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

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Jennifer Stock: You're listening to Ocean Currents, a show where we talk about the blue watery part of our planet, the ocean. My name is Jennifer Stock and Ocean Currents is the first Monday of every month and on this show we talk with ocean experts about anything having to do with the blue part of our planet. We discussed conservation, management issues, science, explorations, education, ways to get involved and enjoy the ocean, and more. I bring this show to you from NOAA's Cordell Bank National Marine Sanctuary based in Point Reyes Station, California. The sanctuary is part of a network of 14 unique marine areas that are part of the NOAA National Marine Sanctuary program. Locally here off of the Marin Coast, many of you are aware we are lucky to have three contiguous areas that are overlapped with some of the most amazing, diverse, and biologically productive ecosystems in the world, although not completely….not vulnerable.

They are vulnerable and we're going to be talking about some of these large-scale vulnerabilities today on the show. We're going to be talking about climate change. So, when I come back in just a few minutes we'll have a couple different folks on the phone that have been very involved in identifying the current science that we know about today regarding climate change. I have Dr. Bill Sydeman from the Farallon Institute that will be joining us and Dr. John Largier from UC David Bodega Marine Lab. So, please stay with us. We'll be back in just a minute to talk a little bit more about the climate change impacts for the coast here of Gulf of the Farallones and Cordell Bank National Marine Sanctuaries.

(Music)

Jennifer Stock: If you're just tuning in, this is Jennifer Stock and this is Ocean Currents and on the phone with me I have two folks that have been very involved with identifying the current science that we know about today regarding climate change and helping to identify some of the future impacts. On global and regional scales, the ocean is changing due to increased atmospheric carbon dioxide and associated global climate change. This rapid change is larger than any solo, local regulation or oversight any agency can control. So,

today we're talking about these potential impacts for this region right here off the Marin Coast between Point Arena and Ano Nuevo. Locally, these two national marine sanctuaries here, the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries, with many, many partners and collaborators decided to look deeper at what this means for these extremely vital areas to the marine food web and humans.

The report titled, "Climate Change Impacts" was developed by a joint working group of the Gulf of the Farallones National Marine Sanctuary and Cordell Bank National Marine Sanctuary advisory councils and identifies and synthesizes potential impacts to habitats and biological communities along the north-central California Coast. So, I'm very pleased to welcome two well-known scientists that were part of this team. I have Bill Sydeman on the air. He is president and senior scientist of the Farallon Institute, which emphasizes long-term multi-species multidisciplinary research into the inter-dependent aspects of the marine environment including the effects of natural and human-based climate change and the broad implications and influences on ocean currents, weather patterns, fishing practices, and coastal development on marine food webs and ecosystem processes. Bill is very familiar with plankton to predator studies in the California Current, doing some long-term studies here. So, Bill, welcome to the show. You're live on the air.

Bill Sydeman: Thank you very much. Good Afternoon.

Jennifer Stock: And I also have Dr. John Largier who is a professor of coastal oceanography at UC David Bodega Marine Lab and John focuses his research on coastal oceanography and ecology, specifically focusing on Bays and upwelling regions, estuaries, and nearshore circulation of water. John is also a member of the Gulf of the Farallones Sanctuary Advisory Council and has been on the show before and I'm delighted to welcome him back. So, welcome, John. You're live on the air.

John Largier: Thanks, Jennifer.

Jennifer Stock: Thank you so much, both of you, for taking this time on this federal holiday to share your expertise with our listening audience. You both have such in-depth knowledge of this region in terms of the way things work on the coast and such intricacies. So, thank you so much. John, I want to start with you. As a lead author on this report, can you give us some background on the diversity of science that is addressed in this report and some of the collaborators that you might want to identify?

John Largier: Yeah, Jennifer. The report really is asking the question, "So, we know climate change is happening, but what will it mean for us here?" Particularly for our ecosystems, not just is it getting warmer, but what about all the marine populations and how they interact into this rich food web. So, that's a tall order both…for two reasons. One is the ecosystem, of course, is complicated, the other is because we're looking at one region, not at the earth…not the average of the earth. So, as we look at it, we start off with the physics of it. If the Earth is warming up, then perhaps the temperatures are warming up here, but even that is not so clear.

The sea levels rising around the Earth…it's clearly rising here in our region and so, as we get from the physics and look towards the chemistry of the ocean towards biology at the lower trophic levels or lower at planktonic and all the life forms and really try to work the whole way through up to the birds, the mammals, the whales, et cetera and as one gets more and more into the system, it gets more and more complicated. So, in our results, there were probably about ten key points that we bulleted in the executive summary and the ones like the sea level is rising is things that we are completely certain about.

