Ocean Acidification with Dr. Liz Perotti

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SPEAKERS

Announcer, Liz Perotti, Ashley Biggs

Announcer 00:01

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Ashley Biggs 00:21

Hi, everyone, this is Ashley Biggs with the Maryland State Library for the Blind and Print Disabled. And I'm here today with Dr. Liz Perotti, the education and outreach coordinator for NOAA ocean acidification program, and she is serving as a liaison between scientists, educators and stakeholders. She comes to OHP from the Oregon Department of Fish and Wildlife where she managed Oregon shellfish resources and supported Ocean Acidification and Hypoxia policy with the staff of Oregon's Ocean Acidification and Hypoxia Coordinating Council. Liz earned her BA in Biology and Environmental Science at Boston University and continued her career at UC Berkeley. Her doctorial research focused on the role of geology and geologic history. Her interests include embroideries, biology, evolution, ecology, and then sent her to University of the Y to study the developmental mechanisms of settlements and effects of hydrodynamics on fouling communities. She lives in Oregon with her family and enjoys camping, arriving planning watersports, sci fi fantasy media, and has a budding interest in cosplay. So, for the cosplay, I've got to ask, Who are you cosplay?

Liz Perotti 01:38

That's a great, great question. Right now, I'm pretty into Marvel, the Marvel Universe and so I really like Captain Marvel, as well as some Loki variants.

Ashley Biggs 01:47

Oh, yeah. Lucky, dangerous fellow right there. I'm so excited that you're here and I do apologize. A little bit dyslexic, and have was trying to read off the screen. So I do apologize. But I'm so excited that you're here. We talked a little bit before and I didn't even really even know what ocean acidification is. So without further ado, I'm going to turn it over to you to explain.

Liz Perotti 02:16

Thanks, Ashley. So like Ashley said, today I'd like to talk to you about ocean acidification and we're going to start our story in an early morning in 2007. When Mark weigert a fourth generation oyster farmer steps into Whiskey Creek hatchery in neat heartspace, Oregon. What he finds for the first time are millions of dead Pacific oyster larvae. These larvae or young oysters are the moneymakers for the hatchery. They're sold to waste farms along the west coast to be grown in bays and estuaries until they get to market size. This problem continued with catastrophic losses in oyster production. So after ruling out disease and contamination, he turned to scientists to see if it was something in the water causing problems for these young oysters. They discovered that the 100,000 gallons of water they were pumping from the bay each day into the hatchery was more acidic than they had seen before. This was causing the larvae to die during their first 24 hours a critical time when they make their first shell. This Hatchery and others now monitor the water and treat it when conditions aren't good. And this helps them bring up production and stay in business. During this period in the 2000s the West Coast saw about $110 million in losses with the industry Coast wide. So why was the water more acidic and how did it impact these young oysters? We call this problem of a more acidified ocean ocean acidification it goes beyond this hatchery in Maryland, home of the East Coast's largest oyster hatchery. Oysters are also sensitive to increase acidity in Chesapeake Bay. Ocean acidification is a carbon problem. It occurs when our ocean absorbs carbon dioxide from the atmosphere, causing change in the chemistry from pole to pole. This has consequences for marine life and the people who depend on healthy ecosystems. Carbon can be packaged in many forms, one of which is carbon dioxide, or we call it co2 for short. Because it's one carbon atom bonded with two oxygen. It occurs in the atmosphere but also in other things like the ocean land plants and animals, fossil fuel reservoirs in the ground and lakes and rivers. Carbon dioxide moves between these sinks on different timescales. So in the short term, carbon dioxide moves through regular natural processes like our breathing and photosynthesis, and between the ocean and the atmosphere through gas exchange. Other processes in the carbon cycle like the weathering of rocks in the formation of fossil fuels are much slower processes that occur over centuries and millennia. Now, a small amount of this carbon is released from underground reservoirs of fossil fuels back into the atmosphere each year by volcanoes completing that long Long Term carbon cycle.

