October 4, 2016, oc100416.mp3
Blue Carbon
Jennifer Stock, Dr. Ariana Sutton-Grier

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!

(Musical Intro)

Welcome to another edition of Ocean Currents, I'm your host, Jennifer Stock. On this show we talk with scientists, educators, explorers, policy makers, ocean enthusiasts, adventurers, archaeologists, children, authors, and more, all uncovering about the mysterious and vital part of our planet: the blue ocean.

I bring this show to you monthly on KWMR from NOAA's Cordell Bank National Marine Sanctuary, one of four National Marine Sanctuaries in California, all working to protect unique biologically diverse ecosystems. Just off the shore of the KWMR listening area are the Greater Farallones National Marine Sanctuary and Cordell Bank National Marine Sanctuary, which together protect 4,581 square miles.

The National Oceanic and Atmospheric Administration, also known as NOAA, is a leading administration in oceanic and atmospheric sciences. NOAA has a global network in measuring greenhouse gases in the atmosphere, and in August of 2016, the monthly mean of carbon dioxide in our atmosphere just reached over 400 parts per million, which is way above what scientists deem as safe. All over the world policy makers, economists, politicians, scientists, communities, and individuals are searching for ways to reduce carbon emissions that continue to produce energy sustainably. While we as a global community seek ways to reduce emissions, there are efforts afloat to increase carbon sequestration, which remove carbon from the atmosphere and provide ecosystems with services.

So today we're going to focus on the Blue Carbon concept with NOAA ecosystem science adviser Dr. Ariana Sutton-Grier. So stay tuned and in just a moment, we'll be back with that interview.

(Musical Interlude)

Jennifer Stock: Welcome back, you're tuned to Ocean Currents, and today we're talking about Blue Carbon, and on the phone with me, I'd like to welcome Dr. Ariana Sutton-Grier. Ariana, you're live on KWMR!

Dr. Ariana Sutton-Grier: Great, thanks so much for having me!

Jennifer Stock: Thanks for calling while you're on the road traveling, I really appreciate it. So I just wanted to dive in because I noticed when I was getting ready to talk on the show with people and I talked about Blue Carbon people were like "What's that?". So let's just start with a basic concept; what is Blue Carbon?

Dr. Ariana Sutton-Grier: Sure, so there's actually a number of colorful terms that sometimes get applied to carbon, so I actually start with what Green Carbon and Black Carbon first to frame this picture.

So, Green Carbon taken up and stored by vegetation on land, and we oftentimes we think of forests as a really important Green Carbon thing. And it's green because plants are green, and plants are what takes up that green carbon. Now Black Carbon is the carbon emitted from the mining and burning of fossil fuels, as well as from the burning of forests and other land use change. So hear Black and think of things like oil, gas, and things from forest fires.

Okay so then Blue Carbon, is the term that we use to talk about carbon taken up and stored in coastal and marine ecosystems. And I actually like to differentiate the part that is from open water marine systems that take up carbon, and then also the coastal systems, and here I'm really talking about coastal wetlands, so tidal marshes, seagrasses and mangroves. And they actually only make up about .2% of the ocean's surface, of that ocean coastal surface, but they actually contribute about 47% of the carbon burial in marine and coastal settlements, just under half of that is being done under those coastal wetlands.

Jennifer Stock: So when you say it takes up just 2% of the ocean's surface, is that the current estimation of the current amount of wetlands versus what we historically had?

Dr. Ariana Sutton-Grier: Yeah, it's .2 percent--

Jennifer Stock: Oh .2

Dr. Ariana Sutton-Grier: It's much smaller, and that's current distribution. And we do know we've lost some of the habitats, we've probably lost close to 50% of those habitats in many places, but it's still a very small fraction of that total, if you think about the surface of the ocean versus the surface of our coastal ecosystems along the fringes of many of our continents. It's still a very, very small percentage in comparison.

Jennifer Stock: But a huge, huge, incredible update of carbon, that's amazing.

Dr. Ariana Sutton-Grier: It's much greater than 10 times per unit, and so that's why they're such impressive carbon sinks, that they are burying amazing amounts of carbon in their soil. So that really distinguishes blue carbon from other plant-based carbons sinks, because forests tend to store most of their carbon in biomass, so in the wood, in the branches, some of it in the soil, but the majority of it is actually in biomass, whereas in these wetland systems, a majority of it is in the soil, so it's in a place where we can't see it. And I think that's part of the reason why the conversation about blue carbon has been growing in the past six to eight years, prior to that we weren't thinking of these systems as impressive carbon sinks the way they are, because you can't see it buried underground.