Exactly how fast is the question, but at the other end, what is going to happen to the ecosystem…really difficult to predict. So, our approach is to use the best available scientific knowledge to identify things that could happen. So, just the fact that we don't know exactly what's going to happen doesn't stop us from saying, "These are likely scenarios of what could happen," and we focused on things which are more likely or we're more certain about as well as things which are more threatening. There are a couple of things that might happen to our ocean with climate change. Most recent, just in the last, really, several years, there's been a lot of attention going towards that our oceans are becoming more acidic. We're in the early days of research on that, but if our oceans get more acidic, it would just be devastating and not just to the corals and the tropical areas, but to a lot of our plankton and nearshore shellfish along this coast as well.

So, a diversity of things. In terms of people, I'd love to mention everybody because it really was a community effort. We got together a few different times in workshop settings, but also spent a lot of time in a collaborative writing phase. On the other hand, I don't really want to call out anybody particular, because then I'll have to mention twenty or thirty other people, but I'll just say it was a real collaboration, not only with sanctuary staff and

sanctuary scientists, but also with the Universities with other research organizations like the Farallon Institute and with other government research groups and NOAA with the state scientists. It really was a very rich collaboration of people who are working in this area and know this place as well as anybody can know it.

Jennifer Stock: Do you find that having an opportunity like this…this was about a year and a half of meeting and writing. Did you find the opportunity to be a good place for scientists to come together to discuss what they had been working on independently, but really rallying around this huge topic?

John Largier: Yeah. It was rewarding in the way of getting together and really trying to deal with a major challenge to the Earth and to humans, really. I love to say the ecosystem will continue. It might be very different and it probably won't suit us quite as well as it does now, but it was also frustrating because it is so difficult to figure it out and there's a lot more we can learn and we're trying to learn as fast as we can and that is actually, sort of, a limiting factor in terms of being able to comment on the future state of the oceans and the changed climate. There is a lot to be learned and that was sort of frustrating because you'd come up with questions that we're pretty sure we can get the answer to, but we don't have it now.

Jennifer Stock: Interesting. So, one of the things I'm curious about as I was reading through the report and there's such great information in it. I'll give the web address a couple of times throughout the show. You can go to farallones.noaa.gov for anybody that wants to download this report, but it's well-written in terms of people that are not scientists being able to understand it. So, I really appreciated that, but one of the things that came to mind for me is how do scientists attribute the recent changes in climate change in terms of comparing it to the natural fluctuations that we have on this very variable ocean ecosystem? There's yearly cycles, decadal cycles, multi-decadal cycles and how do we look at those things together in terms of really identifying climate-related ones?

John Largier: Yeah. Well, you're really putting your finger on one of the difficulties in understanding change because there are, just like you say, there are these cycles and you can identify many and the seasonal one is obvious to all of us, but the other one that has become pretty obvious is the El Nino and La Nina and if you just talk about upwelling, then some years will swell more strongly than others and there are longer decadal cycles, as you say, Pacific decadal oscillation is well known.

Perhaps one of the more well-known things accosted with that is Cannery Road and the decline of fisheries in the late 40's, 50's, and we go through these warm and cool periods. So, how we do it is difficult and this is where the length of the record is important as well as scientific understanding and the use, sometimes, of computer models to say, "Could this be due to an underlying trend?" But where we have long-term data like sea level, in San Francisco Bay it's one of the oldest…I think it may actually be the oldest tide gauge, since about the 1850's…well, of course the earthquake messes that a bit, but we have at least 100 years now of really good data on sea level near the mouth of San Francisco Bay.

So, on that you can start seeing the cycles and you can see an underlying trend very clearly, but where we have ecological data, it tends to be a shorter period and Bill probably can comment on this better than I can, but even if you have 30 years of data, you still have to continue questioning if it's a cycle, but there are aspects of spatial structure or understanding the underlying dynamics allow one to say, "We really don't think this is a cycle. This is something more fundamental"

Jennifer Stock: Bill, do you want to comment on that in terms of data sources and the length of time we have data for to compare to?

Bill Sydeman: Sure. The, I mean, as John just mentioned, this is a real limitation in what we can say with any degree of certainty because of our biological records, the ecological records tend to be much shorter than the physical records, for example, sea level, which is probably the best one we have at 100 years. In terms of biology, we're looking at the best, the longest term records may be in the realm of 30 to 40 years and so, that doesn't even contain a full cycle of the Pacific Decadal Oscillation, which supposedly operates on the scale of 50 to 60 years. So, it's a real problem.

