

*April 4th, 2016, oc040416.mp3*  
*Restoring White abalone: From the Lab to the Wild*  
*Jennifer Stock, Melissa Neuman, Kristin Aquilino*

*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.

*Jennifer Stock:* 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, authors and more. All uncovering and learning about the mysterious and vital part of our planet, the blue ocean. I bring this show to you monthly from NOAA's Cordell Bank National Marine Sanctuary, one of four national marine sanctuaries in California all working to protect unique and biologically diverse ecosystems. Just offshore of the KWMR listening area on the west Marin Coast, are The Greater Farallones and Cordell Bank National Marine Sanctuaries, which together protect 4,581 square miles.

So on today's program we're focusing on the recovery efforts NOAA is leading with the historic abundant, iconic, and yummy snail, the White abalone. It was not so long ago that beach goers could pluck abalone from any tide pool in Southern California, but that's not the case anymore as they face potential extinction during our lifetime. So when we come back in just a few moments, we're going to be talking to NOAA Fisheries abalone recovery coordinator Melissa Newman and Kristin Aquilino a post doctoral scholar at UC Davis Bodega Marine Lab, who's helping play a key role in recovery efforts. Stick with us here on Ocean Currents.

*Jennifer Stock:* Allright and we're back. Welcome back to Ocean Currents. This is Jennifer Stock and today we are talking about white abalone, an iconic species for California, but in quite a bit of trouble and the National Oceanic and Atmospheric Administration has a recovery plan to help bring about a return in this population, hopefully for the long run. And on the phone with us is Melissa Newman from the NOAA National Marine Fisheries Service, and she is the abalone recovery coordinator. Melissa you're live on KWMR.

*Melissa Neuman:* Hi Jennifer. Thanks for having me today.

*Jennifer Stock:* Welcome, thanks for joining us. And also here in the studio, I have the person who's in charge of helping with the aquaculture and the recovery of these by doing some propagation in the lab, Kristin Aquilino at UC Davis Marine Lab and she happens to be right here in the studio. So welcome Kristin.

*Kristin Aquilino:* Thanks very much.

*Jennifer Stock:* I wanted to start with you Melissa. In 2001, white abalone became the first marine invertebrate to be listed as an endangered species. Can you take us

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back to what led to the listing and the intense recovery efforts that you have been such a big part of?

*Melissa Neuman:* Sure. I am not sure how many of your listeners know how important abalone were to the commercial fishery here in California in the 1940's, 50's, 60's, and into the 70's. But, in case they didn't know it was big business in California for a very long time. Prior to that of course it was very important culturally to the indigenous people who lived in California. But with the advent of better fishing methods being able to refrigerate abalone on boats, more and more abalone were taken through the 1950's and 60's. And with regard to white abalone, the height of the fishery really occurred in about 1972 when 140,000 thousand pounds of white abalone were collected.

Over 90 percent of the white abalone that were collected in the commercial harvest from, which lasted about ten years, came from San Clemente Island and the offshore banks so a large number of those animals came from, a relatively small geographic area in Southern California. The species was hit very hard by the fishery. They were considered be a rare species even prior to the fishery really getting going on them and, and then it was just hard in roughly a ten year period their numbers, dwindled steadily, until about 1979 or 1980 when very few white abalone were collected in the commercial fishery. The recreational fishery mirrored that and peaked in about 1975 when 1,600 animals were taken in that year. One of the problematic things that occurred during this fishery was that as the species was getting fished down the monetary value of the species actually rose. So as they became more rare the price per pound went up and so the demand for the species actually stayed high. They were in high demand because according to those who fished them and ate them back in those days they were actually the tastiest of all the California abalone species and that's why they fetched such a high price on the commercial market. Anyway, what you should know is that the species ranges down into Baja California Mexico into central Baja California actually. And the harvest trends of white abalone, in Mexico, as best we can tell mirrored what happened in California.

So as the fishery was declining in California, in the 1970s the same thing was happening in Mexico. And this prompted the California Department of Fish and Game at the time, now the California Department of Fish and Wildlife, to close the fishery for white, green, and pink abalone in 1996. And then in 1997, all fishing for abalone in California was closed except for red abalone fishery north of San Francisco.