Jennifer Stock: So as a reverse on that, because of that incredible uptake on blue carbon, if we destroy blue habitat coastal carbon uptake systems, do we also release carbon dioxide into the atmosphere when we actually take away these systems?

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Dr. Ariana Sutton-Grier: Yeah, it's really a double-whammy in terms of losing climate benefits, because you not only lose the impressive sequestration that you're getting every year. So if you think of sequestration--think of like a bank account, and the sequestration is what's going in every month or every year, think of it annually for these systems. It's like your annual income that you're getting every year in your checking account. So, we lose that annual income every year if we destroy this ecosystem. So the other thing we lose if you think of your bank account, hopefully everybody's bank account has some in savings already, and in these wetlands there is an amazing amount of carbon in the quote "savings" or stored already in the soil, and so when we degrade or destroy these ecosystems, what was a really impressive natural sink, it becomes a really important carbon source, which provides an organic or human-based source in the atmosphere.

The main reason why they are such good carbon sinks is that the soils are anaerobic for most of the time. And what I mean by that is there's no oxygen or there's very little oxygen in the soils, and that's because it's underwater for most of the time, and as a result they're waterlogged, and there's not a lot of oxygen present. That slows the decomposition or degradation of organic materials, so that's what makes them such impressive sinks, the organic materials that get's trapped in the soils and then doesn't decompose. If we destroy or degrade these systems what tends to happen is we drain them, we dig them up, we expose that oxygen-poor soil to the atmosphere which has plenty of oxygen in it, and that starts to decompose, and we basically lose our storage

Jennifer Stock: So, I understand that in the United States the most common blue carbon habitat we have would be wetlands, but it's actually not the best at sequestering carbon as some habitats around the world. Can you talk about some of those other types of coastal wetland habitats that are really good at sequestering carbon?

Dr. Ariana Sutton-Grier: Well yeah, so we are actually lucky in the United States to have all three blue carbon ecosystems, we do have a lot of salt marshes you were pointing out, and tidal marshes, but we have a lot of seagrasses, and we also have some mangroves, particularly down in Florida and a little bit along the Gulf.

And mangroves are a really impressive carbon sink, because they not only have that soil component we were talking about that's so important in all these new carbon ecosystems. But then because they're standing biomasses the wood of the mangrove trees you get an added bonus because it's a forested wetland, so you get the soil storage as well as additional storage in the biomass, so they really are very, very impressive carbon sinks. In the rest of the world, that's the majority of some of the blue carbon habitats that exist in more tropical, warmer countries.

Jennifer Stock: How about--You were talking about how this stuff is stored in the soil, but what about those seagrasses and kelp in itself and phytoplankton as well as other sources for taking up carbon; it sounds like they may not store it as long as the soil would.

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Dr. Ariana Sutton Grier: Yeah, that's a really good question. I get this question a lot of "Why aren't we talking about kelp or phytoplankton as much?" So it turns out, and I actually have a review paper coming out discusses this very clearly because it is a very important conversation that comes up in a lot of policy contracts. It turns out that kelp are a very important part of the carbon cycle in these coastal to marine ecosystems, they exist at that boundary between land ecosystems and deeper sea ecosystems, and they are very important parts of the carbon cycle and very important parts of the coastal food web, because they do photosynthesize and take up a lot of carbon and make biomass in the form of kelp.

But, they tend to be very yummy, very digestible, degradable material, again I don't know if I said it but they're part of the food web. It's a very important food source for a lot of organisms, not to mention providing habitat and refuge habitat and security for other organisms. But they don't actually sequester carbon long-term and that's because there is no pathway from kelp into deep, long-term storage in sediments or soil. So you really don't have that long-term carbon sequestration in kelp.

Now when it comes to phytoplankton, the answer is a little different. Phytoplankton are also incredibly productive in taking up carbon and growing entire marine food chains on just that basic process phytoplankton are doing. And so they do take up a lot of carbon, but again, it tends to be very quickly consumed and eaten up in most cases by other organisms. And as soon as something is eaten, then it basically gets decomposed and that organism is gonna blow off CO2, right? We all respire, and when we eat food we actually break down that carbon and then we respire the CO2, that's exactly what all the organisms are doing in the marine environments are doing, so that phytoplankton is a very important, a very basic part of that food chain.

