind of a sweet, it's almost like C3PO.

Jennifer Stock: So, is this echolocation we'll be hearing?

Michael Stocker: These will actually...there's two signals here. There is a social call, which are the kind of squarely, tweety stuff and stuff like that and then you hear the bzzt and the bzzts are actually buzzes that they use to echolocate to find.....So, here we go.

(Whale Sounds)

Michael Stocker: Okay that was one, where's the other?

Jennifer Stock: Those were belugas?

Michael Stocker: Those were belugas and I've got another beluga here.

Jennifer Stock: It sounded like there was another type of sound in there. Was that different noise in the area or a boat, or..?

Michael Stocker: No. Those are all belugas.

Jennifer Stock: Can you play that one again?

Michael Stocker: Yeah I'll do that.
(Whale Sounds)

Jennifer Stock: Almost sounds like a little moped getting started up.

Michael Stocker: Yeah, it does doesn't it? Let's see if I get this with a beluga here.
(Whale Sounds)

Jennifer Stock: It's like R2D2.

Michael Stocker: Yeah, or C3PO or whatever it is those guys talking to each other. It's kind of like that.

Jennifer Stock: That's amazing.

Michael Stocker: But, it's really sweet, very musical, and one of the things that we're trying to push is the idea of biomimicry. These animals are cooperative hunters, pack hunters. They can coordinate fairly fast and tight hunting strategies and they do it with these sounds that they create.

Jennifer Stock: So, how could we use biomimicry? Are you talking about a way to lessen the impact on marine mammals?

Michael Stocker: If you take, for example, this...
(Beeping Sound)

Michael Stocker: That's sonar, you know, communications sonar. Would you rather that or would you rather hear something that sounded more like the belugas?

Jennifer Stock: Yeah. Belugas.

Michael Stocker: Yeah, belugas, right. So, then some people say, "Well, if you put those signals in the water, maybe you'll confuse these animals."

Jennifer Stock: That's what I was wondering. I was thinking a way to compare... we have this issue with what we call spam email or phishing emails that people think that, well, if you get an email and you think it's something from somebody you know and you open it up, it could become a very dangerous thing.

It's like mimicry in a way and I was just trying to think of ways to make... a sense of what mimicry is in the ocean and if you're making the sounds of an animal, it's like, wouldn't it want to go towards that sound in terms of... or go... why would it want to go away from a sound that sounds like itself?

Michael Stocker: We haven't tried that, but the idea behind this is these sounds are pretty loud. They're up between 160 and 185 decibels. That's loud, but these animals have been living with sound, they're habituated to it for the past 20 some odd, maybe 30 million years in some cases. A lot of these animals have not really changed morphologically for the past 30 million years.

So, chances are they've adapted to that sound. They can handle it and if we are using signals that sound like that, but embedding our own data in that, I don't suspect they're going to get confused by it. They're probably going to say, "Well, who's that? What's going on there."

Jennifer Stock: (Unintelligible)

Michael Stocker: Enunciate! I can't understand you, you know?

Jennifer Stock: Got that. Okay, language barrier.

Michael Stocker: Yeah, right.

Jennifer Stock: Well, that's interesting. So, is there any research being done? It sounds... you know, the case I brought up earlier, the sperm whale and the sable fish, the black cod, sounds like an experiment happening with biomimcry, but are there others that you're aware of?

Michael Stocker: We're really pushing... this is one of the issues that, you know, in the... in the bioacoustics field, there are really two schools. There are the people who are the physicists who are kind of physical photographer-types and they look at animals as if they're input devices and then there's the people who are biologists who understand animals as being a repertoire of behaviors and in some kind of an envelope, but they don't tend to speak a common language.

We're getting a bit more of that right now, but so, some of these ideas really require people to kind of step outside of their own particular discipline and start looking at how we can actually... biomimcry is really a generalists field and generalist is

not really something that's promoted in academics right now. So, it's starting to happen. People are getting dual majors that are actually crossing over the different silos, we're starting to see that, but, you know, essentially, we're trying to push this ourself.

Jennifer Stock:

So, let's go further with that. It's a quarter to six. We've got about ten minutes left. Those tuning in, this is Ocean Currents and my name is Jennifer Stock. I'm talking with Michael Stocker about ocean noise, but if you were in the perfect world, what could we be doing right now in terms of raising this issue towards more legislation and regulation? Where should we be? Where can we be or where should we be aiming to get with this issue?

Michael Stocker:

Well, you know, I'm trying to do what I think is the best, most time-efficient, cost-effective way of coming up with solutions to the problem and what I see as some of the possibilities in biomimcry is to...actually, first we need to understand what the impacts are. There are some things that are fairly obvious. We've developed a metric that has helped express the differences in sound qualities.