Now, that said, one of the things that we've done, and I think this is telling, is when you see unusual events, failures of birds, let's say, and their reproductive activities, or invasion of the large…the Humboldt squid, the jumbo squid of recent years into the system, these things are occurring during both, let's say, positive and negative times of the Pacific Decadal Oscillation. So, and then there can be trends in the data as well and so, in those cases, you can say with a fair degree of certainty that it doesn't have anything to do with this long-term variability, the cycles that we're seeing. It has something to do with either a longer-term trend or something that's just unusual in the system.

So, I think those are the kinds of ways that we go about making these attributions, but attribution in terms of biology, be it in the climate change report that we prepared for the sanctuary or the IPCC, this is very, very tricky business and this is where everybody starts using the word, "Uncertainty," and it is difficult.

Jennifer Stock: You just mentioned the jumbo squid as one and I'm glad you brought that up in terms of some ways you're able to identify something more likely contributing to climate change, but for both of you, having a lot of time and experience here in the California Current ecosystem, are there some long-term changes that you've seen that you believe are related to climate change? And I know some of these are also referenced in the report as well. So, Bill, why don't we start with you?

Bill Sydeman: Well, I mean, there's sort of a host of changes that we believe are related to climate change. I think that the Humboldt squid, to me, is one of the prime examples of something that just doesn't fit with what we used to see in the ecosystem where Humboldt squid would come in and then they'd leave. They'd come into the system, typically during El Nino events, and then leave when the waters returned to a more normal temperature.

Now, they just don't leave, which would suggest that the waters…that there's a new available niche for them to fill in warmer waters, possibly lower oxygenated waters. So, that's a prime example I think, of maybe one of the better examples. We've seen changes in distribution, range expansions mainly to the north of inter-tidal organisms, rocky inter-tidal. One of the species, I believe, is the volcano barnacle that now occupies a range further to the north than it used to.

So, what we're seeing here in general, is a change in the community organization, the community structure from a community that was more of what we might call a subarctic type of community to a community that's got more subtropical species and those changes in individual species, of course, have implications for species interactions in the ecosystem, in the community, and those are…that's when we start really not understanding things very well. It's when you start asking the question, "What are the implications, the ecological implications, of those changes?"

There's also been…recently there was auklet reproductive failure on the Farallones in 2005, 2006, to a lesser extent in 2007. Those failures were unprecedented when they occurred and while I

wouldn't really want to say that because something is unprecedented that it necessarily has to do with climate change, that really is another example of something that leads you towards that conclusion. I'll stop there.

Jennifer Stock: That sounds good. How about you, John, have you seen some changes that you believe may be related to climate change in your work with oceanography and tracking currents and water masses?

John Largier: Definitely. I mean, as I was trying to say in the introduction, the more physical, sort of, foundation of the ecosystems…there are clear changes, partly because we have longer data, but also because it's more what we call deterministic. If you have a balancing book and you push it, you know it's going to fall over, that's determinism. And other things are more probabilistic, that they may happen, and so, Bill's identified a number of things that we know are happening and exactly how the ecosystems going to respond and feedback is the question, but on the more physical aspect, yes.

The rising sea level, the increasing coastal erosion, the reduced snow pack in the Sierras, which leads more to more winter rain and less in spring, quite important to the ocean as well, the increasing variability in precipitation, more winter storms and wetter wet years and drier dry years, the increasing temperature, and this is an interesting one because offshore, out in the California Current, the surface temperatures are increasing and in the Bays, they seem to be increasing as well, but in between the two, we have this process of upwelling of cold waters and that seems to be getting stronger. So, over the continental shelf, the waters are probably cooling, that appears to be the case, whereas warming offshore and near shore.

The winter waves are getting better. Again, that ties into storms. All of those features are…there are varying levels of certainty, but I think all really are fairly clear trends and there are long enough records and they make sense with our global understanding of changing climate. So, they're all fairly reliable things that we, on the period of the record that we are pretty sure are happening, but as you get into the ecosystem and you have thirty different or 300 different players or components in the ecosystem and they're all responding to the changing environment, who's going to win the game when you're competing for food or you're competing for space or you have a synergy helping each other.

As you knock one player in this ecosystem, it has a ripple effect and so, that's where there are a couple like the Humboldt squid,

jumbo squid, and volcano barnacle and so on where we're seeing clear climate-related movements and arrangement and grey whales are coming up here more than they have and some of these species, you can dig back into time as well and using non-quantitative records of people's memories and what's been documented, sort of, historical ecology, but anyway, yes. It's very clear the physical environment is definitely changing. There's no doubt about that.