Now some of the phytoplankton, a fairly small fraction, but some of it does actually sink below the really productive top surface layer of the ocean, and a small fraction of it gets incorporated into marine sediments long-term. So it is a pathway for long-term carbon sequestration, and it's an important one globally. Interestingly we don't tend to talk about phytoplankton when we talk about our blue carbon efforts, and that's mostly from the logistics perspective of it, in terms of most of the phytoplankton exist in international waters. So it's not clear who, if anyone, would own it or would try to manage it. The other issue is that when it comes from management of that particular carbon storage mechanism, the only real mechanism that's been proposed for how to try to increase carbon sequestration in phytoplankton is to do iron fertilization of the ocean. And that actually comes with a lot of scientific certainty on whether it even works to increase productivity, and there's a lot concern from environmental scientists and ecologists that it would actually do more damage to do iron fertilization than it would do good. And we often want to try to do no harm when doing science or policy management decisions.

So basically at the moment, phytoplankton is not a very climate policy-friendly opportunity because there's no really good way to try to manage that carbon and

try to increase the sequestration, whereas with these coastal habitats we can manage them. We can manage them with carbon in mind, which really just needs managing a healthy coastal ecosystem. And because we're losing these ecosystems at high rates around the world, we have a opportunity to better manage them, to better protect from where they're threatened, and to restore them from where they've lost or degraded. And so that's really why the blue carbon efforts have focused just on those three coastal systems I talked about, and not on some of these other habitats that are important as far as the carbon cycle, may even a carbon sequestration role, but are very difficult when it comes to the policy and management considerations.

Jennifer Stock: How about eelgrass though since that is so close to these coastal habitats?

Dr. Ariana Sutton-Grier: Yes! And eelgrass--definitely. That is considered one of the important coastal blue carbon ecosystems, and there's evidence that there's high variability in the eelgrasses and there's definitely a need in data when it comes to our seagrasses--all different seagrass species. And actually some of the work I'm currently doing with the Commission on Environmental Cooperation right now is improving on our mapping data and our carbon measurements in Canada, Mexico, and the US, in seagrasses. But we generally know that seagrasses are important at sequestering carbon and depending on where you're located and which species and which conditions, they're really really big sinks or somewhat smaller sinks. But generally they're still considered an important carbon sink.

Jennifer Stock: Also quite a bit of buffering in a local watershed I understand as well, in terms of regulating pH during the day and the nighttime.

Dr. Ariana Sutton-Grier: Yeah, there's growing evidence, it's really still very cutting-edge and new science that's suggesting seagrass, as well as other plants such as kelp or other macroalgae, can basically have a local buffering ability against some of the ocean acidification problems. So, in some places where shellfish is being grown, or coral are really needing some local buffering for protection from ocean acidification, there's evidence that we may be able to try to manage for some of these other systems like seagrasses to try to help with getting some of that local buffering. And so the way that works is because the coral plants are taking up CO2, because they're photosynthesizing, they're removing CO2 from the water column, which then temporarily means that the effects of climate change and the additional CO2 in the ocean--that dissolves in the ocean, can be buffered locally so that you might even get anywhere from half a pH unit, maybe as much as one pH unit, but definitely half a pH unit, increase, right, so that locally there's that small local buffering against those ocean acidification effects.

Now this is still some early research, we're still really trying to figure how often this can happen and whether there's best management practices that could be used, but it's very exciting! There's actually folks out in California, there's folks in Washington state looking at this because the shellfish industry there that's so important. And you have folks on the east coast and New England looking at this too. And again, where there's an important shellfish industry this is an interesting

and exciting topic, to see whether there's these cross-ecosystem boundary service flows. So basically one ecosystem providing a service to another, that can help with that ocean acidification buffering.

Jennifer Stock: That sounds great. For folks tuning in this is Ocean Currents, and my guest today is Ariana Sutton-Grier, and we're talking about blue carbon coastal ecosystems helping to sequester carbon from the atmosphere.

So, something that keeps coming up for me is I keep thinking about these coastal habitats as sea-level rise, and the pace of which we're expecting to see sea-level rise. How many of these habitats will continue to keep up with sea-level rise, in terms of building out as sea-level rises?

Dr. Ariana Sutton-Grier: Yeah, that is another really good question that comes up a lot,and it's really important to think about. So it's also one I would say that scientists are working hard to do a better job at addressing and answering that question. What I think is exciting is that some of the recent stuff that I'm seeing in literature, is suggesting that coastal marshes, tidal marshes in particular, are very resilient to sea-level rise. They've actually survived hundreds, and even thousands of years, and the way they survive is to continue to accumulate soil, and they do that is through two different mechanisms.