And it's really this over fishing, pressure that occurred in the height of the fishery that brought the species to the brink of extinction. What that fishery did was it reduced the densities of White abalone to such a level that what we think is happening now in the wild is that we have some remnant

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populations but the animals are just too far apart from one another in order to spawn successfully. So low density or low abundance is really the approximate threat to the species that was produced because of overfishing. And our main efforts and what we highlight in our recovery plan that was published by the National Marine Fisheries Service in 2008 is to try and boost those numbers in the wild.

*Jennifer Stock:* Wonderful overview about the abalone in general. One of the questions that came up for me when you were talking about how they're still some out there and thinking about that timeliness of recovery efforts, is what is the life span for an abalone?

*Melissa Neuman:* Well, we think that abalone can live to be 35 to 40 years old.

*Jennifer Stock:* Oh.

*Melissa Neuman:* There was a "radio-bomb" paper published a few years back that actually substantiated the fact that abalone can live to be at least 30 years old. So we're thinking that they probably can live, at least to 30, 35 years probably 40 years.

*Jennifer Stock:* Wow that's incredible. That's actually really helpful for this recovery plan overall, I would think. So, we have several species of abalone in California and our whites typically in south you said they go down range to Baja, but what would be the northern range for white abalone?

*Jennifer Stock:* The northern limit of the range is said to be Point Conception.

*Jennifer Stock:* Okay, so they are really a Southern California species and some of the others are spread out throughout the rest of California.

*Melissa Neuman:* Correct.

*Jennifer Stock:* Alright, so tell us a little bit about what's been happening starting in 2008, it sounds like, where there was a recovery plan published and efforts put in place by NOAA to get going on helping this species specifically. Tell us a little bit about what steps were taken to help the species.

*Melissa Neuman:* Well the recovery plan outlined a multipronged approach to bringing about recovery with an emphasis on two major efforts. The first, was to implement a captive propagation and enhancement program for the species because low density was cited as being the biggest threat to the survival of the species in the wild. We needed to focus on a method that was going to help us boost those numbers in the wild and the best solution was to try and bring some brute stock, some wild animals, from the wild into captivity and attempt to spawn them in captivity using culture techniques and methods

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that had been developed very successfully for other species and it was thought that they could be developed for white abalone as well.

And while that effort was going on we also identified the need to continue to monitor the declining population in the wild because there were at the time of the listing a few remnant populations that had been monitored using a remotely operated vehicle and a group down at the Southwest Fisheries Science Center led that effort under John Butler, at the time, and now Kevin Stierhoff, where they would take the remotely operated vehicle out into areas that are too deep really to do any kind of meaningful scuba surveys in and monitor populations, remnant populations in those areas and try to learn something not only about how those populations were declining over time, but also more about their habitat, and so that has continued through time as well.

And we've learned quite a bit on both fronts. I know Kristin is going to speak in just a few minutes about all of the advances that have made, that have been made on the captive breeding side of things and I can fill in some details on the habitat and population monitoring as we get along in the conversation.

*Jennifer Stock:*

Great, thank you so much. Ah, before we get into the propagation part, I wanted to also ask, I know that over harvesting was one of the main reasons why we got to this situation, but there is also some diseases that were happening at the time. withering foot syndrome, I believe, was one of them and how have those diseases been a part of what's happening to date now? I know you said you were monitoring that little population down there in Southern California and, do we, is this disease still a real threat in the wild for abalone?

*Melissa Neuman:*

Well, the disease known as was identified primarily as a threat to black abalone, which is also listed under the Endangered Species Act. We do not have any evidence from the field that White abalone declined in the wild due to withering syndrome, as opposed to black abalone, where we do have the evidence. It was a major, a major threat and a major cause for their decline in the wild and what we do know however, after bringing animals into captivity and Kristin again can speak a little bit more to this when she, when she comes on, but when we first brought these animals into captivity, they were housed at the Channel Islands Marine Resource Institute and we had some very successful spawns early on, but one of our partners Tom McCormick, who was in charge of this Marine Institute and unfortunately many of his animal that he was able to reproduce back in the early 2000s, became ill from withering syndrome and died. So we know, based on experiences of keeping white abalone in captivity, that they are highly susceptible to the disease and it nearly wiped out our entire captive population at that time. So, they're very susceptible.