Jennifer Stock: And many of those things that you mentioned actually have quite a tie to humans and we'll talk a little bit more about that towards the end, but one of the things you mentioned, and another thing I read in the report that I think people might be confused by is, we're told upwelling is really such an important part of the food web here, really important for the seabirds, the fisheries, the whales, everything depends on that and there are predictions that there will be increased upwelling, stronger winds, more upwelling. Can you explain why this may not be such a good thing in the long run?

John Largier: Yeah. Well, I would prefer not to cola things good and bad because the environment is changing, the climate is changing and there will be different responses and perhaps when you look at the benefits to humans you could say it'll be good for us or bad for us. I'm not sure, but things will change. So, actually, a study that a graduate student of mine did using 30-year records we have showing increased upwelling off the coast here, but it ties in with some previous studies and model studies and hypothesis. So, it's gaining strength that the upwelling is increasing.

So, that part of the place where the ecosystem is what we don't really know, but I can think of a scenario where it might be good or make it more productive because you're brining up more nutrients to the light-filled surface layers of the ocean. So, you're having more primary production. There's more green matter for things to graze on, but at the same time, if you've been on the coast, which most of the listeners have, I'm sure you know the winds blow really strongly and the currents become quite strong as well.

So, a lot of the surface water is moving rapidly offshore and down the coast and if you move it offshore and away from the coast too rapidly, all the good stuff is going to be offshore. You'll end up with a situation that in southern Namibia you see quite a lot. The upwelling is really strong and really persistent and so, near the coast, you mostly just have newly upwelled water that's full of nutrients, but there's not all that much living matter in it and then

you have to move offshore to get that rich soup of planktonic organisms that is so important in the Gulf of the Farallones.

The reason why the Gulf of the Farallones and Cordell Bank is full of fish and birds and mammals and so on, things higher up the ecosystem is because plankton is produced in that region and it's retained in that region and it can move up the food chain. So, it could reduce the productivity of the Farallones and Cordell ecosystems, but we don't know exactly how it will play out.

Jennifer Stock: And is there also the potential for some of the waters that get upwelled to bring up more acidic waters? I understand that there's more acidic water at depth. I'm wondering if you could explain that a little bit.

John Largier: Yes, exactly. Well, you know this is a big issue. Thanks for introducing it. Ocean acidification is the phrase we're using for it. Basically, waters in the ocean can become more corrosive and it's really, really important for things that form calcium carbonate structures, whether it be a skeleton or a shell and various other structures like that. If the pH of the ocean, the oceans become more acidic, then they really struggle to form those hard structures. So, the question is, "How does it work?" Well, it's all about carbon dioxide again. That's the primary thing.

So, the ocean has been helping us out really well as we've increased the carbon dioxide in the atmosphere from 280 parts per million to 380, 390 parts per million, a huge increase. It's less than it would have been if the ocean weren't sucking up a lot of the CO2. So, the ocean has helped us out there, but as the oceans increase with Carbon Dioxide, the CO2, it changes this balance in the formation of hydrogen ions and changes the pH of the ocean. So, the oceans are slowly getting more acidic, very slightly so, but enough to be a real ecological problem. How does upwelling play into it? Well, there's the CO2 at depth…the carbon dioxide is a high concentration at depth and then this deep water gets upwelled along the side of the contentment along California, Mexico, Peru, Chile and other places in the ocean and so, that's where you get the waters that are richest in carbon dioxide and as a result, lowest in pH, almost acidic.

The question is, as you say, the upwelling increases and you're bringing waters from greater depths, they're colder and more acidic. So, there's sort of a double whammy there if you're making the oceans in general more acidic and you're bringing up water from greater depths, then our coast along here in California and

upwelling region is sort of at the bleeding edge. It's really going to see the lowest pH and the most severe and sooner than other places. It's really concerning and we're trying to get a handle on how bad is it or would it be…when the waters that are upwelling here and now, maybe were formed 50 years ago. So, it's quite a complex problem and I'll just leave it at that.

Jennifer Stock: It's really interesting just to hear. A lot of us don't think about how water moves and how it influences everything else biologically and the things you're talking about here, we're getting a picture of different depths of the ocean and how things are stratified and they move and they effect other things. So, thank you for describing that. It's already 1:30. We're coming up here on a break and I want to talk a little bit more on the second half, a little bit more about some of the biological processes and changes and what could happen.