One of them is, as water flows through the tidal marsh systems, through that vegetation, the water slows as it's having to make it's way through the vegetation, and you get sediment that settles out. So for some coastal wetlands, the sediment piece is really an important pathway for continuing to having that elevation gained. In all systems I think there's some roles for sediment, there's also some roles for the second pathway as there's actually an accumulation of organic materials, so that's those plant roots, and also the dying back of the plant parts, the shoots and the leaves, which are then getting incorporated into the soil.

And for some wetlands that's an even more important pathway of both, and both of those two mechanisms, it's really very heartening actually, some of the research suggesting that coastal tidal marshes are very likely to keep up with not only the current rates level of sea-level rise, but also even accelerated rates of sea level rates in the future. Now, I need to put a caveat on that, which is that they have to be healthy ecosystems, which means--coastal wetlands--which means we can't have done things to them to degrade them, like pumping them full of nutrient waste, extra nitrogen or phosphate that speeds up decomposition and they can't necessarily accumulate enough sediment to keep up.

We also can't keep up the hydrology systems, and so as far as the United States we are losing basically the most wetlands annually, and probably folks are fairly familiar with this, is in the Gulf, where you know, you hear we're losing half a football field every half an hour. I don't remember exactly what the physics is, but it's incredible how quickly we're losing wetlands down there. Part of the reason for that is that we have changed so many things down there. We're changing their hydrology, they're not getting enough sediment they used to get due to flooding concerns in the area there we've basically replumbed the water system,

and the Mississippi River doesn't flood into the coastal wetlands the way they used to. So they aren't getting the sediment supply they used to, we're also pumping out groundwater, we're pumping out oil, we're doing all these that cause extra additional subsidence of land, so the wetlands are actually sinking, when they would not otherwise be sinking.

So there's a number of factors contributing to the fact those systems are greatly stressed, and they're having a hard time and aren't really staying, in many cases, keeping up with sea-level rise. Again, healthy ecosystems, evidence really suggests, if they can maintain levels of sediment input and levels of organic input, that they've already been able to do for hundred of thousands of years.

Jennifer Stock: So interesting, this is so fascinating. So what about--I mean, are you familiar with San Francisco Bay, in terms of the ecology of SanFrancisco Bay? Because up the bay and the watershed have been so altered by filling in and rerouting water, I'm curious, what about the up area of the bay, not so much the coast but maybe upwards a little bit?

Dr. Ariana Sutton-Grier: Yeah, I'm somewhat familiar with the area, and there's actually a great deal of interest in Blue Carbon in the Bay Area, we have some of our experts located out there in the United States, some of our primary experts. So, it's definitely a topic of interest, and one of the things I didn't mention previously but I do think is important to consider is in some places we will have wetlands that can't keep up for whatever reason with sea-level rise. As so it is important to think about, what I would term "assisted migration", so basically making sure we don't have what can called "coastal squeeze". And that's where development, whether it's a road or a building, a community, some kind of hard structure that is preventing the migration of coastal wetlands. And the more we can prevent those kinds of barriers from being in place, we will prevent that coastal squeeze from happening so that ecosystems--as they need to--coastal systems can move inland, move upland as sea-level changes. And so I can definitely see that playing a part in the San Francisco area, as well as other areas.

The other thing that I know that's happening with San Francisco is the hydrological changes, there are now places that are well below sea-level, because of a lot of the organic-rich soils have burned off over decades of farming and other uses. The interesting thing is that some of the evidence, some of the research suggests that if you restore the hydrology, the wetland plant community will definitely come back and actually start to accumulate organic materials in the soil at a very rapid rate, perhaps allowing those soils, with enough time, to possibly gain back to the current sea-level. They don't necessarily have to stay below sea-level, again that means restoring the hydrology so they're more like a wetland, and not using it as prime agricultural area. So this one of those things where we're dealing with trade-off of different human uses, and society has to understand those trade-offs, and then make educated, informed decisions about what needs to happen, where, and use their land-use planning with that in mind, because it's impossible often times to get all the benefits one might want out of a particular parcel of land.

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Jennifer Stock: We just had an area open up last year, the Sonoma Baylands, that was diked farmland, historically, and with many many partners in play, they restored the water flow , removed the dike, and it's incredible to go out there now and see the change in water turning into the way it used to be. And it provided a lot of inspiration of, like "Wow, we could just do this more!" There's so many ecosystem services that could happen, and it's a great place people can hike out along the edge, it's right off Route 37 here in southern Sonoma County, so it's great.

