

*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, fishermen, explorers, policymakers, ocean enthusiasts, kids, 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 the 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 of rocky shorelines, sandy sea floor, rocky banks, deep sea canyons, and maritime artifacts.

I'll just add, we have some scientists out at sea right now in the sanctuaries that are doing some remotely operated vehicles to survey some of those deep sea habitats, except it's been pretty windy so I don't know how successful they've been yet. I'll certainly report back any exciting findings.

I'm so excited. I have a really full show today! We have two really great guests. We have two different topics, so it's a two part show. In the first half of the show, we're going to be talking with Dr. Craig Downs of Haereticus Environmental Lab in Virginia. This past year, while attending the International Ocean Film Festival in San Francisco, I saw a film called "Reefs at Risk" that shocked me. I had to bring the scientist on the air to talk about his findings and what's happening with the new findings about the impact of some sunscreen chemicals on coral reefs and fish reproduction. So you'll definitely want to stick around for that.

In the second half of the show, we're going to take a deep dive into some local beach ecology and natural history with Dr. Karina Nielsen of the Ocean and Estuary Science Center at the Romberg Tiburon Lab at San Francisco State University. We often go to the beach and enjoy it this time of year. There's a whole other world going on beneath the sand, and I'm really excited to dive into it

with Karina. Stick around, we got a full show! We'll be back in a minute.

All right, we're back! You're tuned into Ocean Currents here on KWMR, and I'm on the phone with Dr. Craig Downs of the Haereticus Environmental Laboratory in Virginia. Craig, welcome! You're live on the air.

*Craig Downs:* Thank you, Jennifer! Hi!

*Jennifer Stock:* Thanks so much for calling in today! You are an ecotoxicologist. Can you tell us what that is?

*Craig Downs:* Sure. Ecotoxicology is the study of xenobiotics and the toxicological pathologies that they manifest in non human feces. There are aquatic ecotoxicologists, marine ecotoxicologists, and wetlands ecotoxicologists. We study how organisms respond to poison.

*Jennifer Stock:* We have quite a bit of these days, don't we, in the environment. So your lab... oh, go ahead.

*Craig Downs:* No, no.

*Jennifer Stock:* Okay, your lab is based in Virginia. How did you get to study coral environments and sunscreen?

*Craig Downs:* I used to work for the US NOAA. I was a scientist in the Coastal Center for Environmental Health and Biomolecular Research in Charleston, South Carolina. I was kind of drawn away during the biotech boom in San Francisco, and I left US NOAA. The biotech technology was so successful. We went ahead and started a nonprofit because we were having so many pro bono requests. We were having a lot of fun doing that kind of work. After, I think 15 years, we're still going strong, doing a lot of work, and having a big worldwide impact.

*Jennifer Stock:* Well, the film that I saw "Reefs at Risk," I know is just a snapshot of the issue we're talking about today, but I think originally you were contacted by the National Park Service to look at why their corals are dying, is that correct and how you got on to the sunscreen issue?

*Craig Downs:* Yes, exactly. Back when I was working for US NOAA, I worked a lot on the molecular and cellular pathology of coral bleaching. This was in 1998, when the first big bleaching event had hit the Florida

Keys, and we published a number of I think really cool scientific papers. We found out that many of these cellular markers were also amenable to profiling toxic responses of coral and other coral reef organisms to a number of different xenobiotics, a number of different chemicals. We learned how to nestle that technology in a larger field called forensics. That is the examination of characterizing the behavior of an environment or ecosystem as a response to a pollutant like sunscreen pollution, oil pollution, or heavy metal.

We were asked to figure out what was killing the reefs around the Virgin Islands National Park. The one that really gave our head a scratch was Trunk Bay, and it's considered the most idyllic beach area in the national park. It's on the 94th US postal stamp. There were no other anthropogenic activities in the watershed. And because this was a snorkel pathway, boats aren't allowed in this bay. The only thing really getting into this bay was people, and it had decimated over the last 10 to 15 years. A huge elkhorn reef had died, about 95% dead, in front of the science coordinator's home. In the park, there was no new coral recruitment. All the corals are slowly dying. We would do a laceration regeneration where you take a one centimeter biopsy from a coral tissue, take a picture of it with a ruler, and then over time, measure how fast it's healed. In five years, none of the wounds heal.