There's a couple different options there and some of the impact to humans. So, Bill and John, please stay on the line with us. I'm going to put you on hold for a little bit. For those of you just tuning in, you are listening to Ocean Currents on KWMR. My name is Jennifer Stock and we have Dr. John Largier from Bodega Marine Lab, UC Davis on the phone as well as Dr. Bill Sydeman from the Farallon Institute and we're talking about some of the potential changes from climate change that we might receive here in our large ecosystem right of the coast here, the Marin-Sonoma coast and our national marine sanctuaries and beyond. So, stay with us. On the next half hour, we'll continue to discuss that. I'll be back in just a moment.

(Music)

Jennifer Stock: This is Jennifer Stock. You're listening to Ocean Currents on KWMR and on this show today, we're talking with two scientists in the region who have been working on the current science and where we're headed with climate change and the impacts that we might receive here in our ecosystem and we just finished off the last half hour talking a bit about ocean acidification and upwelling and how we're getting more upwelled waters that may have more carbon dioxide….or, more acidic waters that can effect the food web.

Bill, I want to ask you, one of the potential responses for individuals and populations in the ocean, we were talking a little bit earlier about some range expansion, but there are a couple other things that were mentioned in terms of options for populations to

react to this changed ecosystem and I'm wondering if you can go into that a little bit or what are those options for the different animals and plants in terms of adapting to these changed ocean conditions?

Bill Sydeman: That's a very good question. Let's see. I think one place to start is just to think about individual species or, as you say, populations are composed of individuals and that those individuals can alter their behavior in different ways to adapt to changes in their environment and also to maintain what we call their inclusive fitness, which essentially is the production of offspring that then re-enter the population years later when they reach maturity and I think one of the big changes that we're expecting, this has not necessarily been demonstrated in our system here, but globally, it's been demonstrated that there would be a change in the growing season and that there would be an advancement in when, let's say, the phytoplankton blooms and the zooplankton blooms occurred in the Gulf of the Farallones marine ecosystem.

So, things are supposed to get earlier and the predators that are then dependent upon those parts of the ecosystem for food, they could respond by tracking the changes in the timing, if you will, of the phytoplankton blooms or the zooplankton blooms by also getting earlier. Now, there is some evidence that this is actually going on. We've seen an advancement in, let's say, the laying dates of common murres, a species of seabird on the Farallon Islands. They've gotten earlier by about 20 days over the last 30 years.

So, almost a day a year, but there's a limit to how far they can change and that limit is set by photoperiod. So, in other words, the birds may get earlier to track the changes in their prey base, but they may not be able to adapt all the way because there are other things that start to play a role in terms of when they lay their eggs each year. So, these are some of the complexities that we were talking about earlier in the show about the ecosystem and the response of the ecosystem. We're not sure how different species are going to be able to respond and how those ecological interactions will actually change, but the timing is one of those things that we're particularly interested in and, again, there's pretty good evidence that in different places around the globe that the spring is getting earlier and that does have some implications.

Jennifer Stock: Yeah. It was interesting you said about the photoperiod, that's true in terms of how many days of daylight we have in terms of phytoplankton reproduction and the timing of all that. How about species that are more resilient than others? Are there some species

that we have here that are more resilient and will be able to adapt to these big changes and stay put or maybe even thrive?

Bill Sydeman: Yes, absolutely. What we like to call winners and losers. I think we mentioned this earlier, there are species that are certainly more resilient. They tend to be the species that are…one would term more of a generalist. they are able to adapt to human dominated landscapes, for example, gulls, western gulls, species like that. They eat anything that you put in front of them. They're not reliant on one or two prey items and should those prey items disappear from the environment, then those species have trouble.

These are species that are able to eat anything and also, species that are able to search for food over a wider geographic range, they tend to be more resilient. So, we have, let's say, well, harbor seals at Point Reyes, you know, they're pretty much restricted to the Gulf of the Farallones region whereas an elephant seal, they may reproduce on the Farallon Islands or at Point Reyes or at Ano Nuevo, but they forage in the central north Pacific and as far north as the Aleutian Islands. So, and certain species are more resilient and that resiliency also has to do with the distance that they can travel to find food.

Jennifer Stock: Interesting. That's interesting about some of them just having to stay here. Some of them have a broader range that they can adapt in and deal with. How about…this is a little detour, but for 2010, I've been hearing a lot of people say, "These are some of the coldest sea surface temperatures we've had. What is your thoughts on this year's upwelling in terms of it being a productive year in terms of krill production and how are we doing in terms of this year and is this related to the La Nina event or where are we at right now with our spring upwelling season?

