
Jennifer Stock:

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

(Music)

Welcome to another edition of Ocean Currents! I'm your host, Jennifer Stock. On this show, we talk with scientists, educators, explorers, policymakers, ocean enthusiasts, authors, and more, all uncovering and learning about the mysterious and vital part of our planet, the blue ocean. I bring this show to you monthly from NOAA's Cordell Bank National Marine Sanctuary, one of four national marine sanctuaries in California all working to protect unique and biologically diverse ecosystems. Just offshore of our KWMR listening area on the West Marin coast are the Greater Farallones and Cordell Bank National Marine Sanctuaries, which together protect 4,581 square miles.

Without sex or joining of gametes in the ocean, there would be no ocean life today, and we talk a lot on this show about ocean conditions, threats, habitats, ecosystem integrity, uses of the ocean, and more. What it really comes down to every day is the ability for animals to get it on. Our local national marine sanctuaries are trying to set the right dating scene to optimize this important life history stage.

I'm thrilled to welcome back, Marah Hardt, author of the book *Sex in the Sea*. Marah is a creative writer, storyteller, a scientist, and works at the crossroads of research, creative communication, and strategy to build a sustainable future for people in the sea. She currently works as a research director for a nonprofit systems change incubator called The Future of Fish. I'm so happy to welcome back Marah to Ocean Currents! Marah, you are live on the air!

Marah Hardt:

Hi there, thank you so much for having me.

Jennifer Stock:

Thank you so much for calling in. We talked a little bit before our show about where we might go with our time here, and I thought, we have been doing so much work here on the west coast to learn more about the deep sea environment that plunges below 1,000 feet and goes way beyond 8,000 to 10,000 feet. Right now, there is a wonderful expedition happening on the Nautilus in the Monterey Bay National Marine Sanctuary. Last week, they saw this amazing

Dumbo octopus, and I was just thinking about life in the deep. How do they reproduce? There's corals and invertebrates, so I wanted to give us some time to talk about deep sea species and how they reproduce.

Marah Hardt:

It's deep sea sex. I love it. It's a great topic, and the fact that nowadays that technology and ocean exploration has gotten to the point where we really can bring this incredible and really alien environment right into our homes. Like you said with that with the novelist that books can be watching this live as the scientists are discovering it. It's amazing, and we are able to see so much more now.

When it comes to reproduction in the deep sea, one of the things that holds true that we see in other aspects of the deep sea life is extremes. We know that in the deep sea, animals are dealing with incredible pressure, they're dealing with incredible temperatures, very cold environments, very dark environments, and they've adapted to deal with this extreme environment in all sorts of ways and that includes how they reproduce.

One of my favorite examples of this is a set of animals known as osedax. These are really great to talk about right before Halloween because they're also known as "zombie worm" or "bone eating worm." I thought they would be a fun example, and they were discovered actually just near the Monterey Canyon, about I think about 15 years ago now. When scientists first went down and we're kind of exploring the environment, they came across a whale fall. This is a dead carcass of a whale that had come into the bottom, and they noticed that the bones were covered in this sort of red fuzz. As they approached closer, they realized that these bright red sort of filaments were worms. They were a new kind of deep sea worm.

There were a couple things that scientists noticed right away that were really strange about these animals. The first thing was that they had no mouth and no gut. That's kind of weird. Instead, what they do is, these worms have sort of like fibrous tendrils at the base where they attach into the bone. They grow almost like these root-like structures, and they dissolve the bone. Then, the protein and fat that's trapped in the bone, kind of, absorbs into the worm and is actually digested by bacteria that lives in these sort of tendrils of the worm. Then, the worm feeds off the bacteria. This is a really weird system. It's almost more plant-like than animal-like. Then, the other thing that's really strange that the scientists discovered was that all of the worms that they saw were females.

Every single one of them had fully developed ovaries. In fact, they also had these tiny little black dots inside that looked like sperm. Some of them were releasing fertilized eggs. So the scientists were faced with this strange question of like, "Okay, we have all these female worms." They know that the males have to be around because there's fertilized eggs, but where are the males? It took them over a year. It was the case of the missing males. They were trying to figure out where these males could be.