We were getting pretty frustrated because we had figured it out, what was causing the death of all these other places, all these other beaches and coral reefs in the Virgin Islands National Park, except for this one. We were complaining to ourselves in a grocery store, on St John Island, and a Rastafarian fellow overheard us complaining. He kind of told us and discussed that he couldn't believe we couldn't figure it out that it's the people. I said, "What do you mean it's the people?" He told us to go to the bay after 4:30 to 5 o'clock after all the tourists had gone. He said because you'll see the oil slick on the bay. We went the next day, and it was a doldrum day. He was right. Around 5:30, when the sun was setting, the water was beautiful. It simulated an iridescent red, orange, purple, and blue, and that was because of the oil that was on the surface of the water. Talking to the lifeguard there, he estimated that about 3,000 people showed up on that day.

*Jennifer Stock:* Wow.

*Craig Downs:* That just kind of lit the light bulb, and we sampled the water. We looked at how sunscreens are made, what the ingredients in the sunscreen were, and the one thing that showed up the most in our

chemical analysis was the chemical oxybenzone. From there, we started to do toxicity studies called of coral, in embryonic fish, sea urchin embryos, and macro algae. We found that oxybenzone is quite toxic, probably one of the most toxic chemicals in infancy. It's not the only one, but it is one of the most toxic.

We started measuring oxybenzone levels elsewhere in the Red Sea and in Hawaii. Our findings in Hawaii took a lot of people by surprise. We were surprised, but the folks in Hawaii are kind of desperate for an answer why their results are degrading and not coming back. That's kind of the process that we're seeing is that you'll see a punctuated mortality event like an El Niño induced bleaching event. You'll see a lot of corals dying off, but it never comes back. That's kind of what we saw in the Virgin Islands, and that's what we see in the Florida Keys. It's not coming back. That is a big problem.

We get coral mass death both historically and geologically. It's not all that infrequent, and actually, there's a fairly well argued hypothesis that these mass bleaching events are necessary for sustaining high levels of biodiversity. It's like a tree falling in a forest. It creates a meadow, the biodiversity goes off, and you get the successive restoration back to the climax forest. That's what we think happens in many places around the world where you get these mass mortality events. The corals will come back.

Nowadays, we don't see them coming back, so there's no recruitment. What's causing that lack of recruitment? We think it's land based sources of pollution, sunscreen pollution, pesticides, fertilizer, algal blooms, and sewage. Every geographic location is this unique and has its own pollution profiles signature. You need to figure out what each one of those locations with the pollution profiles signal signature is so that you can go in and mitigate. Most people like to wave a magic wand and say it's climate change, the ocean acidification... It's usually multiple stressors in a given area and to figure out which one they are, what the relative contribution of those stressors are to that ecosystem.

*Jennifer Stock:*

I wanted to jump in here. This study came to understand that oxybenzone is very toxic, and it is causing the corals not to reproduce. They can't come back. They've been knocked down by multiple stressors, but they're not coming back. I understand that the industry that uses oxybenzone... a specific company tried to reproduce the study, and they have the same results. Can you talk a little bit about that, and what are the implications for a company discovering, "Oh, this is happening."

*Craig Downs:* The implications are actually the consequences. I think that guy got fired. It's really unfortunate, but in 2016, there was the International Coral Reef Symposium in Honolulu, Hawaii. It happens once every four years, somewhere in the world where there's a coral reef. This just happened to be in Honolulu. This person from L'Oreal was there, and he came up to me because I'm here in Hawaii, at this conference because you. I had no idea who it was. They said he worked for L'Oreal, and we repeated your work. We saw something very similar to what you saw, and this company contracted the Monaco laboratory in the Principality of Monaco with a very famous coral reef scientist, but he is a coral scientist but not an ecotoxicologist. They did expose the adult coral with oxybenzone, another UV chemical called avobenzone, and a third UV SPF chemical called non nanotized zinc oxide. All three of them saw induction of coral bleaching.

He said that what they were planning to do is stop all production of products containing oxybenzone. I'm like, "Why would you do that?" He said because we see the writing on the wall. Yes, their industry knows that there are definite toxicities that humans associate with oxybenzone, causing contact dermatitis, and causes you to carry it. It also causes birth defects.

*Jennifer Stock:* There it's also an endocrine disruptor as well. Can you talk about that in terms of the fish genders? I was learning about how this is acting as a way to change fish from males to females or male fish are growing female gonads. Is that around all oceans or just coral reefs? I'm just thinking about the larger scale beyond coral reef impacts, and oxybenzone is going into the water everywhere.