But now we are releasing carbon dioxide into the atmosphere at much higher, more rapid rates. Through the activities we do every day, we drive our cars use electricity transport goods. Most of this carbon dioxide stays in the atmosphere, but the ocean absorbs about 25% of these emissions. So what happens in the ocean when it takes up all this carbon dioxide? Have you ever been told by your dentist or parent that a carbonated soda is bad for your teeth? Aside from the sugar soda is acidic and can wear down the enamel on your teeth if you don't take good care of them. When carbon dioxide dissolves into seawater, a series of chemical reactions occur water and carbon dioxide combined to form what we call carbonic acid. It's a weak acid and it breaks into other smaller parts, namely hydrogen ions and something we call bicarbonate. Now, this is important because seawater with more of these hydrogen ions is more acidic. We measure that acidity or that concentration of these hydrogen ions by pH. You may have heard that in school, the pH scale runs from zero to 14, with some being neutral. Anything higher than seven is basic or alkaline, and anything lower than seven is acidic. To give you some context, that soda we were just talking about is very acidic with a pH of two, your morning coffee is a little less acidic than that with a pH of five, pure water is neutral at seven. And cleaning your house with bleach is something very alkaline or basic with a pH around 13. So what is the ocean, the ocean itself is slightly basic. But over the last 150 years, ocean pH has dropped from a pH of 8.2 to 8.1. Now, you're probably thinking that a pH drop of 0.1 parts might not seem like a lot, but it actually represents about a 30% increase in acidity. So like the Richter scale, we use for measuring earthquakes, pH is logarithmic. And what that means is that a pH of four is 10 times more acidic than a pH of five, which is 100 times more acidic than a pH of six and 1000 times more acidic than a pH of seven. And this change in acidity that we're measuring is faster than anything we've seen in the last 20 million years or more. Now many chemical reactions, including those that are essential for life are sensitive to small changes in pH. So I'll give the example of our blood. Our normal blood ranges between about 7.3 and 7.5. And just a small drop a pH of point two can cause seizures, coma, even death. Similarly, a small change in the pH of seawater can have harmful effects to marine life, impacting their chemical communication, reproduction, growth and survival. So that was a lot of basic chemistry. But take home here is that when the ocean absorbs carbon dioxide, it creates more hydrogen ions, and that increases the acidity of the seawater. So like the oysters I mentioned before marine life that build shells and skeletons is particularly sensitive to acidity. Hydrogen ions are like free agents loose in the water available to react with other molecules. One of the molecules that the hydrogen ions bond with is carbonate. It's a key building block for making calcium carbonate shells and skeletons. In this way the carbonate hogging hydrogen ions are making it harder for shelled organisms to build their homes. Even when animals are able to build skeletons and more acidic water. They spend a lot more energy doing it energy that they could be using for things like reproduction and growth. calcifying or animals like oysters, clams and corals aren't the only ones affected by ocean acidification. commercially important crab like Dungeness blue King and Tanner crab. Also delayed development and in some cases lower survival at these early life stages and thinner shells. Zooplankton may be small, but they are big players in the food webs and are critical in the carbon cycle. One kind of zooplankton that uses calcium carbonate to build its shell that you may not have heard of, are called pteropods. There's sometimes also called Sea butterflies because their name means winged feet. They are tiny shelled snails that swim in the water and are important food source to fish like salmon pteropods and become an oceans canary in the coal mine. They are very sensitive to increasing acidity and when they are impacted, it's likely that marine life that depends on them will also be impacted. These changes in ocean chemistry can also have non lethal effects on marine life. Flounder are economically and ecologically important flat fish in the northeast and mid Atlantic. In acidified conditions, young fonder showed delayed development and altered growth. They have otoliths, like many fish that are ear bones made out of calcium carbonate. They use these otoliths to both hear and orient themselves in the water. acidified conditions can negatively impact the growth of this important organ in some of these fish. Ocean acidification can also affect behavior in some fish. Salmon rely on olfaction or smelling their environment. salmon return to their natal streams to reproduce in a way they kind of sniff their way home, and they also use the sense to navigate in the ocean. Ocean acidification and pears disabilities sniff out home, raising concerns about their potential effects on reproduction, and the stocks people rely on for both food and income. Ocean acidification makes it more difficult for some fish to detect predators or trap prey as well.