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So we highlight withering syndrome as being a very important threat to White abalone as we move forward and look and basically look at the current situation and as we look into the future because we know that the bacteria that causes this disease is still present everywhere in Southern California. And so we need to make sure that what we are raising in captivity is going to be able to somehow handle that, pathogen, when it is reintroduced into the wild.

*Jennifer Stock:* Well I'm sure there are some other issues too that they're going to have to survive that were not so much of an issue back then in the 50s and 60s. But now let's talk a little bit about the propagation. We've got Kristin here. Kristin welcome.

*Kristin Aquilino:* Thank you.

*Jennifer Stock:* Folks tuning in, this is Ocean Currents and we are talking about a really cool effort to recover the White abalone population that's endangered and some exciting ways that NOAA and partners are working together to help bring them back. Kristin is at the Bodega Marine Lab. And she is leading the propagation efforts. I see you are an abalone matchmaker?.

*Kristin Aquilino:* Ha, ha, ha. Yes, I do my best to match them up so they are all happy together and make wonderful offspring.

*Jennifer Stock:* This is exciting. So can you just start and walk us through how you raised White abalone in the lab and how you get them to propagate?

*Kristin Aquilino:* It's a very unromantic process, believe it or not. We keep them separate in buckets. We put this mild solution of hydrogen peroxide in the buckets with them and what that solution does is create free radicals in the water. Those free radicals, we think create the same response in an abalone as when the abalone spawns. So the abalone is in its bucket all by itself, but sensing that Abigail and Abner and whoever else is spawning as well. And because these animals are broadcast spawners, they release their eggs and sperm into the water column. They all have to do that at the same time in order to be successful and so when other animals are spawning they need to spawn too. When they sense these chemicals, they released their gametes and we mix them in a very precise ratio.

We have to be careful with abalone because they have this thing called polyspermy, where more than one sperm can fertilize an egg. So we have to make sure not to have too much sperm that we get polyspermy, but we have enough sperm to optimize fertilization. So, occasionally we'll throw some Barry White or something in there for fun, to make it a little more romantic for the rest of us, but it is, it is very sterile.

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*Jennifer Stock:* Is there a time of year that abalone would spawn in the wild and do you try to mimic the natural time of year, the seasonality of it? Or is this a keep going abalone keep pushing those gametes?

*Kristin Aquilino:* White abalone tend to spawn in the late winter to early spring time and so that's where we focus our efforts. And actually one of the things we're trying to do in captivity is figure out, what environmental cues made them spawn during that time of year. Our efforts to get them to release their gametes are working quite well. So when we put them in these solutions, they give us all the eggs and sperm that they have. But in the past that often hasn't been very many and we think that could be because they are not becoming very reproductively mature during the time of year they are supposed to, which means they might be missing some sort of really important environmental cue to let them know, hey winter early spring is coming, I better invest in my gonad so I have something to spawn when it's time. So we're trying to do experiments in the laboratory to figure out what might make them tick.

*Jennifer Stock:* Interesting. What do abalone eat in the lab? I know they eat algae and kelp out in the wild. And do you bring in kelp from the outside or?

*Kristin Aquilino:* We do, we try to feed them a natural diet. Abalone love *Macrocystis*, the giant kelp. Its kind of like a Twinkie to them, it has lots of calories, but not necessarily a lot of nutritional value. So we also feed them and algae called "dulse," which is a red algae, you can actually buy it at Whole Foods or your local health food store. It's a very proteinaceous and they don't like to eat it quite as much, but there is a lot of evidence from abalone aquaculture that they do better on this diet: They grow better, they become more reproductive. So we make them eat their "vegetables" as well.

*Jennifer Stock:* So tell me, how does it feel to be responsible for raising an endangered species. It sounds tough; it means there's a lot of pressure for you to be managing these and also managing the lab itself. Is there concerns that you have to keep an eye on all the time and they are kind of like your little babies that you kind of have a lot of responsibility for?