One of the researchers by the name of Dr. Greg Rouse who works down at Scripps Institution of Oceanography decided one night, after about a year, to put some samples of these worms under a very, very high powered microscope. He's up late at night in the lab, and he's zooming in and zooming in and zooming in. Finally, he makes this discovery that those tiny little black specks that they thought were sperm were actually males. The individual males were 100,000 times smaller than the female. It's mind boggling! It's the biggest size difference between a male and a female that we know of in the animal kingdom. Now that we've discovered the males, they are trying to figure out what is happening here because this is not a system like we see on land. You don't go on a farm and see this guy with a mating pair.

It turns out that the tiny little males, not only are they just microscopic little dwarf males, but there's other really strange characteristics, which is that they look more like juveniles than adults. The only adult feature that they have is fully grown testes. They're actually basically larval worms that have fully grown testes, and they ejaculate sperm out of pores in the tops of their heads while living inside the female.

Jennifer Stock: This is not a good Halloween costume.

Marah Hardt: Or a really good Halloween costume but very bizarre!

Yeah. What they think happens is it makes sense if you take a step back and think about how these worms are living out their life. Right. Again, they live off of whale bones or other large marine animals that fall to the floor, mostly mammals. It's a very limited food supply, and the females need a lot of energy to produce eggs. Eggs are an energy intensive thing to produce. Sperm is cheap. The males can produce a ton of sperm without actually needing that many nutrients.

What we think happens, it's still being sorted out, but the hypothesis is that the first worms to sort of come out of the ocean

and see that there's a whale fall and land on the bones, they develop as females. They grow bigger. They're about the length of your finger, they develop their ovaries, and they feed off of the bones. As that whale gets covered in these worms and the food supplies starts to run a little thin, then the late comers, the larval worms that are sort of arriving late to the party, potentially the females release a chemical signature that stunts the larval worms' growth. They sort of freeze. The only part of them that actually matures is testes. Instead of becoming fully grown females and growing on the bone, they swim down the worm tube. They actually form little clusters around the female's ovaries and as the eggs are released, they just hang out there, pumping sperm out of their heads, fertilizing the eggs, and they live off of the reserves from the yolk sac. When they are hatched, then they die. And that's it. The female collects these harems of males, these microscopic males throughout her lifetime until the bones basically run out of fuel, and then they all move on.

Jennifer Stock: Where do they go? When they eat up the whale bones, and the whale fall community is somewhat dissolved, do they just kind of float around to the next community?

Marah Hardt: It's a good question. I think, and I'm not 100% certain... But my understanding is that the females kind of live out their life on that whale fall, and it's the released eggs, the fertilized eggs, that then go off into the Black Sea and sort of float around until they hatch. Then, probably using their sense of smell, they hone in on the next whale fall. I think they will live and die on that one whale fall and then spend the time kind of drifting around as larvae until the next next set of bones. I think once they've rooted, I don't think they can release. The understanding is that they're kind of permanently attached until the food supply runs out, and then they die.

Jennifer Stock: It's just another amazing story about how much we don't know about the details, but the fact we know about these worms is absolutely phenomenal to me in terms of the biology and figuring out these mysteries that are important.

Marah Hardt: There's like 20 different species or more than 20 different kinds of these osedax. Now that we've discovered it in just less than two decades.

Jennifer Stock: I'm going to look it up on during the break. I did a show with, can't remember the name of the scientist, but it was all about the whale fall community. We talked about osedax worms before. This was

many years ago, so it's fun to hear about them again and a little bit more about their details.

Marah Hardt: Their intimate lives!

Jennifer Stock: Unbelievable worms! Well, let's go on to something a little bit more familiar with people: the cephalopods of the deep. Last week, I happened to be watching Nautilus or nautiluslive.org, as Marah was mentioning, is streaming live video from the deep sea feeds that they're doing in the Monterey Bay Sanctuary. I think they're transiting right now to another dive site, but I happen to be watching when a Dumbo octopus appeared. It was just so beautiful, and it was incredible. The visibility was just amazing. How do they find mates down there?

Marah Hardt: Yeah, it's a really good question. Cephalopods in general, so octopus, cuttlefish, and squid, they're such a phenomenal group. In the deep sea, it can be really tricky. A lot of times, we see that animals do use scent. It is an asset because obviously visually it's hard to see down there. Currents help sort of pass hormones or pheromones along, and they can find one another that way. When it comes to octopus because they don't tend to form groups like we see with some fish and having you know big annual orgies. It really is a question of finding a mate, and when you find them, being able to mate with them safely.