Dr. Ariana Sutton-Grier: That's wonderful, I would just mention just a couple other places I know of. I know that there was just a project at the Elkhorn Slough, and then also at Seal Beach, where they're definitely looking at how restoration influences carbon sequestration. And then there's another project at Rush Ranch, which is part of the San Francisco Bay National Estuarine Research Reserve, and you can definitely visit the Rush Ranch site as part of the Near site, so it's open to the public, and so I would encourage people who are interested to go check those sites out.

Jennifer Stock: Fantastic. We're gonna be coming up on a break in just a little bit, but you really brought up a point here about how we know the incredible services these wetlands play. But what a conflict with development agencies and development in general. Where do you see this conversation going in terms of local communities and counties taking this into consideration, because development is money, and people, and people need to go somewhere, and here we are trying to make these buffers bigger and bigger. But I'm curious, how is it going in the local and global conversations I guess, in terms of adopting these restoration efforts?

Dr. Ariana Sutton-Grier: Yeah, I think that's a really important point. And I actually think that we have perhaps, maybe, we'll have to look back, history will tell of course, but I think we may have hit a turning point in the conversation when we're thinking about coastal development versus coastal restoration and protection. And I think that part of the reason why I think we've hit that turning point is after Hurricane Sandy--Superstorm Sandy, when New York got hit as hard as it did, and Boston was only spared due to some luck and timing in the storm and when it hit. We have had a real change in the conversation and the thinking about coastal resilience, and the resilience of our communities. So it's not coastal development and that we still love to live by the coast, we have about 40 percent of our population living in less than than 10 percent of our land, because we all love the live near the coast. And those who don't live in those coastal counties tend to visit them at least once or twice a year, and so we love our coast, but we love our coast almost to death in some cases. And there's been a real recognition that in order for people to enjoy living near the coast, we need to rethink the way that we do coastal development and we need to think about these coastal systems, and here I'm talking about the wetlands we've been talking about, but also beaches and dunes, coral reefs and oyster reefs. All of those natural coastal ecosystems really provide an important storm-risk reduction and erosion protection. There's a

real shift in the federal conversation and I'm seeing it regionally as well in terms of when we think about protection, not just immediately going for those tried-and-true coastal development solutions like seawalls and dikes, but saying "Hey, there's gotta be other opportunities, we don't wanna lose the other ecosystem services", particularly communities that are dependant on fisheries, where these really beneficial fishery habitat benefits, these coastal systems provide that habitat benefit. But also places that are really dependent on tourism, where people don't really, so you'll hear this thing called "green infrastructure", or "natural infrastructure", or "nature-based features". And sometimes it's not just the natural features, it's what I have called "hybrid infrastructure", where you take a built component, but it also have a natural component, and a living shoreline is a really good example of that, where you've got definitely something that's designed definitely for erosion protection, but it has natural features like oyster reefs and salt marshes, etcetera. So it's a very exciting conversation, and I really hope that we have hit a turning point in the conversation in the way we think about coastal development and coastal resilience so that we include more of the ecosystem perspective.

Jennifer Stock: Excellent, thank you. We're gonna take a short music break, Ariana, I hope you don't mind staying on the line for a little bit. We'll talk more about what you're doing to help get the word out to the different agencies and policy-makers on how to implement this on a large scale. So, stay on the line, and listeners stay tuned we'll come back in a minute to just continue our conversation on Ocean Currents about Blue Carbon. Stay with us!

(Musical Interlude)

Jennifer Stock: You're tuned to KWMR in Point Reyes' Listening Station, my name is Jennifer Stock and you're listening to Ocean Currents, and on the telephone with me I have Dr. Ariana Sutton-Grier and we've been talking about Blue Carbon. Ariana is an ecosystem advisor at the National Oceanic Service, part of NOAA. And Ariana, if you wouldn't mind, I would like to hear how you're applying all this wonderful knowledge to your work with NOAA as an advisor?

Dr. Ariana Sutton-Grier: Sure, so there are a lot of really exciting opportunities as the science of blue carbon has developed, so we have a better understanding what happens in these ecosystems, how they function normally, and what happens when they are degraded or destroyed.