Liz Perotti 11:00

Not all fish have bad effects from ocean acidification some show resilience to ocean acidification. Have you ever eaten a fish stick? If you have most likely you've eaten Alaskan walleye Pollock. Early life stages of these fish show resilience in their development compared to other species, which is a really good sign for one of the biggest fisheries in the world. Understanding species sensitivity to ocean acidification is a critical component of being able to prepare for the effects of ocean change. There are still huge gaps in our knowledge about which species might be affected, and how these effects might play into food webs and ecosystems. Another way to prepare for ocean acidification is to know where it occurs, how fast it is changing and what's coming. This means having an extensive monitoring system worldwide. The United States monitors ocean acidification using several tools. There are buoys and moorings that continuously measure the components of this carbonate system I mentioned, stationed along our surface waters from Hawaii to Alaska, the Gulf of Mexico and the Atlantic including Chesapeake Bay. Gliders are a newer tool that we use to collect information. Instructions are sent via satellite to these autonomous vehicles that traverse either the surface water in the case of wave gliders or below the surface with underwater gliders. Fighters expand the area we collect information beyond those stationary points like buoys and moorings and they do it without needing a person to man them on site. research cruises are a way to collect information of a particular ecosystem or area. Ships surveys offer several advantages. They let us collect high quality data that go deeper than surface waters. And they also help validate the information that we get from those autonomous tools I mentioned. Ships of opportunity and volunteer observing ships are privately owned vessels equipped with ocean sensors. The ocean is a big place and utilizing these fleets helps us cover more ocean, they tend to traverse the same routes and sample an area more frequently than the snapshots we get from those research cruises. This helps us better track ocean acidification. Another type of monitoring we do is focused in coral reefs. Coral reefs are one of the most productive ecosystems in the world. Curls build their skeletons out of calcium carbonate and face several challenges including ocean acidification. Installing instruments in coral reefs lets us track conditions in this economically and ecologically important ecosystem. And all of these types of monitoring provide data that can be used to model change and conditions in areas where we aren't able to sample and to forecast what may happen in the future. Ocean acidification is affecting the entire world's oceans, including coastal estuaries and waterways. Many economies are dependent on fish and shellfish and people worldwide rely on food from the ocean as their primary source of protein. While ocean acidification occurs Worldwide, there are disparate local and regional effects. Some people industries and communities are more effective than others and finding out who's more vulnerable helps us prioritize action to support those affected. Monitoring. Understanding the biological response to ocean acidification and identifying the social and economic impacts are all necessary to evaluate what's at risk and build resilience to adapt. Just Chesapeake Bay is the largest estuary in the United States and one of the most productive in the world. The Chesapeake Bay has provided livelihoods, sustenance and recreational opportunities, and is deep rooted in the cultural identity and history of the surrounding communities. A regional vulnerability assessment of Chesapeake Bay found that both global and regional changes work in concert to enhance carbon dioxide uptake by the estuary. On top of global temperature and atmospheric carbon dioxide effects on the bay. There are local processes that also contribute. The bay is fed by rivers and these rivers bring more acidic waters. nutrient loading from agricultural runoff into the bay also spurs growth of plants and plankton. After they after these plants and plankton Bloom from these nutrients, they die and sink to the bottom and their decay releases more carbon dioxide into the water, making it more acidic and lower and oxygen.

Liz Perotti 15:32

This is important for a lot of people who make their living from the bay waster farming and Chesapeake Bay has been one of the fastest growing industries in Maryland over the past decade. Early research found that these oysters are sensitive to acidification and the industry is utilizing this resource are likely to be affected now and into the future. Through a monitoring network researchers are now able to determine how water quality and changing ocean conditions may affect oysters in these businesses. Forecasts using the information from this network are publicly available to oyster farmers and others. This promotes awareness and gets the information to the people who need it most. For example, hatcheries can prepare to treat their water with an upcoming ocean acidification event. And farmers can plan how best to plant and harvest and coordinate with their buyers. This is just one example of how to build resilience with species and communities at risk. Maryland joins the rink of other states and creating a state ocean acidification action plan. This is a commitment and a plan to reduce the causes and increase resilience, improve the scientific understanding of ocean acidification for the region, and expanding public awareness and partnerships for action. So what else can we do to address ocean acidification. Carbon emissions are the primary underlying cause of ocean acidification globally, we can all do our part to reduce our carbon footprint. Some actions are using energy efficient appliances, planting water efficient landscaping, and being more mindful about our means of travel. Monitoring is important to keep track of changing ocean conditions and you can get involved with community sampling. One way to find out about these opportunities is to get involved with your regional coastal acidification network that connects scientists and stakeholders to find solutions within the Euro region. Ocean acidification is only one stressor marine life and ecosystems face. Minimizing stressors, like increased temperature, nutrient runoff, pollution, and overharvest can help them better deal with the effects of ocean acidification. And lastly, sharing what you know with others helps increase awareness so that they can take action to do you want to learn more about ocean acidification taking action or finding your regional coastal acidification network, visit the National Oceanic and Atmospheric Administration's ocean acidification program at Ocean acidification.noaa.gov.