*Kristin Aquilino:* They are. I feel very proud to be a part of this program and I feel very lucky to have an amazing amount of support. Not only support from NOAA, but we have great facilities at the Bodega Marine Lab, which are great. We have lots of technicians, animal care staff, physical plant staff, aquatic resources staff that help us there. And we also have partners in Southern California that help us such as aquarium and aquaculture facilities, abalone farms. And so there is a great group of people that really put a lot of effort into making this happen and make it be successful.

*Jennifer Stock:* That's great. Melissa, can you talk to us a little bit about some of the other folks that are raising, sounds like there is a little bit of a collaboration

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happening Bodega is the one local one but are there other sites that are also raising stock?

*Melissa Neuman:* Yes so, Kristin mentioned our Southern California partners and they are the Aquarium of the Pacific in Long Beach, California. We've got the Cabrillo Marine Aquarium in San Pedro, California. We've got the University of California Santa Barbara and the Santa Barbara Natural History Museum Sea Center and we've also got our own southwest fishery science center down in La Jolla, California. And as Kristin mentioned we're also on the verge, hopefully, of establishing a really nice partnership. We already have one, but these farm facilities both in Claidas and Cayucos, they don't have any White abalone yet. We're hoping to add additional partners. It's part of our Species in the Spotlight focus for White abalone. To get more partners involved in captive propagation because as Kristin can tell you, as she and the program get more successful, there's even greater need to have more facilities available for receiving early stages of White abalone as we scale up production. And it is going to take quite a large number of individuals producing captivity to turn this situation around in the wild.

*Jennifer Stock:* Kristin, how do you manage water in terms of the concern of disease. She was mentioning earlier that it nearly wiped out a whole stock of abalone and how do you manage that?

*Kristin Aquilino:* Managing disease has really contributed to the amount of success that we've been having recently and the main way that we do that is to make sure that disease doesn't even get into our lab, so we heavily treat our sea water. We use filtration. We filter our sea water down to five microns, which basically takes out nanoparticulates and we also use UV radiation to treat our sea water. We use very careful laboratory practices, where we douse our hands and feet into iodine solutions to make sure that we don't bring anything into the lab and that makes that space free of any sort of disease, whether ones we know about or ones we don't know about yet.

*Jennifer Stock:* Excellent, it sounds like the place I'd want to be if I was going to be under medical treatment. So in terms of, I am just think okay we've got all of this abalone that are increasing here in these labs. Melissa can you walk us through a bit of, what do we do with them once they get to a certain stage and have there been some efforts to actually reintroduce them back into the habitats?

*Melissa Neuman:* So Jennifer, we have not reintroduced White abalone back into the wild yet. We are, the approach we are taking is actually a step wise approach, where we're experimenting with other species, what we call surrogate species, and trying to work out the methods that we would use for White abalone when the right time and place come. So this means that we've got a couple of different groups, who are doing work without planning pinto abalone up in the state of Washington, where they are not doing well in the San Juan

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Islands. And then here in California we've got a group who's done some Green abalone out planting at Palaces Verdes off of Los Angeles and the California Department of Fish and Wildlife in conjunction with a variety of partners including UC Davis's BML and some of the other partners I just mentioned. They are doing some red abalone outplanting also in Palaces Verdes. And part of the reason for that effort is to figure out when, where, how many, and exactly what methods to use in order to do the out planting.

*Jennifer Stock:* But basically increase the likelihood of success when we get to the white abs.

*Melissa Neuman:* Exactly.

*Jennifer Stock:* Alright, so what are some of the biggest abs that you have right now in captivity, Kristin?

*Kristin Aquilino:* Well, we actually still have one animal that was collected from the wild in 2000, when right before these animals were listed, when we first realized that captive propagation and outplanting were probably going to be the main way to save the species, we collected 20 wild brute stock from native habitats and only one of those remains. He's our largest animal and he's in one of our tanks at Bodega Marine Lab.