So there are a lot of really exciting policy opportunities, where we can apply what we know about the science, so I'll give you a few examples: so one of them is that in the United States we don't have a national greenhouse gas market or carbon market. But we do have some regional examples, and I'll try to speak to that in just a minute. We do have the voluntary carbon market, so one of the exciting opportunities is as we better understand these carbon systems in these coastal wetlands has been to adopt a methodology for how to get carbon credits on the market if you're wetland restoration or protection. And so NOAA has worked with Restore America's Estuaries, or RAE, and they put together a

methodology for the Verified Carbon Standard, or VCS, which was actually approved last November, and so this is super exciting. This is for all tidal wetlands, including seagrasses and mangroves that counts as a tidal wetland, this is for anywhere in the world, so that methodology now exists on the VCS website, and it's the process you follow if you want to apply carbon credits for any restoration project anywhere in the world. And the whole idea is that the carbon market might generate additional interest and additional revenue to support coastal restoration. And eventually the actual coastal protection as well, there's a couple partners in NOAA that has similar methodology to be able to get credits for protecting a wetland.

So that's one policy opportunity I see as very exciting, I wanna take a side-step here briefly, because it probably would be interesting to your California audience. When it comes to regional carbon markets, California is really leading the way in the US, so that with the passage of AD32 in 2006, which was the Global Warming Solutions Act, this actually requires California to reduce emissions to 1990 levels by 2020. And what's really neat about this policy is it's using a variety of mechanisms to get there to do the emissions reduction, and this includes markets, but it also includes policies and regulations.

So there's a cap-and-trade program in 2012, and those who use it can offset 8% of their compliance requirements using offsets. Now, currently there is not a wetlands offset. They are available in forestry, dairy digesters, destruction of ozone-depleting substances, and those proceeds from those credits actually go into the Greenhouse Gas Reduction Fund. What I think is really exciting is that California has chosen to use some of those proceeds from the Greenhouse Gas Reduction Fund to fund wetland restoration, and in 2015, 12 projects were started, four of them were wetland projects. One of them was actually in Elkhorn Slough, as I mentioned earlier. So these are some of the projects being funded with the greenhouse Gas Reduction Funding, and I'm really hoping these projects inform maybe the future opportunity to have a wetland offset as part of the California system. And California's really leading the way on this, which is exciting to watch.

In terms of other policy examples where this is really coming up, you've got the international scene, which is really interesting. So, the United Nations Framework Convention on Climate Change is where countries report their annual emissions to, so they have to go the UNFCCC. And in 2013, the Intergovernmental Panel on Climate Change, or the IPCC, which is sort of the scientific guidance that goes with United Nations FCCC, they released a wetlands supplement, this provides guidance to countries, suggesting that wetlands should be incorporated in our Greenhouse Gas Reduction Fund. They were not previously included because it had been decided that there wasn't enough data to support the inclusion of wetlands, but in 2013 there was guidance saying "We know you aren't including this, but we really recommend to countries that you start incorporating wetlands." And based on guidance and based on support in the United States, we are on track so our 2017 submission in spring, we are planning to include coastal wetlands for the first time in that national greenhouse gas

inventory. This is really exciting, the US is really one of the first countries to really doing this, we're going to be reporting to the UNFCCC to try and see how that went: what were our challenges, how did it find the guidance work. And so we're really leading the world in this, but it's also been a very interesting learning experience trying to figure out what our data even needed, what data are currently available, what are our gaps, and has really helped us learn to some degree how we can be shaping future research to better inform our Greenhouse Gas Inventory and really just understanding our natural carbon cycling are in coastal wetlands.

The last example I would like to point out is something else I've worked on, how do they have this knowledge about the carbon in these ecosystems? How could systems affect the implementations of policies that are already in place, so no new policies, but existing policies. And here I'm thinking about things like the Clean Water Act or the Natural Resource Damage Assessment Process. I and some colleagues at NOAA did some analysis to look at how would this change the way we implement policies, and most of us came up with is right now when we implement these policies, we focus primarily on living resources that might be affected. For example, if we decide that we need to build a road and it goes right through a wetland, and so we focus on how much of that wetland is going to be destroyed, and then we try to offset that particular living resource. So for example if it's acres of salt marsh that might be affected, and you look at things like were there birds nests that were affected or other specific species, and then we need to offset that habitat law. This also means that litigation issues might be off 3 to 1, and so for 1 sector you might need to store 2 or 3 somewhere else--maybe 5 to 1. The interesting thing is that by not incorporating what we know about the soils now and the important roles soils play in carbon sequestration, if you disturb that wetland, and the top meter of it basically gets disturbed enough and the carbon in it is released into the atmosphere, you're destroying what could be--definitely decades if not hundred of thousands of years of stored carbon. So if we were to fully account for the carbon iss these systems, it might need litigation issues maybe 20 to 1 or 50 to 1. So it could definitely change the kinds of litigation and restoration that we would be needing to do.