*Craig Downs:* It would be in all waterways where oxybenzone is a contaminant for a loop. There's a difference between contamination and pollutant. Contamination means that just there, but you don't know if there is an adverse effect. When a chemical is a pollutant, it's there, and it's at a level where it has a toxic effect. In Vancouver, Canada, I guess, tubing has now become a very popular pastime in these blue ribbons rivers for trout fishing. In the last six to eight years, they've noticed that all the species in those rivers have declined. Not just the trout but the mayflies, caddisflies, and crawdads. They're now coming to the conclusion of generating data that allows them to come to the conclusion that these tubers... On some of these rivers they get up to 1,200 to 1,800 people a day. They sit in these flotation inner tubes, and most of the time they just spray themselves down with aerosol sunscreen. About 50% of that sunscreen doesn't get on them. It gets on the

water. They think that the sunscreen pollution is having a major impact on the trout population there. In other places, more inland, like Kentucky, Tennessee, West Virginia, they are also seeing drops in species where this new popular tourism activity has really taken hold on that river. One of the pathologies that they're noticing is that they are turning all female. You can Google that all around the US with largemouth and smallmouth bass populations that many rivers are seeing a dominant ratio of female to male, and it should be about one to one. They're seeing all females.

*Jennifer Stock:* If it's having an impact on fish populations, and humans are putting this on our bodies too, this has got to be a contaminant for humans as well. Can you talk a bit about how we have sunscreen on our skin, and sometimes they say wait 15 minutes before going in the water. I believe that's about the effectiveness of being a sunscreen versus sloughing off into the water. It's going to slough off no matter what because it's oil based. Well, there's oil in it. There's other ways it's absorbed into our skin and getting into the waterways. Can you talk about how people in the middle of the country that aren't even near a shoreline, if they're wearing sunscreen with this chemical in it, how it's getting into waterways and interior ways?

*Craig Downs:* It's calculated about 8% of the oxybenzone on your skin per hour gets absorbed into your body. We actually did this test. We put sunscreen on occupants' arms, and 20 minutes later, we are able to detect it in our urine. Other groups that have actually published these studies say that they've seen the same thing within 20 to 30 minutes of application of an oxybenzone sunscreen. You can detect it in your urine. I think it was 96.8% of the population of the US has oxybenzone contamination in the year, which means that it's contaminating their whole body. It's fat soluble, and there are studies showing that women who were breastfeeding passed the oxybenzone over to their infant when they breastfeed. Concentrations of this breast milk can be fairly high in the parts per billion. We see ecotoxic effects with sea urchins and fish, non-human, down as low as the parts per trillion levels. Being exposed to oxybenzone is just one of the industrial chemicals that contaminate our bodies is pretty high. It's not just sunscreens that can contaminate you with oxybenzone. It's also the water you drink and the food you eat. A number of studies have shown that municipal tap water can be contaminated with oxybenzone, especially those municipalities that don't first clean the water with an activated carbon filter.

- Jennifer Stock:* Interesting. I didn't know that. I am going to look into that.
- Craig Downs:* Because most subsistence fish, like cod and tuna, they're swimming in the ocean, and oxybenzone concentrations are getting fairly high in the general oceans. We can detect it as far north as Alaska. Our subsistence fish are now becoming significantly contaminated as in parts per billion. Not parts per trillion but parts per billion with oxybenzone.
- Jennifer Stock:* Wow.
- Craig Downs:* The Ministry of Fisheries in both Spain and Portugal published studies showing the contamination of commercial subsistence fish, and they said it's only in the parts per billion, so it doesn't pose the danger. What if you're a population that eats fish every day or every other day? Your oxybenzone levels are going to be fairly high. It's just going to be constantly both the biggest problem due to sewage, because again, either you put it on you, and you urinate it out or you shower and it comes off in the shower. It all goes to the sewage, and then, it ends up in our rivers, lakes, and oceans. It's a lot of oxybenzone. I mean I heard that one company buys and uses 100 million tons of oxybenzone. I find that incredulous and hard to believe, but the EPA back in 1992 or 1994 showed that oxybenzone was being imported into the US at over a million pounds per year. It might not be 100 million tonnes, but it is quite a bit of oxybenzone. All that is going to go someplace in the environment.
- Jennifer Stock:* Craig, I'm sorry to jump in here, we have five minutes left in the show. This is really, really interesting information, and we now know there's this is a very toxic chemical. It's having extreme impacts around coral reefs around the world, which are facing a lot of other threats too. The coral reefs and the environment are really supportive of a very important tourism value. I think it's 9.9 trillion dollars. It seems that the economy and money can get the attention of lawmakers. Can you just talk, we just have three minutes left now, to just talk about what's happening. I know there's some big positive changes that have happened as a result of these results being shared. Can you talk a little bit about some of the things that are happening and how people can find out more about legislation or ways to get involved in helping to get rid of this chemical?
- Craig Downs:* Sure. A lot of places are looking to ban products that contain oxybenzone. Hawaii has been the first to pass legislation banning products in 2021 in sunscreens and other cosmetic products, but other countries like Bonaire have also passed similar laws. Mexico

has a regulatory code, or you know how to use oxybenzone as well as other SPF chemicals products in their nature reserves.