And then Melissa mentioned we had some great success early on in the captive breeding program, where hundreds of thousands of juveniles were created. Unfortunately, most of those died from disease, but we still have 30 of those remaining or so sprinkled throughout our California facilities. So some of those are also at our Bodega Marine Lab. And those are about 8 inches or so.

*Jennifer Stock:* Are they somewhat slow growing or I mean from the age range you mentioned before and the size of an abalone, I would think sort of slow growing right?

*Kristin Aquilino:* Yeah, they grow about a half an inch to an inch a year.

*Jennifer Stock:* Alright they're going to be excited when they get out. There's got to be a little movie created about that, The Release of the Abalone. Let's see. Let's go onto abalone farms here. This is something that I just don't know that much about. Melissa, I was wondering if you could talk a little bit about it. I am familiar with oyster aquaculture, especially up in this region and up in the Pacific Northwest, but I don't really know that much about how much aquaculture we have for abalone. But I understand this is one of, well the only way really for abalone to be sold for consumption in restaurants or I guess even personal consumption.

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*Melissa Neuman:* Yes, so I am not sure of the history of abalone farming in the state of California. I know it's been going on probably since about the 1950s or 60s and unfortunately, though there aren't that many farms in California. When I've attended meetings, international meetings where the world wide abalone trade is discussed, California is on the list, but there are lots of other nations in the World that are seen as being the mass producers to feed the demand primarily in Asia. And those countries are Australia and some of the Asian countries are actually producing quite a few farmeries to abalone right now as well.

In California, I believe there are 6 or 7 farms in operation and California Department of Fish and Wildlife actually manages and tracks those farms. So they would have much more information about the history of the farms and what exactly goes into those farms operating and continuing to be able to operate in California. I know from the farms that we work with that they are really filling a niche market here in the United States, where most of the red abalone that they, and it is all red abalone by the way, that they're producing here in California, which is the largest of all of the abalone species world wide. So it is it is a prized species in terms of it producing, you know, the basically the largest foot muscle and meat that one would consume of any abalone species around the world. But the farms here in the U.S. are really selling to niche markets in the major cities across the United States and there is probably some other business that they do but that's really all I know about the aquaculture industry, the commercial aquaculture industry in California.

*Jennifer Stock:* Interesting. I know there's one actually locally in Sonoma County, very close to Bodega Bay on the Estero Americano.

*Melissa Neuman:* So that one hasn't been operating for a few years.

*Jennifer Stock:* Okay.

*Melissa Neuman:* But there was an abalone farm there in the past.

*Jennifer Stock:* They must have the propagation methods down. And Melissa you were saying you were hoping to maybe get some of these involved in helping to propagate, you might add.

*Melissa Neuman:* Yes, actually UC Davis Bodega Marine Lab has been working with one of the farms over the past couple of years. Mostly, you know they have been incredibly helpful as we've tried to set up facilities. So they've provided a lot of guidance to Kristin and all of the partners in our program on how actually to set up tanks, manage water flow, all of that sort of thing. They've donated quite a bit of time and were hoping that they may be able to donate, not necessarily donate, but participate in our program using part of their facility

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and also their expertise to help us grow out some of our White abalone in the future as we run out of space.

*Jennifer Stock:* That's great. Well you know what we are just going to take a short break. So Melissa if you don't mind just holding on the line for a moment. We'll come back and keep talking about the recovery efforts for white abalone.

*Melissa Neuman:* Sure.

*Jennifer Stock:* Okay. Stay with us. We'll be right back.

*(Break: Music plays)*

*Jennifer Stock:* You are tuned into KWMR Ocean Currents here. This afternoon, and in the studio with me, I have Kristin Aquilino, who is leading the propagation efforts of White abalone at UC Davis Bodega Marine Lab and on the telephone I have Melissa Newman with NOAA fisheries, who is leading the abalone recovery efforts here in California. And we have about 10 minutes left and I just wanted to talk a little bit about how do you sex an abalone in terms of male and female because whenever I see them they just, they all kind of look the same.

