Stuart Sandin: Dr. Knowlton is the Meredith and chair for Marine Science at Smithsonian National Museum of Natural History. In that position, she led innovative research into the origins and magnitude of biodiversity in the ocean at the Smithsonian, and then before that, here at Scripps Institution of Oceanography, Nancy spent decades digging into the fundamentals of ecology and evolution. She always thought deeply about what we think of as a simple to use word biodiversity. Being here, it's likely that we all share that curiosity about diversity. I don't think we'd be a birch aquarium without that.

That curiosity includes questions about what is a species, what drives the creation and maintenance of species and populations, and a timely concern, how many species are there? Through her research and her accomplishments, by the many teams that Nancy led, we have fundamentally shifted our view about this seemingly simple topic. Nancy showed that the biodiversity of a taxonomic group, like a genus or a family or an order, these taxonomic units, they can be composed of many species that look really similar but have different functions. Sibling species. Nancy showed that the biodiversity of an organism may not be as simple as just the one organism, but may also include a lot of the symbiotes and the partners living on it. Ever heard of a microbiome?

Nancy showed that the biodiversity of an ecosystem is likely many times larger than that which we've counted, much more than any of us could see by just looking at it due to that cryptic biodiversity. Nancy's challenged our community to reconsider what biodiversity means as a principle and what it means in practice. For this work, she's won a ton of accolades, and I could go on for quite some time discussing them, the Darwin Medal from the International Coral Reef Society, the Heinz Award with a special focus on the environment, nomination into the American Association for the Advancement of Science and the American Academy of Arts and Sciences, and membership in the National Academy of Sciences.

But Nancy is here today because of another way in which she asked our community to focus on that word biodiversity. That is in her fundamental role in the foundation of our Center for Marine Biodiversity and Conservation here at Scripps Institution of Oceanography. Twenty-five years ago, Nancy took an ambitious step to include the word biodiversity in not just research, but in programs that face and inform the human communities around us. The vision was built upon what I imagine being a very tough duality. The academic research that we conduct is able to show that there's biodiversity that we didn't know of. But at the same time, you read the news and you watch that that biodiversity is in threat due to human activities. The need emerged to bridge the research realm with the societal realm.

The Center for Marine Biodiversity Conservation was founded with the view that we could make a bridge, that we can improve stewardship of our marine resources while maintaining the viability of our human communities. In partnership and having earned the trust of Ven director Charlie Kennel, Nancy was able to found the Center for Marine Biodiversity Conservation. CMBC, since then has innovated interdisciplinary education. It's organized research visions, and it's inspired collective action to better the relationship between human activities and our wildlife. We'll be celebrating our 25th anniversary this week, and we launch it by hearing Nancy Knowlton share her perspective on ocean science and her celebration of 25 years of CMBC. Nancy? [Applause]

Nancy Knowlton: Thanks so much, all of you for coming tonight. It's really an amazing pleasure to be here. I mean, birthdays are always kind of a funny thing. I actually, I turned 77, but 75 is a pretty big birthday. But in some ways, the 25th birthday of CMBC almost feels like a bigger birthday than my own 75th birthday, and it's just really CMBC was my baby, in a way. I was here for almost a decade, and it was the thing that I really worked hardest on when I was here. I have to say throughout my whole career, I think it's the thing I'm most proud of so it's really a pleasure to share some thoughts about CMBC with you all tonight.

I'm going to talk a little bit about the history of CMBC, and how CMBC happened a little bit of the backstory, what was going on back when I arrived at Scripps in 1998. But also, I'd like to spend a big part of tonight talking not so much what CMBC has accomplished, because you'll hear about that in a lot of different ways over the course of the week for the events that you can participate in, but also how CMBC shaped me and how it transformed how I think about the world in a really fundamental way. A little bit about CMBC and its history and a little bit about how CMBC made history for me.

CMBC, we've heard it's 25-years-old. It's an amazingly successful enterprise at this point. It's really hard for me, having been here from the very beginning to really comprehend all the different things that it's doing. First of all, it's sitting in this amazing building, the Ted and Gene Scripps Marine Conservation and Technology Facility. If you haven't seen this, it's a beautiful, beautiful setting and it has all these different programs that were certainly never part of CMBC when it first started. To give you just a sense of it, there's a big program on sustainable seafood. Another one on the stewardship of the deep ocean, which, of course, is a particular concern in the context of deep sea mining and sustainable seafood, of course, we all know and have known for a long time that being able to enjoy seafood without wrecking the ocean is one of the biggest challenges that we face.