Bill Sydeman: Well, we've shifted very rapidly into a cold water situation. We went through about eight or nine months of a weak to moderate, depending on how you define it, El Nino event. It started in 2009. It was relatively weak in terms of its effects. It was also not, sort of, your eastern tropical Pacific El Nino. It was what's known as a western tropical Pacific El Nino and they're much more shorter lived and not as intense and now we've transitioned to more of a colder situation.

I think we're headed towards a rather mediocre year in terms of overall productivity because generally what happens during the winter period, during January, February, and March, is predictive of how well the season turns out. It can get a little bit better, but

generally if the winter productivity, if the winter season is off in some way as it was this year, then that translates to poor to moderate sort of productivity. So, even though the upwelling system has kind of kicked in now and there is krill in the environment and in some cases, things are doing well, I think overall when we look back upon 2010 we're going to say that it was kind of the result of a weak El Nino event and not particularly productive.

Jennifer Stock: Interesting. Thanks for explaining that. So, we have about 5, 10 minutes left in terms of talking about some of this climate change and I just want to transition a little bit more into some of these impacts to humans and that's one of the main things the sanctuaries are going to be looking at in terms of how are we going to respond with the management authority we have to help protect the ecosystem, but also to help humans adapt with this that are living along the coast specifically.

So, John you were mentioning earlier a lot about snow pack and rainfall and the impact that could have on the changes that we could have there with that and could you translate that a little bit more into some of the…how does that translate down to humans in terms of water? You know, this year we had a pretty good year of rain and the reservoirs filled up, but what could the next few years look like?

John Largier: Yeah. So, just to reiterate for the listeners. The idea that you put forward earlier that there are climate fluctuations and there are climate trends and so, what we've been talking about is El Nino and La Nina and things like this are fluctuations superimposed upon some underlying trend. So, the real climate change problem is trying to understand that trend that underlies it. Although, these fluctuations can create problems for us humans as well as birds as well as describing…the El Nino got it's name from Peru because it's really created havoc for the fisheries there, but fluctuations are a problem, but they have always been around.

This underlying trend is, as I was saying, not only an issue for the ecosystem, but for humans. The reports that Bill and I and others worked on and was directed at trying to understand the ecosystem impact, but humans are part of that ecosystem. So, we looked at it to some extent, but not in a lot of depth. The, as you said, the changing snow pack in the Sierras is a huge issue for humans directly and economically and in many other ways. The snow on the Sierras is really a big reservoir of water. Since it slowly

releases water all through the spring and it's only around about now that the flows start really decreasing.

Now, if there's snow pack then that reservoir is not there and the question becomes how do we manage our water because we're going to run short of it earlier in the year? So, there are big issues like that. Sea level rise, coastal erosion, flooding of water into coastal communities, coastal towns and villagers and not only on to the road, but down into the pipes which take our waste water to the ocean. All sorts of issues. The key thing we focused on was how do those humans respond to those things and therefore maybe aggravate or hopefully mitigate, but more likely aggravate, the impact to the ecosystem.

So, if rains flow in the rivers through the delta and so on are really low in springtime, the sort of human response is to take more of it because there's less of it and therefore the ecosystem is probably going to get a doubly whammy. So, that could be a real problem…the same thing with sea level rise and bigger waves and shoreline erosion. Left alone, the people that own the land along the shoreline are probably going to want to build sea walls. It's becoming more difficult, but if they do, that then in turn sort of deflects the erosion and creates bigger erosion problems elsewhere.

So, there's a real…the way humans respond to the direct effects are going to aggregate or mitigate and most likely aggregate the impact on the ecosystem, which, in the end, provides the ecological goods and services. There are a lot of things we get from the ocean, like we catch fish and we eat them. That would be good, but there are many services, a lot of the clean air we have, a lot of the other benefits we get are directly from having a healthy ocean ecosystem. So, that is a primary…there were two human aspects. That is the one approach we took.

The other one that is very important is if you're interested in this ecosystem, Cordell and Farallones ecosystem, it's getting stressed out in a variety of different ways. One of them is it's changing climates. The other more direct way is that we impact the ocean and I think we're all familiar with that we do pollute our ocean, that we do take fish out of it, that we do a variety of things to the ocean and if we keep them under control, maybe we don't damage the ocean too much, and that is the question of, we call them parallel stresses, things that are in parallel of climate change also stressing the ocean.