*Kristin Aquilino:* They do look really similar and I'll start just by saying that one of my goals in this besides recovering abalone and making them viable in the wild is to convince people that abalone are cute. They're actually an animal that we can all relate to. They have a very, you know, and in the wild when you see them they might look like a rock, they are just a big shell, but when you pull them off of that rock you see there strong muscular foot. That's the first thing that will be obvious. That is the part that is most tasty to us as humans and you can also see their eyes and their mouth. So they are like, just like your garden snails. And we can sex them as well. We can usually pull back their foot and look at their gonadal and we can tell by the color of that gonad whether or not they are male or female. So, a male abalone has kind of a milky white gonad, because it is filled with sperm. A female white abalone has more of a grey colored gonad because the eggs that the female carries are a little bit of a greyish color.

*Jennifer Stock:* Interesting. I had no idea you could peak under their clothing to see what they are. I'll have to check that out. And I know that we I've seen abalone tide pooling where are parts where you'd go I know actually I am going to talk about this the White abalone kind of has a different range than some of the red abalone but where would you go to see abalone on the coast here?

*Kristin Aquilino:* You can see red abalone in most parts of the Sonoma Coast, certainly if you are willing to don a wetsuit and dive a little bit you're likely to see more than you might see intertidally, but they definitely like habitats that have lots of kelp and lots of hard rocky substrate.

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*Jennifer Stock:* They don't like sand right? Because it's...

*Kristin:* They don't love sand.

*Jennifer Stock:* It's a little vulnerable. Interesting. I've seen a lot of black ab, no I shouldn't say a lot, but I have seen them more frequently than I thought I would see them, not only here in Sonoma but also down in the San Mateo Coast and it is always a thrill and I've seen red abs on the San Mateo Coast as well which I was always shocked about so maybe there is some good things afoot in the wild, afoot in the wild playing with the words here. So, in terms of numbers, you know it sounds like there is a lot of cultivation happening in some different facilitates and Melissa, what are some ideal numbers that you feel you need in order to start that effort of outplanting once you have an idea of an ideal method for outplanting them.

*Melissa Neuman:* Well I don't think we know exactly what that target number is, there is a person at the California Department of Fish and Wildlife, her name is Cynthia Button and she is actually working on trying to model what outplanting numbers should look like. At the experimental phase, though, I think we're looking at having to outplant hundreds if not a few thousand animals perhaps even more and that would be just an experimental level of outplanting in one area because the reality, the harsh reality of this is that some of these animals are going to die. This is part of the reason we are doing these experimental studies with surrogate species because we really would like to get a sense of what might that mortality that initial mortality rate look like. It is going to help us gauge how many we really do need to put out there in the wild in order for us to get to a viable population which is our benchmark.

But, also, you know, we are experimenting with all kinds of different methods for tracking the animals once we put them out in the wild. So we know that a certain number are going to die but then the challenge really is how do you follow them over time? And we're just not sure how we're going to do that yet. We're hoping that we are going to be able to use visual tags but also perhaps genetic tags in order to track our success over time. And if we can do that with other species first, then sort of scale it up a bit to try to do some experimental outplanting with White abalone or putting out thousands perhaps in one area. Then, we can start thinking even bigger picture where, and Kristin can chime in here, but we really think it is going to take millions of abalone outplanted in order to restore populations in Southern California.

*Jennifer Stock:* That gives me a good idea. Millions It's a lot more than I thought maybe. What's the ideal size do you think for outplanting? Or is there going to be an experiment on different size, perhaps?

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*Melissa Neuman:* Kristin, I think you should probably take that one.

*Kristin Aquilino:* Sure.

*Melissa Neuman:* You know I think we haven't taken anything off the table just yet in terms of the life stage of abalone, we would consider outplanting. I think that ideally we are looking at juveniles and, Kristin, you take over from there.

*Kristin Aquilino:* One of the things we know about white abalone natural history is that there is this really critical metamorphosis that happens between when the larvae, the abalone are swimming larvae which happens for their first week of life to when they become crawling snails they find a place to settle on the bottom of the ocean. And they go from these swimming things that don't eat, they rely on a yolk from their mother to crawling things that have to eat for the first time to a really energetically costly process. And for the first three or four months of that settlement we actually expect very high mortality, natural mortality on the order of 95 to 99 percent.