Awareness of plastic, you don't have to be to be pretty oblivious not to know that plastic is a big problem, not just in general, but specifically for the ocean. Then also a program on the connection between the ocean and the land, specifically how healthy islands can promote healthy communities underwater as well. Then, of course, in addition to these research and outreach programs, there's the educational program, a very interdisciplinary PhD program, which I'll say a little bit later, and also a master of advance studies. There's a lot going on with CMBC, and there's a lot, I think, that CMBC has to celebrate. But it didn't start out this big. This is a picture. I found this online. The 1999 catalog for the University of California San Diego. I looked so enthusiastic and bright eyed and bushy tail. I look at that picture. I go, oh, my God, what's happening to me?

But Anyway, that's what I looked like when I first arrived. Really, I came as a biodiversity and a coral reef scientist. What was on my mind when I arrived, I'd spent 14 years at the Smithsonian Tropical Research Institute in Panama studying coral reefs and coral reef organisms. The things that were on my mind when I arrived here was one, that really ocean health was collapsing. This actually been clear for quite a long time. One of the first things I observed as a young scientist, I did my PhD research in Jamaica in the 1970s, and by the 1980s, the reef that I'd studied as a grad student were essentially gone for a variety of reasons. I'd seen a whole ecosystem that I loved and studied for quite a while just collapse literally overnight. I also learned in the course of the work that I've been doing on coral reef that there's a lot of biodiversity that we didn't understand. It was hidden, it was cryptic.

I was thinking a lot about that and also the fact that this cryptic biodiversity can matter in unexpected ways and in particular, one of the projects that I worked on both in Panama and actually here when I arrived here were the tiny little plant cells that live inside corals, and we used to think that they were just one single species, one little type of algae that lived in all the different kinds of corals, as well as giant clams and the sponges and variety of things. It turned out to be this hugely diverse group equivalent to multiple families. There are now different genera so there are lots and lots of species, lots of genera. It turned out one of the things we discovered was that they differed in their sensitivity to heat, which that discovery basically jump started a whole field of research which continues today on how we can use that diversity to help coral survive global climate change and global warming. Those are the kinds of things that were on my mind when I got here.

But I wasn't really even though I'd been watching coral reefs suffer and decline for all those years before getting here, I didn't really come here thinking I was going to start a Center for Marine Biodiversity and Conservation. I just arrived thinking I was going to continue some of the research that I was doing and start some new projects. But there were some early opportunities that happened here that really shaped my trajectory once I arrived. The first was actually Charlie Kennel has been

mentioned by Stewart. He had a retreat, which he called all the Scripps faculty together and asked for new ideas. I can't really remember exactly how this new idea came into my head, but I thought, we should have a Center for Marine biodiversity and conservation of the Scripps Institution of Oceanography.

Eventually, that came to be thanks to Charlie's support and the support of the faculty. It wasn't as if there was no conservation here at Scripps. In fact, Paul Dayton and the late Mia Teagna were doing amazing work in conservation, and so were other people. But it was like the hole was smaller than the sum of its parts. I felt like if we could have a center that brought people together, then maybe we could do bigger things. I also was lucky enough to be selected in the inaugural class of the Aldo Leopold Leadership Fellows Program, and that was all about communication. I'd always been interested in communication, but that gave me a two week intensive training in terms of how to talk not just to other scientists, but to policymakers and the general public about the things I thought were interesting and important.

Then finally, the National Science Foundation launched something called IGERT, which stands for Interdisciplinary Graduation and Research Training. That seemed perfect because it was clear even then that the problems that the ocean phase couldn't be solved by biology all by itself. I used to always tell my students that we can't change the behavior of whales. We have to change the behavior of people and so the need to bring in the social sciences with the biological sciences and actually the physical sciences as well was clear even then. These three things all combined and resulted in what is now CMBC, as a result of my coming here and working with other people and having these opportunities. It's just one of those things that happened.

But it started small. It used to be. It's now in this big, beautiful building. It was two offices in Hubbs Hall. It was a virtual center to my little office in the office of Penny Doherty, who I'll mention again later, she's here in the audience. She's the one who kept all the balls in the air and made sure the center actually was a real center. It was one of these things that started small, and you never really know where something is going to go when you start something like that. They say it's really such a blessing to be able to be here and celebrate the 25th anniversary of something that is a lot lot bigger than two small offices in Hubbs Hall.