The normal citizen can do to help mitigate this pollution is, we think, to wear sunwear or sun clothes. Sun clothes are a much better protector against UV radiation both UVB and UVA, and this is what we're telling everybody. If you put on a sun shirt, you've reduced the need for sunscreen lotion by over 50%, which means that drops the pollution load into a water body by over 10%, but we get more people wearing sun shirts. The guys or gals can also wear trunks, something to cover up more. That means less sunscreen to be used. That's what we recommend. You can also use sunscreens that don't contain oxybenzone; you just have to look at the ingredient labels. There's a lot of them out there that are now labeling themselves oxybenzone free. Those are the ones we suggest you take a look at if you need to use sunscreen, and we do recommend that you do wear sunscreen when you need it.

*Jennifer Stock:* There's lots of ways to cover up with hats and clothes.

*Craig Downs:* I mean a whole bunch of fashion magazines are now putting out articles like in Travel and Leisure. This spring, all the textile companies and all spring catalog clothing companies had sunscreen that doesn't wash off campaign in their catalogue from J. Crew and LL Bean, and Under Armour. It's really kind of become a very strong campaign there.

*Jennifer Stock:* That's fantastic. Is there any national legislation that people should be aware of? Speaking up on a larger level besides taking an individual choice, are there other ways people can do something on a larger level?

*Craig Downs:* I think at the larger level just choosing what you buy has a huge impact. Look at your ingredients in the sunscreens that you purchase. Wear sunwear clothing to protect yourself. I think that's probably going to be the biggest effect that a normal person can do.

*Jennifer Stock:* To share the word with other people, I'll add since I've learned about this. I've been spreading the word big time because it's such an easy thing to do. We all need to wear sunscreen, especially during special times a year, and if we can buy the right one or cover up, we can help the ocean.

Craig, I want to just say thank you so much for calling in. I'm sorry to cut you short. I've really enjoyed talking with you and reading

about your work and implications and changes that it's resulting in. Thank you so much for sharing the results to larger audiences and keep up the great work.

*Craig Downs:* Thank you. Thank you for having me on. I appreciate it.

*Jennifer Stock:* You're welcome. Take care! To learn more about the Haereticus Environmental Lab, you can go to [www.haereticus-lab.org](http://www.haereticus-lab.org). You can also Google "Craig Downs sunscreen," and there are wonderful articles that are online talking about this. I encourage people to read up on it, share it with other people, and there are some fantastic other alternatives out there. The Environmental Working Group is a great source for sourcing sunscreen. It gives you a good rating, and based on the chemicals, it tells you which ones are in there. Check out [ewg.org](http://ewg.org).

We're gonna take a short break. This is KWMR Point Reyes Station, and when we come back, we're going to take a deep dive into beach ecology with Karina Nielsen, so stay with us!

(Wave and water sounds)

I'm here at Ocean Currents, and I'm thrilled to have Dr. Karina Nielsen in the lab... in the studio with me, we're all here. Let me bring you up your mic three. Welcome, Karina! You're live on the air.

*Karina Nielsen:* Hi there!

*Jennifer Stock:* So great to have you!

*Karina Nielsen:* Pleasure to be here today!

*Jennifer Stock:* I've wanted to have you on for many years because you've been involved with beach ecology for a long time, and I finally caught up with her this year. I said, "I need to get you on the air!" Thanks for coming in.

*Karina Nielsen:* Oh, you're welcome. It's great to come here and talk about beaches.

*Jennifer Stock:* The Estuary and Ocean Science Center is a relatively new name for the formerly known Robert Tiburon Center with SF State. What's the new name about and tell us a little bit about the center.

*Karina Nielsen:* Oh, yeah. Well, we decided to sort of redefine ourselves a little bit because we really focus on the estuary and the ocean. We decided

it would be easier if we just said what we did with our name, and our mission really hasn't changed that much. We snapped it up a little bit into a cute soundbite, I think. Our mission is to connect science, society, and the sea for a healthy planet. I think everyone can get behind that.

*Jennifer Stock:* Yeah, it definitely helps to have that in the name, so people connect with it more. You're the director, but you've also been a longtime scientist. Are you still keeping up with research efforts as the director of the lab as well?

*Karina Nielsen:* Yeah, it's a little bit more of a balancing act, so I would say that I used to spend a lot more time in sort of far flung places. I'm getting more in tune to the estuary, marine labs, and field stations. We're all about what we call place based research or the natural history of the place where we are. We're trying to connect people to that, so I've been learning a lot more about San Francisco Bay, the estuaries, and the connections with our ocean so that's great.