So this is something we've identified as an opportunity but also changing practice, when standard environmental practice takes time, so it's not something where you could turn that ship really quickly. However a colleague and I have actually incorporated the carbon benefits of salt marshes that is in the San Francisco Bay Area, it's at the Sears Point site where they're doing salt marsh restoration. And we were able to incorporate into the environmental protection statement that for the National Environmental Protection Act or NEPA document, we were able to incorporate a discussion of the carbon benefit restoration potential project that were proposed. And so waiting is great as it just sets the precedent we can incorporate it, but it isn't always easy to do so, because it does take a considerable amount of knowledge about the carbon science to incorporate it in this kind of implementation. And so then you have to have some careful thought as to if this is what the US wants to do more broadly:on how we provide guidance to other agencies at the national or local level, on how you

incorporate these benefits into the implementation of our policies, but we do know it's possible.

Jennifer Stock: That's fantastic, that actually follows up to the last question I have in terms of how can listeners get involved and support blue carbon initiatives? The first thing that comes to mind for me obviously is knowledge, but also our local coastal plans, in California we have the Coastal Act, which creates a mandate that coastal counties to manage conservation and development of coastal resources through a local coastal program. Are there other ways that listeners can get involved to support these initiatives?

Dr. Ariana Sutton-Grier: Well I wish I knew more about the California example you just gave me, but definitely if there are ways to be raising awareness. I find that one of the big challenges is still the fact that these coastal wetlands are such impressive carbon sinks is not widely known. And once people start to recognize that as an additional benefit, it can help to change the conversation. So definitely be telling your friends, your neighbors, and definitely your elected officials about the importance of coastal wetlands. In one being a carbon sink, it's more reason to love our coast, right, and communicating that is really important.

Another thing I would suggest is that we need to support coastal restoration in any way possible. I think finding innovative ways to finance that restoration is exciting, and I think California already has that example with how you're using the Greenhouse Gas Reduction Funds to do this. I would be telling, again, all local and regional elected officials that you support this, and that supporting additional coastal restoration is really important. And again, you get the carbon sink but you get all these other benefits that come with those coastal wetlands. You get the habitat, the recreation, the water quality benefits, and of course that resilience piece, that form in erosion risk reduction. So really, you get a whole bunch of benefits in one.

If you're interested in offsetting your own emissions, or your business is, I would be asking companies "Hey, do you have a Blue Carbon offset?" because I think the more people ask "Hey, are you working on coastal marsh restoration? Could I fund that?", there has to be a demand often times, particularly in the voluntary market, there needs to be demand in order to derive more opportunities. So if that's something of interest, the asking of "Hey, is there a blue carbon offset I could fund"--

And then the last thing I'll mention, this isn't as true in the United States, but it still does affect US customers, one of the main drivers of the loss of mangroves and then of course the accompanying loss often times of seagrasses, particularly in Southeast Asia is there are a loss in shrimp farms where mangroves used to be. They cut down mangroves, they put in shrimp farms, and basically this is driving our need and the rest of the world's need for cheap shrimp.

And so I wanna mention it's really important when you're making seafood choices, particularly shrimp, try to buy something that is labeled "sustainable". Try to buy something local if you can, so that way you know it's not coming from

Southeast Asia. Or do what I've done, I haven't been able to find a good source of sustainable shrimp, and even though I adore shrimp, I have given them up almost entirely basically because I can't find a sustainable source for them.

That said, I do know that there are sustainable shrimp, I do know one (inaudible) in Vietnam, specifically doing markets in mangroves and they're supporting farmers to have at least 50% mangrove cover, and then they get a better price for their quote "sustainable shrimp". So I know these exist, I just haven't been able to find them in my local grocery store, so I keep asking "Where do these shrimp come from?" and "Can you tell me if they're sustainable?" But unfortunately, that shrimp cocktail you may have had at the party last night, according to a colleague of mine at Oregon State University, actually having 10 times the impact on the climate as a hamburger being farmed out of rainforest-cut beef from the Amazon, for example. So really that cocktail shrimp could be having a much bigger impact, so unfortunately for all of us shrimp lovers at the moment, it's hard to find a sustainable shrimp source that isn't having a big effect on blue carbon destruction.

Jennifer Stock: Excellent connection for shrimp, it's always been about turtles and -- trawling for me, but now I have one more reason not to eat shrimp, which is great because I don't even eat it anyway because we cut it out because of the turtles. So thank you so much for sharing those ideas for learning more! I know for me, I'm feeling really empowered about the idea that I can share this new knowledge about the importance of these habitats, not just a habitat for animals, but a habitat for carbon! And adding that to my conversation when I educate others about the importance of these coastal wetlands, for removing carbon in the atmosphere. So thank you so much for your time today and for sharing this information with our listeners!