When I was thinking about as the years went on. It started off without this we were lucky to get a $3 million grant from the IGERT program, eventually we had to apply it three times. The first two times we were turned down, but persistence paid, unfortunately, it wasn't three strikes, and you're out. But the third one was the one that went through. We got the $3 million, which it made it possible for us to bring students into the program. When I was thinking about it, I had two models in mind. The first was the Bell Labs. I don't know how many of you remember the whole concept of the Bell Labs. They still exist. But I think they're owned by Nokia at this point. But the way I always thought about the Bell Labs was that they were interested in everything from the next telephone to the next Nobel Prize, which is literally true because they did initially work on telecommunications, but they have a large number of Nobel prizes to their names.

I love the idea being able to work on some things were immediate problems that we could see were problems right now, and then also working on things like, for example, those little plant cells in the corals. When we started that work, we had no idea that it was ultimately going to be so fundamentally important in terms of corals ability to deal with climate change. We just thought they were interesting because there were more of them than we thought there were. This idea of working on things where you don't even know it's a problem, but eventually it becomes keys of solving really big problems. That's the essence of the value of basic science, really and so that was part of my model.

But the other part of my model was medical school for the ocean and this came from realizing that the students who were in this interdisciplinary program that was funded by the National Science

Foundation really wanted to do something positive for the ocean, and they could see the problems, but they wanted to work on the cures rather than the obituaries. There was this dual model that I had in my head as CMBC evolved. Then these were the strategies that we came up with, basically a mixture of education, investigation, communication, integration, that is the interdisciplinary thing, and then application, the actual taking some of the knowledge and turning it into solutions.

If you go to the CMBC website now, the words are a little bit different, but it's very similar in terms of what it's doing. It's basically expanded and grown, but many of the roots of CMBC are still there. As I said, the goal was to make in addition to bringing all these different kinds of people together to make the whole greater than the sum of its parts so we could really make a difference. I wanted to say a little bit about some of the early students we had because I'm so very proud of what they've accomplished. These are just a few of them and I think you'll hear from another student later this week.

But Loren McClenachan who's now at the University of Victoria, she was the one who with my husband, Jeremy Jackson, discovered that were something like there used to be something like 50 million green sea turtles in the Caribbean Sea, something that no one had suspected since most of us had never even seen a single one when we were diving or snorkeling around. Totally changed our notion of what was normal and natural in the ocean before people really started messing around with it. Then Octavio Aburto-Oropeza who's actually here at Scripps still was started off as a student. Now he's a professor, and he did has done many things, including very fundamental work showing how important mangroves are in terms of an economic engine for coastal communities.

Marco Hatch, he's now at the University of Western Washington. He's one of our first indigenous students and he was just featured in an article in the Guardian newspaper about his work on clam gardens and using techniques that are thousands of years old to restore clams for the local tribal communities. Jeff O'Hara, I mentioned this was an interdiscilary program. He was a PhD student in economics, and he now works for the US Department of Agriculture on regenerative agriculture and actually also farmers' markets and even fish in farmers' markets so it's amazing how all these different connections that CMBC started have really evolved.

Nancy Knowlton: Ryan Wulff works at NOAA. He was a deputy commissioner for the International Whaling Commission. He came to us as a student at CMBC. He was actually a part time actor. In fact, at one point, he had to leave the class for a week in order to pay his tuition because he made much more money being an actor than he did being a student. But he's gone on to have a very distinguished role at the National Oceanic and Atmospheric Administration. Sheila Walsh Reddy, who was my student, she got a PhD at Scripps, but she basically de facto also got a PhD in the economics department. She now is the Chief Data Scientist for the Nature Conservancy, which is an organization I know well because I sit on the global board, and it has an annual budget of $1 billion. Being the chief data scientist is a big job. Very proud of it.

Perhaps our most famous graduate, Ayana Johnson, she was here just a month or so ago hosting the launch of the paperback edition of these books that she wrote, What If We Get It Right? She previously wrote All We Can Save. I suspect many of you have read one or both of her books, and she's a very well known writer and speaker, great demand all over the world. These are the people I personally know because they were here during the early days of CMBC, and there are, of course, lots and lots more people that are CMBC products that have spread across the United States and across the world really helping to make the ocean a better place and actually the world in general, a better place. I'm very proud of them.

Then this is an example of an early project that, in fact, Enric Sala, he was the Deputy Director of CMBC in its early days, and he brought on board for this project a young postdoc named Stuart Sandin, and the two of them led this cruise to the Northern Line Islands. They are a very interesting

place. The Kingman Atoll and Palmyra Atoll are either uninhabited or largely uninhabited, whereas the bottom most islands in the Northern Line Islands have a lot of people. The project was to compare the ecology of the coral reefs with and without lots of people. What was found during this expedition, which I was part of and was really exciting, now is taken for granted as we know this, but at the time, it was really unexpected.