Why that becomes important is because these are things that we can control. As a society, we can decide we're not going to catch any more fish. I'm not suggesting it, but it's something we could do. As a society we can't say we don't want any climate change next year because we already committed to it. We've probably…50 or 100 years of commitment to it already. So, taking this more holistic approach and making sure that the Gulf of the Farallones ecosystem, Cordell Bank, wherever you're interested in is the vital, healthy, and therefore resilient ecosystem.

Jennifer Stock: So, really reducing the human impacts as much as we possibly can is one way to help restore some vitality to adapt to these changes, it seems.

John Largier: Yeah, exactly and so, that's easy to say, but I think as part of the action plan maybe that the sanctuaries need to take on working with other collaborative agencies is what exactly does that mean and what actions…or what things we think are stressing out the system the most and what can we realistically reduce the stress?

How can we realistically reduce the stress? The analogy I like to use for that is if it's flu season, the best thing you can do is be well-rested, eat well, exercise, make sure your body is healthy and the chances of getting flu are very low. Your body is resilient. You can handle it naturally and the same thing with ecosystems. As a whole, there might be some species that are getting knocked pretty badly. As a whole, I think what we can hope…well, we know the ecosystem is going to handle climate change much better if its healthy than if it's totally stressed out.

Jennifer Stock: It's also kind of like restoring native vegetation. We have ice plant that covers certain areas. As soon as you remove it, it just seems to bounce back. It's pretty amazing, the resiliency that nature holds. We're coming close to the end here and I just want to ask both of you, what are your key recommendations for both the coastal managers, utility managers, coastal towns, government to deal with these fast-paced changes as well as what are your recommendations for everyday people like us every day to help be more prepared for these changes in addition to looking for solutions to slowing down this input of carbon.

So, both the people who are the decision-makers as well as those that are most effected by this, the majority of us. What are your key recommendations and Bill, how about we start with you?

Bill Sydeman: Well, tough question, of course, but I think that my main recommendation in this regard is that people keep their eyes open to things that not only effect themselves or effect a particular interest that they may have, but that they keep an eye on what's effecting other people in other sectors of society and I say that and John just touched upon it, because the issue of climate change and the way that it will effect different sectors and we can't really manage on a sector by sector basis.

We now have to work together and this is what people are calling the ecosystem-based approach to management where all of the agencies, all of the local and state, federal groups that deal, let's say, with the Gulf of the Farallones, really need to be working together in a cooperative format and paying attention to what's effecting the other person sitting on the table, sitting at the table with you and I think that that's kind of my main recommendation in terms of the agency side of things is don't get too overly focused on your own agenda, if you will.

For the individual person, I think that we all do things on a daily basis that contribute to or can contribute to this issue of global warming of climate change, there are some pretty fundamental lifestyle changes that need to happen in order to minimize this process that we've put in place that now will last no matter what we do for decades, if not centuries, and I think that, again, people need to be cognizant of what they're doing and try to take steps to conserve and do all the sorts of things that we've known we should do for a long period of time and some people do and some people don't, but I think now, you have this global problem and it really is global, and everybody contributes to it and by making changes in your lifestyle that change that global problem, then I think you have an effect locally and that's really what you want to do.

So, you know, just be aware of what you're doing and how it may contribute to this overall issue that we're facing as a planet and as a society.

Jennifer Stock: I'll just add to that. In the education outreach world that I work so much a part of, this is such a challenge for us, this climate change communication because people are a little burnt out hearing it and it's such a big scale lifestyle change that it's very difficult to change people's behavior and we're really struggling in our communities, but youth seem to be the power in terms of effecting change and there's a lot of focused efforts going towards younger communities to help be more adaptive and willing to change. John, how about you?

Do you want to add to that in terms of recommendations that you see for the main things we should be focusing on…coastal managers in towns and what not for being ready for this.

John Largier: I think underlying there were two things being said…we really have to both, in our individual behavior and in our political choices, we have to deal with the reality of climate change and the fact that we have a 50 year commitment or a 100 year commitment from things we've done over the last century doesn't mean it's not super urgent to get on top of it right now. So, that is the critical thing.

The other thing we said before if we're interested in the ecosystem and it's probably true for socioeconomic systems as well, if we want them to be sustained, then there are a variety of ways that the ecosystem is being stressed and climate change is just one of them, but we definitely can reduce things like pollution and that leads into the third point is…we don't really understand nearly enough about the ocean and also, even terrestrial ecosystems, but particularly ecosystems in water because we are terrestrial organisms and we don't live there, but what are the things that are really going to matter and what are the things which are going to change the ecosystem and we can life with it? So, I think that is important, that we understand and we improve our knowledge so we can make the right choices and not waste our energy and effort going after ghosts or things that we could have figured out were not going to be as severe of problems.