*Jennifer Stock:* I wanted to dive in and talk about sandy beaches. A lot of us, when we visit the beach, we kind of plop down with a towel or our chair or dive into the ocean, and it takes a careful observer to kind of notice other things going on. There's so much going on in the rock line, below the sand, and at different times of day. I was hoping we could talk a little bit about some of the things that not everybody might see at the beach.

*Karina Nielsen:* Yeah, it's true. Probably for a lot of us, our first introduction to the ocean if we're kids is you go to the beach, right? You're with your family, you're running around playing in the sand and in the surf. You might notice some of the things that are creeping and crawling around or maybe nibbling at your toes if you're in the water. Beaches are kind of the orphan child of marine ecology in some ways. They represent like half of the coastline approximately here in California, give or take. And yet, even as a scientist, people focus on the rocks, the tide pools, the organisms that you can see that are really obvious, big, and have some charisma about them.

It wasn't until I started working on the scientific planning actually for marine protected areas networks that California was really visionary about putting into place that we realized how little information we really had in a scientific sense about what the critters are that live on the beach, who uses the beach, and how important they are. That was when I really got started looking at beaches. We wanted to understand more about what's on the beach. We just put them into conservation areas. We had a little bit of a

challenge understanding them because we didn't have a lot of data. Over the last few years, we did a whole bunch of what were called baseline surveys to really understand who lives on the beaches and where.

When you go to the beach, you're sitting on top of the sand, and you're not going to see all the critters that are there. There could be 30 to 50 different species of marine invertebrates that are living in, under, or on top of the sand in the surf zone. There are zones where they live that go from the surf zone where it's swashy and the water is coming up and down all the way up into the sort of the higher and drier parts of the beach. You get a whole different set of animals. They're not just sitting there sort of attached to the rocks, the way they might be in tide pools or the rocky intertidal like mussels and barnacles that are clinging. They actually move up and down with the tides, a lot of those organisms. It's a very, very dynamic habitat.

The other thing is that from spring to summer to fall to winter with the wave energy, their habitat moves so the sand can actually get moved. It gets moved off shore into the sandbars in the winter and comes back on in the summer. Some of those animals are following those rhythms, so they have a much more dynamic habitat than maybe people had previously appreciated. If you're gonna go study a beach, you're gonna have to start digging. Not diving, but digging! You're gonna have to start kind of enjoying standing in the surf zone because one of the ways that we learned about who lives on the beaches to go take these cores that are these aluminum tubes, if you will. You sort of sugar them into the sand, you pull them up, and you sieve animals out of the sand. The studies that we did in Northern California alone, each beach, we'll probably sit through like a metric ton of sand to kind of get a sense of a good sample of how many animals there are. Those animals include things like an enormous number of crustaceans, so small things. Probably, if you're a kid and spent time on the beach in California, you hunted for sand crabs or mole crabs.

*Jennifer Stock:* They're very abundant right now!

*Karina Nielsen:* Those are super fun. Yeah and some years, you got banner years of recruitment right, or when you get a lot of babies coming on to the shore. They're really interesting. The females will brood or hold on to a bunch of eggs, and eventually, they'll release the eggs and the little larvae. The little tiny baby sand crabs will go to sea, and they go out to sea and they're eating the zooplankton and the phytoplankton in the water. They're out for quite a long time, and

then eventually, when they're ready to metamorphose and settle, they come back to shore. They settle onto the beach in their tiny tiny little microscopic crabs that settle on to the beach, and then they grow up to complete their life cycle again. I think people don't even appreciate that they're these animals that have this epic journey.

*Jennifer Stock:* It's amazing! How far offshore are those larvae travel, do you think?

*Karina Nielsen:* Oh gosh, well you can go out on a boat within the first sort of few hundred meters of the shoreline. They're definitely there, but they go up and down the coast and by the ways. I don't know that I could give you an exact number, but they definitely move faster. Sometimes, depending on the year, their range will expand further north or contract further south, depending on how strong the ocean currents are or the upwelling might be. Any given year, you might get more or less of those larvae that are making it back to shore. There's a lot of environmental push pull with ocean conditions for those.

*Jennifer Stock:* Do surf scoters eat these?

*Karina Nielsen:* Oh yeah, they're really yummy! As a matter of fact, we find that a lot of the beaches that have more sand crabs and more invertebrates in general tend to be places that attract more seabirds and especially shorebirds.

*Jennifer Stock:* Some things are clicking for me now because in the wintertime, at Limantour Beach.

*Karina Nielsen:* Oh yeah.