Kingman Atoll had no people, lots of big fish and many corals. In fact, so many big fish, many more big fish than small fish, which at the time, everyone thought of the ecosystem should have a pyramid with lots of little fish and fewer and fewer fish as they got bigger and bigger. In fact, what you saw in Kingman Atoll and Palmyra was huge numbers of big things and actually very few small things that really turned conventional ecological understanding on its head. Also the results of that expedition helped to inform the decision in 2009 to make Kingman Atoll and Palmyra part of the Pacific Remote Islands National Marine Monument. I remember actually going to the White House, the Environmental Quality scientists there and talking to them about what we had seen at these places and why it was so important to protect them, and then sure enough they were protected.

Even in its early days, there was really a lot happening, a lot going on. As I mentioned, I'd like to now talk about how CMBC changed me because I'm very proud of what CMBC has accomplished, but in some ways, it's not so much that I'm proud of how it's changed me, but it's really, to me, captures how a project, when you work on it, you don't not only create the project, but the project creates you, and it was really transformative for me as well. I guess the two things that really stand out when I think back about how CMBC changed me was first that the research, including the research that I just alluded to on the Line Islands, showed me that there were some places that were still healthy.

Now, you have to realize I had been spending several, at this point, a decade and a half, many years giving lectures everywhere about how terrible things were in the ocean and how the world was going to hell in a hand basket and everything was declining and disappearing, and it was a very depressing set of lectures. My husband, Jeremy, gave a TED Talk called How We Wreck the Ocean, which has been watched over a million times. We were both your quintessential doom and gloom. In fact, we were called Doctors Doom and Gloom on the lecture circuits. [Laughter] That research was really transformative in a way because it it showed me that, yes, there was a lot of bad news, and you'll hear some more bad news during the course of this week, but there were still places that were healthy, and then the other thing was the students.

As I mentioned, they were much more interested in figuring out how to fix things as they were and learning what was wrong. We came upon this realization. It wasn't right away. In fact, this transformative part of CMBC was something we called the Summer Course, which Jeremy led, and then what we did was bring together all these students from economics and anthropology and biology and climate change, put them all together, try to give them a common language. The course would always start when we began with a series of lectures by the core faculty, and they're all about how terrible things were in the ocean. I remember one day looking out at the students as I was giving my doom and gloom coral reflecture and I could almost see a bubble over the head of some of the students saying, oh, my God. Why did I sign up for this career? It's so depressing. [Laughter]

I suddenly realized that we weren't giving them what we wanted. They really wanted more than doom and gloom, and so that led me to start a whole series with Jeremy of a symposia called Beyond the Obituaries, a medical school analogy. You don't send students to medical school to learn to write obituaries. Similarly, we shouldn't be sending them to CMBC to write obituaries of the ocean. A series of symposia called Beyond the Obituaries, Success Stories in Ocean Conservation, the first of which was held shortly after I left here and moved to the Smithsonian in 2009. What was really amazing about this was I had colleagues who said, it was a one day symposium before the International Marine Conservation Congress, and I had colleagues who said, well, you can't have a whole day of success stories because there aren't that many.

Then what happened was we had so many submissions to give talks that we had to limit all the talks to five minutes. There was this whole series. There were more successes than we knew what to do with in terms of the program. This becames really a theme of that early period, the realization that there were all these success stories that no one was talking about. In fact, many people, not only the general public, but even conservation professionals were largely unaware of. That ultimately, that work on Beyond the Obituaries then attracted the attention of some other people, like-minded people, and we together launched something called the #OceanOptimism campaign on Twitter, back when Twitter was a viable place to post such a campaign. [Laughter]

That still goes on, and it's a useful way of flagging good news in social media. Then finally, the #OceanOptimism campaign led to a series of what we call the Earth Optimism summits at the Smithsonian, where we celebrated and tried to learn from the things that were working, not only in the ocean, but on the planet in general. CMBC really did change me, and what I'd like to do is share with you some of what I have discovered in this journey from CMBC through all this work on trying to figure out what's working, why it's working, and how to make more of it. The rest of this talk is going to be lessons from bright spots. Bright spots are in a way of describing the things that are doing better than you might expect given the general bad state of the environment.