For octopuses, I suppose, there's some big challenges because as a male, if a male does encounter a female, oftentimes we do see that as female is bigger. She can often be very aggressive, and octopuses do need to have contact to mate. They have internal fertilization, so the male has to deliver sperm to the female and the female then takes that sperm and brings it inside into a chamber where she can fertilize her eggs. Then, she lays the eggs, and there's some really neat facts about a deep sea octopus and the role of motherhood and we can talk about that in a second.

The way that the male transfers the sperm to the female can take a lot of different forms. With many bottom dwelling octopus, what tends to happen is the male has a special arm called hectocotylus. It's a fancy name, but it's basically the sperm carrying arm. A challenge I can put out to all of you who like to eat octopus or squid, actually shallow water squid have this too. You can look for this specialized tentacle and be able to tell whether you're eating a male or a female. The males often, you'll see, do these very, very long reaches. They basically try to sneak up on the female, as much as they can, and then they just quickly kind of pat her on the

back, so it's a real quick smack. Then, they're out of there as fast as they can. It's a really quick process and done with as much distance as possible.

There's a wonderful example, it's not deep sea but of an octopus called the argonaut, which is a pelagic octopus. They don't live on the bottom, and I'm curious for anybody else who's listening who are octopus experts out there, whether octopus like the Dumbo octopus that are also midwater, would have something similar. This argonaut is known because the males are much smaller than the females. They are at great risk of being attacked during mating. Evolution and all her mighty creativity has come up with a strategy where the argonaut male can actually detach his hectocotylus, so he can sever his own arm. It wiggles its way over to the female as an independent body, and then kind of attaches to her side. Now, he dies when this happens. It's kind of a one shot deal, but it's basically a way of having a detachable penis so that he can just sort of throw it on out there, wiggle his way the last you know couple of feet to the female, and lodges itself up under her mantle so that she then can go on and draw on the sperm and fertilize her eggs. Yeah, detachable penises are a thing with cephalopods, which is kind of crazy. We see it in some snails too. The mollusk world seems to allow for some extreme mating techniques

Jennifer Stock: Unbelievable. Now, I think that the argonaut has been misnamed the nautilus. It's like a nautilus shell. Many people call it a nautilus, but it's actually an argonaut, right?

Marah Hardt: Correct. The common name for an argonaut is paper nautilus, and it gets very confused with the actual nautilus, the animal that has that brown and white spiral shell. The paper nautilus is a cephalopod that creates a very thin, truly like paper-like egg chamber. It's called the argonaut because back in the ancient times, they thought that it used this chamber to float like a sail on the surface and carry it over the sea for movement. They named it the argonaut after the sailors. Yeah, it's different than the nautilus.

Jennifer Stock: Interesting. I actually found one of those paper nautilus chambers.

Marah Hardt: Wow!

Jennifer Stock: Yeah, unbelievable! This was when I was in my 20s, and I used to teach at Catalina Island Marine Institute. One of my very first weeks there, I found a nautilus on the beach!

Marah Hardt: That's amazing because they are so delicate!

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- Jennifer Stock:* I know, and it's just crazy to me that 20 something years later, I'm just learning more about what that animal is actually about. We didn't have the internet on the island.
- Marah Hardt:* That's right! Yeah, and the males are really rare. They're very hard to find. In fact, I think there's only been a handful ever found alive. Again, they're very small, and they have this very bizarre life history. There's still so much to learn about so many of these animals. You know, it's mind blowing.
- Jennifer Stock:* Welcome back. You're tuned to KWMR here in West Marin, and I'm thrilled to have Marah Hardt on the air with us, author of *Sex in the Sea*. We've been discussing some very interesting biology that happens in the oceans to keep life alive and thriving. One of the things that I read towards the end of your book was just how resilient and how eager animals are to reproduce. Even when there's challenging conditions and environmental challenges, they're so resilient and so eager to reproduce. It's a matter of just keeping this balance of the conditions for organisms to continue to thrive.
- Marah Hardt:* Yeah, and I think what what we forget is that the ways life is structured is all about survival and sex. The truth is in terms of the rules of evolution, if you don't have the sex, then the surviving actually doesn't matter. Animals do everything they can including sacrificing themselves just to be able to have the chance to reproduce. That drive is something that is incredibly strong, and if we just get out of the way, it will move forward.
- I think one of the things that I try to talk about with *Sex in the Sea* is that we often feel that the ocean is so far away. It's this environment that we sort of see the surface of or skirt the edges of. The fact is that our activities really can affect these animals at that most fundamental level of reproduction. If we can sort of take a step back and just try to say maybe when they're all getting together for their one time of year giant sex bout, that's not the best time to be fishing them, and you should leave them alone. It's sort of like you know in college where people put the tie on the door handle, and it's like you don't go into the room when things are happening like give them a break during this really critical period of the year or of the season.
- Then, we actually wind up with far more animals in the sea for us to either eat for food security or gain medicines from. I mean there's so much diversity and so many phenomenal chemicals that