*Jennifer Stock:* There are a ton of surf scoters hanging out beyond the breakers, and I guess, maybe they're diving down into the sandbar.

*Karina Nielsen:* Certainly, that's one of the things that they enjoy eating. Absolutely,

*Jennifer Stock:* Yeah and other different things too. Let's talk about the hoppers. There's all these hoppers all over the beach.

*Karina Nielsen:* Yeah. The beach is hopping. (laughs)

*Jennifer Stock:* I mean, sometimes it's during the day. Sometimes, it's night. I see a real connection with what has washed up on the beach in terms of seaweed and algae.

*Karina Nielsen:* Yeah, I mean the beaches are a great processing ecosystem, if you will. They really connect the rocky reefs, to the beach, to the birds, and it's through kelp in a lot of ways as well as other seaweeds. The kelp is really the tasty thing, so you can get offshore kelp forests. They're constantly getting dislodged, that ends up in the drift, pushed on by the surf and the tide, and deposited on the beach. That's what you sometimes see on the rock line when you're walking along. You'll see these big deposits of tangled masses of seaweed and kelp. I'm sure some of you have done this. If you go and you kind of pick it up, you'll all of a sudden see all these things hopping around and jumping underneath.

*Jennifer Stock:* Yeah.

*Karina Nielsen:* Each of those sort of islands of kelp, and they are kind of like islands, become an attractant for what we call beach hoppers or amphipods in technical terms. They will come and feed on this delicious yummy kelp, and they will also make burrows below it. They hang out in the burrows during the daytime. They're a little more active in the evening. The females make burrows where they are breeding their young. It's a very important place for them. It's both a home and food, and their home is always moving because every time the tide comes in it picks up and moves it around. They've gotten really good. They kind of come up, and they'll move around to different piles. If they're older, they might not be as tasty. They have all kinds of perceptions of these piles that we don't even imagine.

*Jennifer Stock:* This is prey for a lot of shore birds.

*Karina Nielsen:* Oh my god, they are incredibly important food for our shorebirds. As a matter of fact, if you look at how abundant these little amphipods and crustaceans are, it can predict how many shorebirds you're likely to see at a beach. In fact, you'll know how many different kinds of shorebirds are likely to visit that beach. They really are important to the ecology of the beach. Taking and transferring fuel from the ocean into the skies, effectively.

*Jennifer Stock:* It's amazing. We've been experiencing historic kelp loss the last few years in California and seen a lot less drift on the beach of bulk kelp, specifically up in this region. What type of impact... I mean, is it just loss of overall decomposers of those amphipods and

then less shorebirds to feed on them? It's kind of all interrelated, right?

*Karina Nielsen:* This is one of those times where you wish you had the resources to go back out and repeat some of the studies that you had done during a time when conditions are really, really different. You would certainly predict that the loss of this incredibly tasty and energetic energy supplying subsidy to the beaches would have an impact.

On the other hand, amphipods are not the only thing they'll eat. These guys are pretty scrappy, and they will eat other seaweeds. They're known even to eat paper. (laughs) Now, I'm not saying they're gonna be as abundant. I would predict they'd be probably somewhat less abundant, but they're probably there. The shorebirds, there are other things for them to eat, and there are other kinds of resources that might form habitat and food for some of these amphipods. We don't know. We haven't studied them enough to know. I would predict it is probably the case if this persists for many years, which is I think what we're worried about. Given the changing ocean conditions, the impact of climate change, you mentioned the loss of kelp on the north coast. Our kelp, the nereocystis, which is the one you're likely to see more of the bulk kelp on our beaches is annual. Imagine you have 2, 3, 4 years in a row of unfavorable conditions. It's going to have a really big impact.

*Jennifer Stock:* They reproduce with spores, right? If you don't have spores around, there's not a lot of growth.

*Karina Nielsen:* Yeah, I mean there are certainly little refuges where there are places where kelp exists, and we hope that's the resilience that will bring them back. We're facing this really dramatic shift in the ecosystem right now.

*Jennifer Stock:* I was talking with some folks up north in Point Arena. I was up this weekend and talking with some folks, and it seems like there are some pockets that are surviving. It's because they are in areas that urchins can't get to. There are certain little habitats and these little areas where the urchins can't get to them.

*Karina Nielsen:* Yeah, yeah. We'll have to see some of the bigger red urchins are starving because there's not enough kelp, and they're coming into the intertidal. The abalone fishery is not doing well though. Yeah, abalone populations are not doing well either.