I'll say this again towards the end. I don't want to let you think that I'm unaware of or dismissive of the gravity of what's already happened and what might happen in the future. But there's a lot to learn from bright spots, and bright spots also serve as a way of inspiring people to do more. What I'm going to do is give you a couple of examples of from five, what I would think of is five different ways that bright spots occur, rescuing species, protecting spaces, removing things from the environment that shouldn't be there, rebuilding ecosystems, and then managing the parts of the ocean that we need to support us. Then how those bright spots emerge.

What we've learned as a function of doing this over now many years is that this complex mixture of science and community and partnerships and leadership, not only leadership in the sense of top down leadership from a government, but also bottom up leadership from members of communities, and then actually the incredible resilience of nature itself in terms of the ability to repair things and how when those things are all combined, you can sometimes not only have things better for the ocean, but also better for people as well. What I'm going to do now is just share some of these examples of bright spots in the ocean. I know most of you probably read a lot of bad news, and I'm hoping that the bright spots that I share with you will make you realize that there's more to the state of the ocean than just doom and gloom.

I'm going to start in California with Northern elephant seals. Northern elephant seals are an incredible success story. I remember being taken to Ano Nuevo State Park, where many of them breed, although they breed in other sites as well, and seeing all these elephant seals, and at the time, I had no idea that they had almost gone extinct. There were definitely fewer than 100 at their lowest point. In fact, this picture probably, a picture like this a number of decades ago, and they would have been practically the whole population of the Northern elephant seals. Literally, were on the brink of extinction, but they were discovered as still surviving and rescued, and now you can see on the right hand side, this is the number of births per year.

You can see in 1950, there's almost an unmeasurable number of births. Between 1950 and 2010 or six years, there's a huge increase in the population, and, of course, the more females, you get more babies. Here's another example, the rescue of herons and egrets. Of course, the northern elephant seals were hunted for their meat and their blubber. The herons and egrets were hunted for something even more ridiculous. They were hunted for feathers to put on women's hats. In the Victorian era, this was all the rage and these women wear these huge hues hats with all these feathers. In fact, there there are pictures of them where it looked like they're essentially wearing birds for hats rather than feathers. The result was this huge industry where people would go out and during the breeding

season.

The recent picture on the right shows you the breeding plumage of a snowy egret. When they are getting ready to breed, they have these amazingly gorgeous feathers. I don't know how many of you have seen them, but really spectacular. Those are the feathers that people want for their hats, and so these hunters will go out and grab the adults from the nests, which, of course, they were protecting very ferociously because they had babies in them. They would grab the adults and literally rip their wings off and their feathers off, leave the babies to die. IT was disgusting. It was also decimating. There's a new book about this called The Feather Wars, and we're very sure our article should be mute as well, but it's really heartbreaking to read what people were doing to decorate women's hats.

Now, it turned out that not all women were really keen on this. In fact, two women in the UK and two women in the United States independently got together and decided enough was enough, and they didn't want to be responsible for the carnage that was happening on American shores or British shores to decorate their hats. The result was ultimately the Ottoman society here in the United States and the Royal Society for Protection of Birds in Britain, and various laws were passed. Now, it's not very hard to find snow egrets or great blue herons or any of these other birds that we brought near to bring a distinction through our desire for fancy hats.

Here's another example of a success story, which is sea turtles. I'm sure many of you have heard about the plight of sea turtles. The eggs are eaten, their meat is eaten, and they get caught in fishing nets. Turns out we've been doing a lot of work to try to stop the loss of sea turtles, including protecting their beaches and making it illegal to hunt them and trying to create fishing gear that is less likely to trap and drown turtles. The result has been a remarkable recovery in many populations of sea turtles. You see on the left, there are about 17 populations among a number of different species of these sea turtles, and the majority of them are now actually increasing. On the right, you can see the numbers for the hawksbill turtle on the top and the leatherback turtle on the bottom.

You can see they go from very low numbers in these locations to up to thousands and thousands. You can go from almost zero to thousands of individuals. Now, In fact, I recently received a paper to review arguing that maybe we had too many sea turtles, which I don't think is the case. But because we still are a long way from, for example, 50 million green turtles in the Caribbean. But still, the fact that people are starting to wonder if we have too many sea turtles is to me, a measure of the fact that we must be doing something right with sea turtle conservation. Now turning from rescuing things on the brink of extinction to protecting, there are a number of different examples I could share with you.