For example, alarming sounds are alarming not because we're taught that they're alarming. It's because they sound horrible and so, we leave. Sounds like the belugas, which is high frequency, moving, it could be, in fact, an alarming sound, but it's not. It's very pacifying and the reason being is there's a certain mathematical, or I should say, you can model it mathematically, but if you look at the harmonic content of it, you look at the time domain variability of it, you'll see what they call, there's a statistical way of expressing is called kurtosis, and it talks about high kurtosis signals are very edgy, you know, shear, shattering, break squealing, and low kurtosis signals are things like violins playing or the orchestra, what have you.

So, there is basically a continuum between low kurtosis and high kurtosis. At some point in time, you'll start to see the continuum correlating with anxiety, panic, and out and out bolt for the door. So, we're developing a metric to express that and we'd like to get that nailed down and then use that to do correlative studies with humans and people who can say it's a horrible sound and see if there's a correlation between high...and back to whales, this is one of those things which you have to kind of prove it scientifically, and then take that into Brandon Southall's controlled exposure stuff, see if there's a correlation there, and not necessarily work with the beaked whales.

We'd work with other animals, work with captive animals that have been worked with before. The Navy's got no....they've got a whole operation down in San Diego where they have these animals. We have these animals, we're trying to learn as much as we can from it.

Jennifer Stock: Sounds like there's some rapid research going on right now. There's a lot to prove, basically, before we can do much more.

Michael Stocker: Exactly, but my suspicions are that if we prove this kurtosis metric as being something that does express agonistic sound characteristics, that we can then start crafting the sounds we use in the ocean to be less agonistic.

Jennifer Stock: Okay because it's not like we're going to get rid of the sound any time soon.

Michael Stocker: 90,000 people were attending that conference down there. They're not going to be out of work tomorrow.

Jennifer Stock: So, we need to figure out a way to lessen the impact as much as possible. What about areas....is there ways to create areas where we have less...I mean, there's some areas that are just so important to the survival of species in terms of feeding and breeding grounds. Are there any special protections that can be put in place in some of these areas and who would need to be working on that?

Michael Stocker: One of the things that I was really thrilled about was when Jane Lubchenko was appointed to the head of NOAA because she's somebody who really understands the importance of temporal spatial mitigation measures, monitoring areas for when they're sensitive, and setting up mitigation procedure and we have now the data processing to be able to handle that, to model the coast and find out at what time is it most vulnerable, what are the areas that are most productive for regenerative life and so, we have the models, we have the people in place to understand it, and I think we're heading in the right direction on it.

I know there's been a lot of resistance, particularly off here, the coast of California, where they basically have the marine protected areas. It's going to be always contentious, particularly if it's just merely off the California coast up to three miles because beyond that, it's still a wild west out there, but it is heading in the right direction and my suspicions are that after two or three years of putting up with those marine protected areas that we'll start seeing the productivity increase in those areas and then the fishermen who

were upset about it, most now will say, "I guess maybe it's not such a bad idea."

Jennifer Stock: Yeah, that's...regarding fishing, I was thinking of noise...well, I'll also mention with the national marine sanctuaries here, we have Monterey Bay, Gulf of the Farallones, and Cordell Bank. A recent working group has been formed between Cordell Bank and Gulf of the Farallones sanctuaries since these are pretty much right next to each other, to address impacts related to vessels and boats and so, there's a working group that has just started up and they're going to be looking at ways...recommending actions to reduce ship strikes and ocean noise impacts in the sanctuaries.

So, we know that there are ship strikes happening because there's whales washing up that have incredible abrasions and deep, deep cuts that...there's been impact there, but it's hard to prove where they happen, but we are...these national marine sanctuaries happen to be right over the shipping lanes where we have all these ships moving in an out, yet they're also really important areas for these whales.

So, I think it's a good thing to highlight to bring up that there are people that are associated with the sanctuaries, different scientists, and different groups that are meeting to look at the existing body of research that we know and with data and facts and accurately characterizing these areas and then hopefully making recommended actions of how to reduce the ship strikes. So, working a lot with the coast guard and other organizations. So, there is some momentum and interest, I should say.

Michael Stocker: And the International Maritime Organization actually put together a noise criteria for boats and it's...they're taking this seriously. So, I appreciate that and I don't know...I know that there's been a lot of work done off the coast here, particularly, I decided not to get involved in the working group because coastal noise profiles are so complicated. It would be very difficult to try to...

Jennifer Stock: They might be coming to you with some questions.

Michael Stocker: Okay.