different animals in the ocean create for us that can fight cancers, heart disease, and neurological disorders. There is a medicine chest that was just starting to tap all of that diversity, all of that abundance comes from the process of sex. We can just give them the chance to reproduce and help support their reproductive strategies by managing the oceans in a way that is in alignment rather than sort of goes against. Then we will all benefit from being healthy and thriving seas for humans and marine life.

Jennifer Stock:

Wonderful. One of the things I love about your book is that it's broken up into acts, and there's dating games, sealing the deal, and different pieces of that such as the penis chapter, inner chambers, and oceanic orgies. What's going on with the groups out there in terms of oceanic orgies? Are these sharks or fish? I think you were talking about groupers doing this kind of big open thing...

Marah Hardt:

Oceanic orgies is a really common strategy for animals that have external fertilization. We don't see this on land very much because in the air, sperm would dry out and as would eggs if they were to sort of just be broadcast out into the wind. In the ocean, animals can actually release their sperm and egg into the water. In fact, it actually is an out of body experience. The joining of sperm and egg happens in the water in the ocean itself rather than inside the female's body. In the case of seahorse, then it's the male's body, but that's another really cool tale. When you're in the ocean, if you're releasing your eggs and sperm out there, you can imagine it's a very big ocean, there are currents, and if you don't time things well, those little sperm and eggs are just going to get washed away and never find another sperm and egg to join with.

Animals group up, and they tend to do so based on environmental cues that they can all respond to. We often see annual mass spawning events of groupers, snappers, and other types of predatory fish tend to do this.

Coming up in the Caribbean, for example, starting in December, we'll see the Nassau grouper will start making their annual migration, and they tend to go to very specific points. For reef fish, it's often an outcrop. You can have the entire adult population of one species around one island. For example, in one place at one time. It's a way for these animals to be able to kind of get in sync with one another. Then they go into these remarkable spawning runs. Often, it's times with changes in water temperature, changes in moon cycles-- the full moon is a huge cue for sex in the sea in general. In the Nassau grouper, they start off Little Cayman Island, and they'll get together. This is an endangered species. It's one of

the largest remaining spawning aggregation that we know of. When scientists started to study them, they realized that every single adult from around Little Cayman Island, over 3,000 of these individuals were gathering at this tiny little outcrop on the southern tip of the island during the full moon in January and in February. They wait till sunset.

As the sun goes down, the female will start to swim out of the outcrop so into the kind of open water, and she'll do this giant swimming arc. At the top of the arch, she'll release her eggs, and then you have about six to ten males that sort of rush after her. Then, they'll release their sperm through her cloud of eggs. Out of this population, there's several thousand fish, you get these little mini geysers of smaller groups that are shooting up off the bottom and going into the giant arc, and within minutes, the visibility of the water goes from being able to see 100 to 200 feet to barely being able to see you know your hand in front of your face because there's so much sperm and egg in the water that's being released by these fish.

It's the entire year's worth of reproduction happening around 30 minutes, right at sunset, for about three days around the full moon, and then that's it. They disperse and go home. You can imagine that if you're fishing at that time, it's highly disruptive. It's very lucrative because you have all the biggest adults in one place at one time. You're really disturbing the one chance that adults have to make the next generation. The story of the Cayman Islands, the government in the Cayman Islands, and researchers with the Cayman Island Research Foundation, they've done some great work to actually protect and shut down fishing during this spawning period. The result of that has been enormous increases in the population. Fishermen are now realizing that they actually catch more fish the rest of the year by not fishing during this one closure period for a few weeks when the fish are reproducing. There really can be a win-win situation when we learn to manage in a way that is supportive of these reproductive strategies rather than exploitative.

Jennifer Stock:

It's so interesting. I'm just thinking about the California current and how the just the whole food web goes crazy. In the springtime with a phytoplankton, the zooplankton, and the fishes releasing their eggs.