- Jennifer Stock:* Well, I wanted to also ask. I know in Southern California, they do a lot of beach raking and probably in other parts of the United States as well to make it more appetizing I guess for humans. What type of ecological impact does that have taking away all that life?
- Karina Nielsen:* Yeah, I mean, my colleague Jenny Dugan from UC Santa Barbara has done most of the research in Southern California on beaches, and she's actually done some pretty amazing experiments together with the folks who are doing the grooming of the beaches. They compared beaches where they groom them and not. You remove that kelp then you lose the diversity of insects, amphipods, and crustaceans that inhabit those little island piles, if you will. You get fewer birds. It's got to strike a balance there. People probably don't want to lie in smelly piles of kelp. I get it. But we got to kind of balance our human needs with nature.
- Jennifer Stock:* There's just having a visual back to talking about your cores. Did you do cores up on the beach as well into the sand?
- Karina Nielsen:* Oh yeah.
- Jennifer Stock:* Give us a quick little cross section going down like I guess two feet. What do you see from the surface sand and then going down a little bit deeper?
- Karina Nielsen:* It's more a cross section sort of across the beach, I would say. Up on the high shore, you're going to get a lot of the amphipods, you'll get some of these insects that are endemic. They're only found on beaches including beetles that may be predatory, things like kelp flies and their larvae on some of those rock piles. As you come sort of to the middle of the beach, you're going to have a lot more of what we call isopods, a different kind of crustacean, and they tend to be fairly abundant. There are several species. Some of them even tend to nibble your toes and things.
- Jennifer Stock:* I've had that happen!
- Karina Nielsen:* As you go lower down on the shore, you're gonna start seeing more of the sand crabs, some of the mollusks, all of the snails and the predatory snails that live in the sand. Then, obviously, you start seeing a lot more worms and things like that. That's kind of the zoning.
- Jennifer Stock:* Yeah. I imagine the type of substrate and influences, what's in order too. Sometimes, we see really rough type rocks when the

tides are really low, and it's so much rougher than other areas, which are really fine sand. I guess that influences what is there too.

*Karina Nielsen:* I could talk for a while about sand and the qualities of sand. We certainly find a huge correlation between or a huge association, if you will, between the size of the sand grains and who lives in them. When the sand is very coarse, it usually means that the wave energy is high on that beach, and it's hard for certain animals to live in that environment. It's very dynamic, and they're getting rubbed. It's a challenging place to live. You find far more on the beaches that have what we call kind of like dissipative shorelines where there's a lot of wide surf zones, and you get a lot of fine sand up on the beach. It's a more comfortable habitat, let's put it that way.

*Jennifer Stock:* That changes seasonally too, right? They tend to get a bit shorter in the winter because more wave action takes sand away.

*Karina Nielsen:* Sometimes, the sand can be completely, or almost completely removed. You're down to like cobbles or even sometimes some bedrock, and then the sand comes back on. A lot of these animals are adapted like I said the sand crabs. They tend to live a few years, and the adults are often pulled out into the sandbars. They travel with their habitat. I suspect some of the other worms and things do too. That's pretty interesting. Up higher on the beach, up in the dunes and things, some of those animals that live on the upper beach will just sort of move up shore to get a little bit out of the fray of the winter weather. They'll stay intact there. Just depends where you are and who you are.

*Jennifer Stock:* That sounds great. One last question! Can you just tell us a little bit about how people could get more involved with the Estuary and Ocean Science Center? I know you do a lot of public lectures, invite scientists to come and give forums, and they're open to the public. Can you share a little bit about that?

*Karina Nielsen:* Oh yeah, I'd love to. As a matter of fact, on August 23rd, we're starting up our ocean film series again in collaboration with the International Ocean Film Festival. We've got a double feature coming up with two great films. You can go to our website, [eocenter.sfsu.edu](http://eocenter.sfsu.edu), and you can learn all about them. We also have, on November 7th, and we haven't started advertising this yet, but we do our Fall Public Forum. It's an evening program with a very special guest coming, and I think your listeners will be interested. Jane Lubchenco, former head administrator of NOAA and under the Obama administration. She's going to be coming and talking to

us that evening. Something to look forward to, keep your eyes out! You can get signed up on our mailing list if you go to our web page.

*Jennifer Stock:* There's also some social media too on Twitter.

*Karina Nielsen:* We're on social media, Instagram, but yeah it'll be up!

*Jennifer Stock:* That's awesome! Well, Karina, we're out of time sadly. I have a few announcements, but any last things you want to share about beach ecology and what people should know about the beach and how to treat the beach.