So, that's sort of a pitch for research, but it's more than research. It's knowledge in a society working together and then the fourth one is policy, that our policies tend to get stuck in a rut and if the system is changing, we need to have policies that can adapt and get reviewed every several years, probably, and then we can not carry on doing things that worked back 50 or 100 years ago, but that our policies can be adaptive and nimble and make us head in the right direction.

Jennifer Stock: And I think that points right back to us as humans in terms of being voting citizens and being very aware of who we're voting for and what we're voting for. So, thanks for bringing that up in terms of us being able to be adaptive and forward thinking. John and Bill, I just want to say thank you so much. This hour has flown by and I really appreciate your time and sharing your comments on the climate change impacts report. Any last words from either of you?

John Largier: I just want to thank you for focusing attention on this and keeping the dialogue going and through this encouraging others to think about this and how they individually and politically as a group can make things different because we can get on top of this issue, but it requires all of us to work together.

Jennifer Stock: Great.

Bill Sydeman: Yeah, thank you very much, Jennifer. I think it's been a very productive conversation and hopefully we get to do it again in the future.

Jennifer Stock: Thank you so much. Have a wonderful rest of your Monday. I really appreciate you coming on the show today. Take care.

John Largier: Thank you.

Bill Sydeman: Thank you.

John Largier: Bye, Jennifer.

Bill Sydeman: Bye bye.

Jennifer Stock: Bye bye. So, we've just been talking with Dr. John Largier from UC Davis Bodega Marine Lab and Dr. Bill Sydeman from the Farallones Institute, two local scientists that have been part of a big group dealing with climate change impacts and making recommendations and compiling current science and knowledge about the climate situation that we have as it relates to the ocean and a summary report was put together for both the Gulf of the Farallones and Cordell Bank sanctuaries to start to put plans in place to do some adaptive management.

How are we going to move forward in the next ten years to best protect these ecosystems and, like John and Bill said, try to make them as resilient as possible for some of the changes we might be having. So, I wanted to direct attention to you to see that there is an executive summary that is a summary of the whole report, much shorter, and there's also the other report is a little bit longer, but so full of really good information, natural history of this region that is very readable for those of us that are not scientists and you can get this report either at the Cordell Bank or Farallones websites.

So, that's Cordell Bank C-O-R-D-E-L-L-B-A-N-K dot N-O-A-A dot G-O-V or Farallones dot N-O-A-A dot G-O-V. Gulf of the

Farallones National Marine Sanctuary really spearheaded this effort and put staff towards managing it and making it happen. So, want to thank them for including Cordell Bank Sanctuary in that as well in the study area.

So, check out the report, climate change impacts, and kind of tying along with some of the ecosystem and habitat responses we were talking about, I just thought I'd announce, you've probably heard in the news that the Cordell Bank Sanctuary just returned from a cruise offshore, part of a deep sea coral cruise that took place from Olympic Coast National Marine Sanctuary up in Washington all the way down to Channel Islands National Marine Sanctuary off of Santa Barbara and we did, despite some very challenging weather conditions and technology challenges, did get a chance to dive in the further western part of the Cordell Bank sanctuary, which…just west of Cordell Bank, drops pretty deep and they had a chance to dive in some pretty deep waters, between 300 and 400 meters with this remotely operated vehicle, this underwater camera and robot and during these dives, they had an opportunity to see some deep sea coral habitats that we didn't know were part of the sanctuary.

We had a feeling they were there, there were some records, but now we have a better sense of some of the corals and habitats that we have on that western part of the sanctuary.

So, they had about 100 observations of six different deep sea corals and some of you may be wondering, deep sea corals, but they are here. These are animals that use the deep, the detritus that washes down from the upper part of the water column down to the sea floor and live at depth. So, very very interesting.

You can keep an eye on the blog from the expedition and you can link to that from the Cordell Bank National Marine Sanctuary website, see some pictures of these corals and hear from scientists about the challenges of sampling out there.

So, cordellbank.noaa.gov. There's a link to our expedition page for that, but we're just about out of time today for Ocean Currents. You can always download past shows or sign up for our podcast at cordellbank.noaa.gov. Thanks so much for tuning in. It's Jennifer Stock, Ocean Currents and you're listening to KWMR, Rick Clark will be up next. Take care.

(Music)

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