Marah Hardt:

Yes.

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- Jennifer Stock:* Interesting. Thinking about adaptive management strategies with reproduction, and we know enough about some of these species. Maybe we could actually take some measurement to help reduce some pressure on them.
- Marah Hardt:* Yeah. Sustainable management has to include knowledge of the way these animals reproduce, and as we sort of started to talk about, especially some of these deep sea organisms, it's really different. It's so different from how mammals reproduce, which is what we're most familiar with in terms with ourselves, dogs, cats, or farm animals. We manage the oceans historically in a way that assumes reproduction in a very limited sense. We've gotten it wrong, and that's not necessarily our fault. I mean, the osedax, these zombie worms, who would have thought there's tiny microscopic dwarf snails living inside the female. That stuff is weird, and it's hard to know. But putting the resources and supporting science that we can have a science based management and understanding systems is critical. As we do so, we're finding we can have great success because they are resilient. Once we figure it out and we make those adjustments, these animals do come back. The great thing about the ocean is that we have very few full extinctions. The raw potential for recovery and resiliency is all there. We just have to work with it. That to me is really encouraging and exciting.
- Jennifer Stock:* Yeah, that's why I really enjoy your topic because it really does give so much hope for getting it right. We can get it right. We have so much resilience available, and there's a lot of we don't know about what's under the water
- Marah Hardt:* When under the water, it's hard to capture. We all know that sex is a fleeting thing. It's an intimate act for a reason. They're often very secretive and hard to really understand, so it takes a little bit of effort, but man is it fun when we try to figure this stuff out.
- Jennifer Stock:* Well, I know there's been a lot of effort. We have about five to seven minutes left. There's been a lot of effort to learn more about the path of the white sharks in California, and we know they're very common in our waters near the coast and around the Farallones Islands this time of year. White sharks are around because elephant seals are returning, and I've heard stories that I don't think there's any basis to about breeding grounds. There's been this effort to go to an area in the Pacific near Hawaii called the White Shark Cafe that scientists down at Stanford are trying to learn more about. Why are they going there? They still don't really

know. Can we talk a little bit about sharks because everybody loves sharks, and it is very sharky around here right now.

Marah Hardt: It is very sharky.

Jennifer Stock: Got a lot of sightings and little nibbles here and there.

Marah Hardt: Yeah. Sharks sex is probably one of my favorite topics. Sharks are really old, about 450 million years old. There's over 400 fish species, so there's a lot of diversity there. Sharks, unlike the fish we were just talking about, which a lot of folks don't realize, they are internal fertilizers. They actually reproduce much more like a mammal than a fish. What's really neat is that, in sharks, it's very easy to tell a boy from a girl shark. If you ever have an opportunity at an aquarium, especially where they have those tanks you can kind of walk underneath like those tunnels and look up. If you look at the underside of a shark back by the tail, there are two pelvic fins, and on the female, you'll just see the basic shape of the fin. On the male, you'll see two very distinct elongate cigar-shaped claspers. They look like penises. That's really their function. It's an elongation of the fin that is kind of rolled around like a burrito. This is the way that the male inserts that clasper into the female, and she has an opening that's like a vagina. It's called the cloaca.

They have to get together. It's often quite rough. Females actually have thicker skin than males could deal with the fact that the males often will bite down on their fins to roll the female into place. She has this sticker hide if you will to protect her. Then, the males roll the female, and then they actually insert the clasper into the female and deposit the sperm. What's really cool about sharks is that unlike a mammal penis where you have a tube that runs from the testes, where the sperm are produced to the end of the penis. With sharks, that clasper is hollow. It's literally just a fin that is rolled around itself. The sperm comes out of a port at the base of the male's tail. There's no really great way for the sperm to kind of get down the clasp or into the female.

What has happened is sharks have evolved to use their water environment. What the males do is they actually can suck up sea water through another tiny pore opening at the base of their tail, and they have sacks that run the length of their body internally. The sacks fill up with sea water. Then, they squirt that sea water out using muscular contractions at a very high powered kind of stream. That water port is right next to the sperm pore. So as the shark releases its sperm and ejaculates, they squeeze these internal sacs and shoot a beam of water that then flushes the sperm down

the clasper and into the female. It is a crazy like Super Soaker Water Gun type of sex and ejaculation. It's a really unique way that sharks deal with having an interval fertilization.