Jennifer Stock: We'll see. What would you recommend to everyday people like us and anybody who might be listening, how they can...what can they do about this issue, or what can we do to stay apprised of the new information coming out?

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- Michael Stocker:* The larger rubric under which this all fits is we have to stop driving our cars. Start riding our bicycles, stop using fossil fuel. All that. Stop using plastics, I mean, all these things which are tormenting us... I mean, I can wag my finger at the Navy all day long, but unless I start changing my behaviors, it's not going to make a difference. We actually have to express ourselves and our concerns in terms of our own habits.
- In terms of becoming more aware of it, we have a website www.ocr.org. There's a lot of information on that. The dontbeabuckethead.org is actually interesting specifically about the ocean, but also we'll talk about collateral noise of oil and gas... really, the biggest noisemakers in the ocean are oil and gas people and the military. The ships are there creating noise. There is an overall noise floor increase as a consequence of that... difficult to tell at what point in time this, what they call "masking thresholds," will be hit.
- Jennifer Stock:* Such a hard area to study.
- Michael Stocker:* Well, particularly with the larger, the mysticete, the larger whales. There's no way you can do operant conditioning testing on these guys. You can't train them to hit the paddle once they're given three tons of krill. It just doesn't work that way.
- Jennifer Stock:* Well, I actually have a blue whale sound I'd like to play. We just have a couple minutes here. So, let me cue that up here. There we go.
- (Whale Sounds)
- Jennifer Stock:* So, is this scaled up?
- Michael Stocker:* I hear that flopping. Is that ship noise? The grunting... I feel like a minke whale... that little dek-dek-dek-dek. Yeah. Hard to say. Could be pitched up. They're usually lower than that.
- Jennifer Stock:* Well, here's the next track that I have here is blue whales with some ship sounds.
- (Ocean Sounds)
- Jennifer Stock:* ...mostly ship sounds.
- Michael Stocker:* Mostly ship sounds!

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- Jennifer Stock:* There it is. That thumping.
- Michael Stocker:* Okay.
- Jennifer Stock:* Now, don't blue whales use this communication to find their mates across the ocean?
- Michael Stocker:* Well, we speculate what they use it for. There was an amazing piece done by Chris Clark where he tracked blue whales in the ocean and found that they didn't go from point A to point B in a straight trajectory. Rather, they would seemingly head towards geophysical features such as sea mounts and trenches and ridge lines and whatever that...it's an informed speculation that these animals are actually echolocating with these low frequencies on these physical features of the ocean. So, there seems to be some support of that.
- Jennifer Stock:* Interesting. Well, it's a wide-open field for research and hopefully we'll get more people involved with learning about acoustics and physics and applying it towards conservation. We really need to have more work done quickly, it sounds, to get action towards protecting these areas that there's oil drill interest and exploration. So, any last comments you have? We have about thirty seconds left.
- Michael Stocker:* Well, I really appreciate this opportunity, Jennifer, to sit and exchange with you on this stuff and it's really an opening field, it's fascinating. The ocean needs our love right now.
- Jennifer Stock:* It needs a lot of love. I agree, but really interesting and, you know, it's such an interesting topic for me. I don't know a lot about ocean noise, so I'm really..it's pretty perplex....interesting information, but hearing the sounds alone is pretty complex to process that animals are dealing with this. So, hopefully other people learned as well today. Thanks for bringing those sounds in.

For those of you still with us, we are just towards the end of the program. Ocean Currents is the first Monday of every month on KWMR, 1 to 2 pm. Thanks for joining us today and you can catch all past shows from Ocean Currents on the Cordell Bank National Marine Sanctuary website, just go to cordellbank.noaa.gov and scroll on down to tune in and you can catch all of the past shows and I'll be back on June 6th at 1 o'clock talking with Dave Reynolds from the NOAA weather service and we're going to talk about how the ocean affects weather and how the atmosphere affects

the ocean and with this very cold spring, I have a lot of questions. It's been really cold this year.

I want to thank Michael Stocker again for coming on in to KWMR. Have a great afternoon and evening and we'll be back on June 6th with Ocean Currents at it's normal time slot, 1 to 2. Take care.

(Music)

Child's voice: Thanks for helping to protect our ocean

Jennifer Stock: Thank you for listening to Ocean Currents. This show is brought to you by NOAA's Cordell Bank National Marine Sanctuary, on West Marin Community Radio, KWMR. Views expressed by guests of this program may or may not be that of the National Oceanic and Atmospheric Administration, and are meant to be educational in nature. To learn more about Cordell Bank National Marine Sanctuary, go to cordellbank.noaa.gov.