Dr. Ariana Sutton-Grier: Thank you for having me, this was great.

Jennifer Stock: Well then just in conversation about the importance of our coastal wetlands for sequestering carbon out of our atmosphere, we have less than 20% of these coastal ecosystem habitats on our planet, but as she mentioned they take about 50% up of the carbon. So huge, huge benefits for our atmosphere by helping to protect these coastal wetlands.

I'm gonna come back in a minute, and we're going to have a new segment airing on Ocean Currents today: "Positively Ocean", produced by Liz Fox of Berkeley. She produced this for Ocean Currents to focus on some of the positive stories about the ocean, and today gives a nice connection to what we've been talking about all day.

(Musical Interlude)

Liz Fox: Hi, this is Liz Fox at Positively Ocean, where we celebrate the ocean and look at what's working well. This week's story on Blue Carbon takes us to Richardson Bay in the northwest shallows of the San Francisco Bay.

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Blue Carbon
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Carbon is a problem when molecules drift from our cars and factories into the atmosphere. This combines with our ocean water, making our seas more acidic, making for some big losers in the delicate balance of ocean chemistry. Acidic waters disrupt shell formation in shellfish, even organisms as small as plankton depend on the right pH for their calciferous shell. And of course, that has a ripple effect on the food web for anything that eats zooplankton or shellfish, or anything that eats animals that eat shellfish or zooplankton, which is everything, almost.

But there are some big winners. When talking about blue carbon, think green! Phytoplankton, eelgrass, kelp, the marine actors play a crucial role in balancing the chemicals of our seas. Marine scientists estimate on a global scale, one acre of eelgrass can absorb more than twice as much carbon as an acre of forest. Here in the Bay, San Francisco State University professor Kathy Boyer, has done SCUBA gear with teams of students, researchers, and environmentalists to restore eelgrass beds. They're three years into a nine year project that aims to replenish 70 acres of *Zostera marina*. So far, their beds are thriving.

Kathy Boyer (On recording): Well, we have a couple of sites in the Bay that have been performing really well, and it's allowing us to expand to larger footprints over time, it's been exciting to see those sites are doing well over multiple years

Liz Fox: With a promising start, Boyer and her team test additional sites using small amounts of plants before sinking too many resources into areas that might not support eelgrass beds. And as the plants take root again, they start burying carbon, scientists don't really know how much though, since the variety of *Zostera marina* grows much larger and more sparsely than eelgrass elsewhere

So while scientists have collected the data, they're still calculating how much carbon our specific seagrass sequesters. Besides the carbon benefits, Boyer's restoration efforts supports habitats for spawning fish, mollusks, and the birds that feed on them. And what's more, voters in 9 bay area counties passed Measure AA last June, securing $25 million a year for habitat restoration. The measure passed with 69% of the vote, exceeding the two thirds majority, and it's the first regional parcel tax to pass in California ever!

Kathy Boyer: That's a nice chunk of change that should really, really push forward a lot of the efforts around the bay.

I think that the public really appreciates restoration, I think that they see it as they hopeful way of having their place in the local, natural world.

Liz Fox: This is an example of how people are doing right by the ocean, folks.
Until next time, I'll be searching for all things Positively Ocean. For Ocean Currents, this is Liz Fox in Berkeley, California.

(Musical Interlude)

Jennifer Stock: Yay, Positively Ocean with Liz Fox, focusing on eelgrass, Blue

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Carbon, the theme of today's show! Some of the main takeaways I heard were supporting local restoration efforts to help protect coastal wetlands and restore natural water flow, limiting development that can happen near these areas, and being really knowledgeable about the sources of shrimp if you choose to eat shrimp, being that some of the shrimp comes from these areas that are destroying these Blue Carbon sources, so another reason to source your seafood sustainably, and really understand it's source. So fantastic segment there about the concept of Blue Carbon.

Ocean Currents has a brand new Twitter feed if you are one of those people that uses Twitter. You can follow us @oceankwmr to get information related to the Ocean Currents radio program. And I'll post some of the websites of supporting each show there, if you're interested in learning more about the information and the guest on the show's topics, so check out @oceankwmr for more information about Ocean Currents programs! And I love hearing from listeners if you have questions, comments, or topics you can email me at cordellbank@noaa.gov or tweet @oceankwmr! Thanks so much for listening, this has been Ocean Currents on community radio at West Marin.

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