Jennifer Stock: Interesting.

Marah Hardt: Yeah. From the males, it's a really funky adaptation, and then in females, oh my gosh we could talk for ages! Some shark female species can have virgin birth, so they can actually reproduce without any male contribution at all.

Jennifer Stock: How does that work? Yeah, I've never understood that!

Marah Hardt: You play the "Like a Virgin" song! Virgin birth! It is called parthenogenesis, and it means "virgin birth" in Latin or Greek... I can't remember. Basically what happens is the egg can divide with itself. The egg itself splits and then reunites. It's just maternal DNA, but the DNA does mix. You do get a little bit of diversity happening. It's not as much genetic diversity as you'd get from two separate individuals, but there is some mixing. Then, that reformed egg can grow into a viable offspring. What we see is, we first started to notice the virgin birth potential in aquarium sharks. Females were isolated from males for a long time, and all of a sudden, they were reproducing. We thought that it was a kind of a stress response when the females could not find a male.

Recently, we found about two years ago, I think now two researchers with one of the scientists names Don Grubbs. They were out studying the endangered sawtooth shark, which is actually a shark. They were able to catch a pregnant female who actually gave birth while the researchers were tagging her to live young, and they were able to get DNA from the live young and from the female the mother. The DNA showed that those pups only had the mother's DNA.

This is an endangered species, and it's the first evidence we have that in the wild that these females may be using this technique to reproduce since they're struggling to find mates. The good news is by doing this, it could be a little bit of a stop gap. They are increasing their numbers. Over the long term, virgin birth is not healthy because again, you're not getting as much genetic diversity as you need. Also, the process is such that you only get one sex. So, they only have daughter sharks through parthenogenesis. Again, your sex ratio can get skewed in the long term, but in the short term, it means that there is some reproduction happening in that population. If we can then kind of reduce the other threats on

that species, it means that perhaps there's a greater chance of recovery than we had thought. So yeah, virgin birth, it happens in the wild, and it happens in aquaria.

There's also really cool sperm storage. Some females can actually start to store sperm for over two to three years and then draw upon that sperm to reproduce when they feel the conditions are right. Yeah, I think some fascinating techniques out there that actually mean that females have a lot more control over what is happening in in their sex lives than we had previously thought.

Jennifer Stock: Unbelievable.

Marah Hardt: Yeah!

Jennifer Stock: Unbelievable, that's just so cool. We probably just have about two or three minutes, so we should probably wrap it up. Where can folks keep up with some of the work that you do or read some other other pieces that you've written?

Marah Hardt: I do try to keep an active blog on sexinthesea.org where I continue to learn from all the great research that's out there and try to present the fun and fascinating world of sex in the sea for folks to learn from and encourage you to check that out.

Otherwise, there's amazing research being done out of so many different organizations and especially things like the marine sanctuaries. I mean, these are the natural laboratories that we get to use to see how life happens when we aren't necessarily putting as much impact or influence into the ocean as we tend to do in other places. The research coming out of national marine sanctuaries and the observation from folks that get to go and dive and explore these amazing protected habitats is a huge source of inspiration on not just sex but just the incredible work and lives that these scientists lead as they explore the amazing marine habitat that is the vast majority of our planet. 99% of this habitable space of our world is in the ocean. It's just endless the discoveries that are coming. I mean, nautilus.org is such another great example. Forget binge watching on Netflix right now and just go tune into that because you have no idea what's going to come next!

Jennifer Stock: I know, it's so exciting! Marah, it's so much fun to interview you. I really appreciate you coming on again to Ocean Currents, and I really look forward to being in touch again to hopefully have more of you sharing your knowledge

Marah Hardt: Anytime! I think it's an awesome podcast and, I'm a huge fan of public radio being able to share the important news and stories of our times so happy to be here! I really appreciate it. I'm humbled that you asked me back so thanks!

Jennifer Stock: Thank you so much, and we really appreciate you being part of KWMR!

Marah Hardt: Anytime.

Jennifer Stock: Alright. Have a great afternoon.

Marah Hardt: Thank you.

Jennifer Stock: I just want to say thanks to everybody, and Ocean Currents is the first Monday of every month at 11 to 12. You can check out the podcast on iTunes for all the hundred plus episodes we've had here at KWMR. Thank you for listening. Enjoy the ocean, bay, or whatever body of water you can get into safely. This is KWMR Point Reyes Station.

(Music)

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