*Jennifer Stock:* Oh, wow.

*Kristin Aquilino:* And so, that's even in the laboratory without predators and poor conditions and all of that so if can get them through that stage in the lab, then, hypothetically we have a much greater chance of having them be successful in the field. So, I think right now in terms our target size for outplanting we want to at least get them through that stage make them a little bit less vulnerable to predation to other kinds of changes in habitat and other conditions.

*Jennifer Stock:* I could image that this is extremely complex. I mean just hearing about all this and just also knowing how things are changing in California. Right now, we are in an El Nino so there's probably not a ton of kelp in Southern California. Melissa and Kristin, actually, how are we, how do you take into those efforts to reintroduce the changing conditions? They seem to be changing rather rapidly and thinking about predators, warm temperatures, food availability is there anything you can do to help to raise really hardy and what's the word I'm looking for anyway very resilient abalone?

*Kristin Aquilino:* I think one of the best things that we can do is raise a lot of them. So, we know that abalone are fairly genetically diverse. If we can make sure that our culture program also has very diverse animals and put lots out there, then hopefully they will have the variation in their genes to be able to handle some of these changes that we expect to happen over the next decades.

*Jennifer Stock:* Excellent.

*Melissa Neuman:* Right and just to add to that, you know, one of the great things about raising lots of animals is it gives Kristin and all of the partners in the program an

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opportunity to actually manipulate some things in the captive setting that will hopefully give us clues as to how well certain families of abalone do when hard times come. And, you know, having been out diving in Southern California recently, in a year, like the year we are having things can be very, very ephemeral.

Six months ago, I was diving in a location where I was getting caught in the kelp at the surface but just a couple of weeks ago there's basically no kelp left in that area. Now the kelp is starting to come back in certain areas because the water has been a lot cooler here but those ephemeral conditions are of course really apparent to us and I'm sure that to the abalone, you know, different genetic make-ups are going to make them more or less able to weather those short-term storms like a one year El Nino versus those long-term perhaps decadal fluctuations in what's going on in nature. And then also the longer term impacts of climate change. So we're thinking about all of those things, as Kristin said, you know just trying to raise the most diverse stock we can and challenge them in a laboratory setting would probably increase our odds of being successful.

*Jennifer Stock:* Fantastic. How are, has there been tests with changing carbon dioxide levels in the water? How do they do with ocean acidification?

*Kristin Aquilino:* Any animal especially when they are at their most vulnerable stages such as little larvae definitely seem to be impacted by changing ocean acidification conditions and we actually have some partnerships with groups at the lab, some of our colleagues are studying ocean acidification in red abalone to try to understand how these changes might impact animals both that are up here on the Northern Coast and the Southern Coast because animals on different parts of the coast might be experiencing already different kinds of acidity in the water due to different ocean conditions such as upwelling that occur in these different zones, so we have these partners who are looking at that. They're looking at whether maternal diet might impact the success or the resilience of abalone as they go through those energetically costly transitions whether or not juvenile diet might mediate the effects of ocean acidification. And we are hoping that some of this information might inform the work that we doing with the white abalone.

*Jennifer Stock:* Fantastic. The fact they are a deeper species overall, do you think that's an advantage for a potential recovery here, Melissa?

*Melissa Neuman:* Oh, that's a tough question, you know historically white abalone did occur in shallow water. And some of the remnant populations that are still around today are in relatively shallow water so even though their quite often tagged as being a deep water species, I think it's probably more correct to say that they are the species that can occur across the, the broadest depth range, so, I don't really know how to answer that question. Being deep or being deeper is potentially good when it comes to things like poaching, potentially,

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And so, that could be good protection for them. And if sea otters ever repopulate Southern California being a little bit deeper may offer refuge, although otters can dive pretty deep.

*Jennifer Stock:* Hmm, Hmm.

*Melissa Neuman:* So, I'm not really sure if their depth range offers them refuge. What it does do, if they are in deeper water, is that water tends to be colder and that might offer some refuge to disease because there is an interaction between the bacteria that causes withering syndrome and ocean temperature whereas when ocean temperature goes up the disease actually or the prevalence of the disease also increases. So, I would say that being a deeper water species may offer them some refuge in terms of disease, that might be, that might be the biggest advantage.