*Karina Nielsen:* Well, just last thing is that it's got a great natural history. It's also an incredible economic importance to our coastal communities, and I would say that one of the things we're really worried about is sea level rise and what we call coastal squeeze. It's kind of the incremental loss of beaches that we're going to have up against development or due to people trying to armor the shoreline. Save the beaches! Think about climate change! It's coming. It's real. We've got to do something about it. I think that's the biggest conservation push I can suggest for the oceans. We've got to mitigate and adapt to climate change. It's coming, but some of it we got to push back on as best we can.

*Jennifer Stock:* That's great. Well thank you so much. I really appreciate you coming in. I wanted to share too with listeners that locally here, you can really take a dive into beach ecology in Point Reyes National Seashore because August 26th is the 37th annual sand sculpture contest at Drake Beach. You can get up close and personal with all these critters that Karina was mentioning.

*Karina Nielsen:* I just also wanted to mention, if you want to come out and help us understand the beaches better, join the Beachwatch Program. Come out and help us! There's a huge group of volunteers that work through the sanctuaries through that program, and that's an awesome opportunity to learn more about beaches.

*Jennifer Stock:* Absolutely! The Greater Farallones Islands National Marine Sanctuary, I think they're celebrating their 20th year or 25th year of Beachwatch this year where their volunteers are monitoring the beaches and an absolutely awesome program for sure! Great data source! Well, thank you! I know we could probably talk another hour about more beach stuff, but we're running out of time here. Thanks again for being here.

*Karina Nielsen:* Thank you so much! It was a pleasure.

*Jennifer Stock:* I do have a couple other announcements here to share, and the films are really all over the place. We all work with the International Ocean Film Festival, which gives you an idea of just how fantastic these films are. They've definitely been educational to me, or it's helped me identify topics to bring on the show with you. I first heard about the sunscreen issue by seeing a film at the International Ocean Film Festival, so I want to share that.

In addition to the films that the Estuary and Ocean Science Center are doing at SF State, August 23 locally here in West Marin, Hog Island Oyster Company are doing some ocean film nights and also in partnership with the International Ocean Film Festival to celebrate their anniversary. I think it's their 25th year. I'm sorry! All these anniversaries... I'm getting confused, but they are celebrating an anniversary. They're drawing people out to the farm to show some films, and all proceeds are actually going to help ocean related causes with each film.

Second one is August 18th. We just had one back in July, but August 18th is the film "Straws," which is pretty self explanatory, and it's all about the crazy plastic straw issues that we have with this single use plastic and some really great storytelling there and some wonderful opportunities for action.

September 22nd is "Blue Serengeti," which is all about the white shark research happening around here down in Monterey. I just saw this film this weekend. It was so awesome. If you want to learn more about those out here, go to [hogislandoysters.com](http://hogislandoysters.com) and click on "news" for all the details. Again, all proceeds from those tickets go to ocean related causes associated with each film.

If you want to get involved with your local national marine sanctuary here, Cordell Bank and the Greater Farallones surround Point Reyes National Seashore area, going all the way up to Point Arena. One of the ways these national marine sanctuaries help manage is by consulting with the public, and we have a Sanctuary Advisory Council that is made up of different constituents to participate in helping to provide advice to the sanctuary management and superintendent. They meet quarterly, and it's a really great cross section of people that care about the ocean from conservation and research to maritime activities to fishing to community at large, education, and both the Cordell and the Greater Farallones councils are recruiting new applicants for their councils. You can go to [cordellbank.noaa.gov/council/applicants](http://cordellbank.noaa.gov/council/applicants)

for information about the Cordell positions and [farallones.noaa.gov](http://farallones.noaa.gov) to learn about the Farallones seats. These are applications that are being collected till the end of August. I think August 24th and August 31st. I'm not sure why those are different dates for each sanctuary, but take a look soon!

We have a couple community members that are part of that here! George Clyde in Marshall has been part of the Greater Farallones Council and the Cordell Council. [Leslie Adler Ivanbrook](#) is also another person and many others, so talk to them if you're interested in learning more.

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We're about out of time here. Ocean Currents is the first Monday of every month at a new time, 11 o'clock to 12. You can hear past episodes through my podcast, which is available at [cordellbank.noaa.gov](http://cordellbank.noaa.gov) or in iTunes. If you happen to listen on iTunes, please leave a review so we know you're listening! We can help grow the growth of people hearing about the Ocean Currents program. I love hearing from listeners, if you have ideas for topics, questions, or comments, you can email me at [cordellbank@noaa.gov](mailto:cordellbank@noaa.gov). Thank you for listening! Enjoy the ocean, bay, or whatever body of water you get into safely. Check your sunscreen and tell others about that! We need to help spread the word about this issue. This has been Ocean Currents here on community radio for West Marin KWMR. Thanks for tuning in!

(Music)

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(Music)