Ashley Biggs 18:05

That, that is a lot of information. And thank you so much for calling in about Maryland. I do have some questions based on what you said. Okay, um, we all we all know that carbon dioxide, that thing that you breathe out, and you were talking about how it's in the atmosphere and the ocean in the land? Is there something that we can do to combat? How much co2 we've put in the air? Like, I mean, can we plant more trees? Can we don't want to say breathe less? You know, maybe are part of our manufacturing processes that put co2 in the air? Like, are those good things to do?

Liz Perotti 18:46

Yeah, those are some good ideas. So like I was kind of mentioning towards the end, you know, anything that you personally can do, or you or your community can do to kind of reduce those carbon emissions or your carbon footprint is good. So for you that might be taking public transportation, or, you know, if you own a business that, you know, I'm here in Oregon, for example. And so timber is really big. And so planting more trees can help take some of that carbon dioxide out of the atmosphere. But anything that reduces your carbon footprint, will help kind of contribute to lowering those carbon dioxide emissions.

Ashley Biggs 19:24

You said that, because of this, that there were shellfish that were weighing in the tree that they were developing thinner shells, does that affect the because we eat those? We not just, you know us, but there's a lot of societies out there that ocean life is their primary source of protein. You know, does though, because of that ohsms edification, does that affect their own? Does it affect the nutrients does it affect how much they can eat?

Liz Perotti 19:56

That's a good question. And we're still learning about that. In every species is different. And that's why we spend a lot of our efforts looking at the sensitivity of different species. So one type of fish may have a different response than another type of fish, for example. So I gave the example of Pollock being more resilient, they seem to not be impacted by those more acidic waters, whereas other fish, like rock, fish, or salmon definitely are seeing impacts. In terms of nutrition, you know, if you are getting a smaller fish or shellfish that might impact the kind of quality of product that you're providing those specific relationships on the exact impacts of ocean acidification to a species depends on that species.

Ashley Biggs 20:45

Okay. You were talking about how that point 01 is, like 100 times worse than what we might think it is, and how it was going up exponentially each time the number went down. Right? You know, there's a lot of talk about global warming, and, you know, ice caps melting and water disappearing, because the global warming affects that pH level, and cause it to increase to

Liz Perotti 21:12

that's a good question. Temperature definitely affects the levels of ocean acidification, our colder water actually holds more carbon dioxide. And so we tend to get more acidic waters in places like Alaska and the Bering Sea than you would in more tropical areas. Okay, and that's just a kind of a matter of chemistry. You know, the ocean is also really important in regulating climate. And so yeah, I think that's all I'll say about that.

Ashley Biggs 21:42

Okay, yeah, no, no, that's fine. Because in my head, I actually kind of see it as going in a circle. I'm like, Oh, my goodness. You know, I really thank you for this presentation. Like I said, when when we first met, I didn't even know this was a thing. And I don't, and I'm wondering how many people out there, you know, because we all know, oh, well, you know, the polar caps are melting and the water is evaporating and sea like it's dying due to plastics in the ocean. But ocean acidification really does sound like a real danger to us in this lifetime. So what I'll do after is I'll make sure in the podcast on the podcast page that I link to our local OAP, because you mentioned it, I'll link to ours, maybe some of the tips that we can you gave on how to that your own apartment?

Liz Perotti 22:33

Yeah, and I think the website that I ended with has like a lot of those resources. And the local Maryland one that I mentioned is the state action plan. And that I think came out at 2020. And, you know, the only thing I would say is like, you're absolutely right, OSHA certification is something that's happening now. It's, you know, industries, and people and communities are already seeing its effects. And so taking action now in ways that we can is really important for maintaining these healthy ecosystems that people rely on.

Ashley Biggs 23:04

Thank you so, so much. I know that you're very, very busy. The time that you took to present to us was just we're very, very grateful. Thank you so much.

Liz Perotti 23:14

Thank you for the invitation. I really appreciate it. Please let me know when it comes out so that we can help share that on our social media and get the word out? Definitely. And I'd be the person to do that.

So I under Yeah, exactly. Yeah. So I appreciate it. Thank you. Thank you, Ashley. I'm sorry, we had to switch the date on you a couple of times. But I'm glad we were able to make this work.

Ashley Biggs 23:38

Oh, this is fabulous. Thank you so much. And ladies and gentlemen, if you have any additional questions that I didn't ask, but if you want to hit me up, you can reach me at the library and I can either research and find an answer for you or I will ask Dr. Pearle. So thank you so much. And I'm gonna go ahead and stop.

Announcer 24:02

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