*Jennifer Stock:* Interesting. Great. Well, Melissa, are there specific web links or things people should Google if they would like to follow more? You mentioned this is a Species in the Spotlight for NOAA.

*Melissa Neuman:* Right.

*Jennifer Stock:* Which is I believe, focusing on species that have are really and severely endangered and need to have recovery plans in place, like right now. Can you talk maybe a little bit about Species in the Spotlight and some other ways people can learn more about this effort?

*Melissa Neuman:* Sure. Well, the Species in the Spotlight effort was really one created to highlight the species that NOAA is responsible for and that are on the brink of extinction, so there is a very small number of Species in the Spotlight species with white abalone being the only marine invertebrate in that group and if your listeners would like to go to [www.noaa.gov](http://www.noaa.gov) they can find out more about the Species in the Spotlight program by, I believe, checking on the protective resources button when they get there.

A little bit more about Species in the Spotlight, what we were charged to do as recovery coordinators when developing some of the material for the Species in the Spotlight action plan was we were really charged with taking our larger recovery plan, that is hundreds of pages long and boiling that down to a very short document that prioritized the actions that must occur over the short term in order to reverse the downward trend of the species. So if you take a look at that Species in the Spotlight plan, there are five primary things that we need to do and we need to do them immediately if we are going to turn the species around. And of course captive propagation is the first action on that list, expanding partnerships for captive propagation is on that list, and then moving into outplanting these animals and basically boosting densities in the wild, that's on the list.

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Also, continuing to monitor habitats so that we know a little bit more about where white abalones still exist in nature and what's those habitats look like so that we can prioritize the places where we want to like outplant them. And then, of course, increasing our partnerships and doing more outreach in education. And connecting with our Mexican colleagues is also a really, really big issue when it comes to turning the species around because greater than 50 percent of species range is in Mexico, and if we're going to remove the species from the Endangered Species Act List we also have to think about what's going on in Mexico because we must recover the species throughout its range not just in California.

*Jennifer Stock:* Excellent. Thank you so much, Melissa, for that incredible overview. Ultimately, this one topic even focused on such a small animal just really to me illustrates the interconnectivity of everything regarding the environment. Also, all of the people at work that are helping to save this species and all the different skills and modalities that are needed to help bring a species back. I think it is a great overview to show how we all have to work together amongst all of these different areas to help these animals. So thank you. Kristin, how about you - any other ways people can learn a little bit more. I know at UC Davis Bodega Marine Lab, there are tours at the lab on Fridays. And people can at least maybe hear about or see an overview, maybe not necessarily get in and touch those abs but..

*Kristin Aquilino:* Yay. Every Friday from 2-4 we have docent led tours, and actually, if you are going to be in Bodega Bay for Fisherman's Festival this coming weekend on April 9th, on Saturday, we will have tours from 2-4 on that day as well. So you can come visit us there. You can also follow me on Twitter or Facebook - I regularly post updates about what's going on with the captive breeding program.

*Jennifer Stock:* There's a wonderful video on the Bodega Marine Lab website just showing all of the different stages through the microscope of the larvae and the different stages as they get bigger and they settle so if folk are interested that's a really cool thing to check out on the Bodega Marine Lab website. Just Google "Abalone Bodega Marine Lab". Well, I also just want to add you know in terms of things to help abalone it's important to report suspicious activity and report poaching and out here in West Marin we are in the zone where red abalone can be harvested during recreational season and at the docks you might see interesting things and it is really important for all of us to call CalTip which is 1-888-334-2258 to report any suspicious activity to help that red abalone population because it is also under a lot of stress with this warm water and lack of kelp and had some issues a couple of years ago with a big die off so that's another way people can help just being vigilant and watching what's happening along the coast. Melissa and Kristin thank you so much for joining me today here on Ocean Currents.

*Kristin Aquilino:* Thanks, Jennifer.

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*Melissa Neuman:* Thank you, Jennifer

*Jennifer Stock:* All right. Take Care

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