And the one I want to share with you is the work of Enric Sala, who I mentioned earlier, the former Deputy Director of the Center for Marine Biodiversity and Conservation, who went off, ultimately joined the National Geographic Society, where he created something called the Pristine Seas Project. This has been a remarkably successful endeavor. I'm very proud of what he has accomplished. He's particularly inspired in many ways by that early cruise that I mentioned to the Northern Line Islands. He has set upon himself a goal of going to these remote places where there are not a lot of people, so you can create very large marine protected areas and protect substantial chunks of the ocean in a way that's very effective.

As a result of the work of the Pristine Seas Project, they protected their almost 7 million square kilometers of ocean area. It's been very successful. All the little green spots are areas that they have protected associated with the Pristine Sea Project. But it's not just the big things that need to be protected. Sometimes you need to protect things that are small and close by. Jeremy and I were very lucky to spend a couple of years as a visiting professor for a month at a time over several years in Hong Kong, and one year, the students took us to this place called Mai Po. It's a little park.

Nancy Knowlton: It's nestled between Hong Kong and Shenzhen. Hong Kong and Shenzhen have a lot

of people, like 25 million people, and there's this little tiny park full of birds and mangroves and various kinds of weird fishes, and in terms of birds, 60,000 birds and of 350 species, sitting there right between Shenzhen, which you can see in this image in the background in Hong Kong. It provides a very important place for the birds to migrate up and down the coast of China, and also lots of permanent habitat for things that don't move around so much.

It's important that things don't have to be really big in order to be successful. Then the third example for protecting is work that has been a lot of work been done by a faculty member here at Scripps, Brice Semmens, on the Nassau Grouper. Now, the Nassau grouper, when I was a grad student in the 1970s, was very abundant. In fact, it was so abundant, I used to study these little snapping shrimp part of my diversity work, and these Nassau groupers would follow me around and whenever I wasn't paying very close attention, would eat my study subjects.

That would make me really irritated. Now, I have to swim a long long time in Jamaica, where I was doing this work in order to see a single Nassau Grouper. I might not see any. That's because Nassau groupers along with many other groupers and snappers, every year, when they want to reproduce, they all come together in a few places, big groups. And of course, it's very efficient for reproduction, but it's also very efficient for fishermen to catch them.

The result has been the decimation of what are called these spawning aggregation sites through overfishing. But the government of the Cayman Islands, working with a small but very effective non-profit has worked on identifying and protecting the remaining spawning aggregations. What you can see from the graphs on the right is the work of Brice has shown that these numbers of Nassau groupers are actually now slowly but steadily increasing as a result of that protective work. There's a long way to go.

There's still nearly enough now. No one's writing papers, but there are too many Nassau groupers but it is moving in the right direction. We move front, one of the most important things on islands to do is remove invasive species, particularly invasive rats, mice that kill, really do a terrible destructive predation on the nestlings of seabirds.

And this is going on in a number of different places. I showed two here, one in Palmyra Atoll and one on South George Island, so one in the tropics, one in the very near Antarctica. Both of these efforts have been extremely successful. They've managed to remove all the rats, and the result has been a huge rebound in the numbers of seabirds that were previously really suffering.

Both of these projects actually a big part of the work has been through the efforts of non-profits, including the South Georgia work, is a relatively small non-profit that organized the fund and the logistics of it. As some of you may know from your own backyards, not that easy to get rid of rats, and especially it's not easy when it's a large island with mountains and valleys and rivers.

You have to do it carefully so you don't kill everything in the process of getting rid of the rats, but they've been succeeding, and the result has been recovery of the seabirds. This project that I mentioned earlier that CNBC has engaged with the Island-Ocean Connections is actually dedicated to increasing the number of islands where we can do this kind of work. Another thing we need to do, of course, is remove pollution.

One of the classic success stories, marine success stories, of course, is the decision, thanks to the vision and passion of Rachel Carson in her book, Silent Spring, to ban the use of DDT. The result has been the dramatic recovery of birds high in the food chain. As I'm sure most of you know, the problem with DDT as a pesticide was it accumulates as you move up the food chain, and in birds, it makes eggshells very thin.

What happened as a result was that many birds of prey, including marine birds of prey, like a pelican

shown here, were on the verge of extinction. When I gave a talk about this in Florida once a number of years ago, I had a friend and colleague come to me and say, we almost lost the brown pelican here in the Gulf of Mexico. It almost went extinct. It was very close. The Silent Spring was written in 1962, DDT was banned in 1972, and now there are pelicans everywhere.

Now, the forever chemicals, which I'm sure many of you have read about, are a bigger challenge. There are more themes, among other things, and they really last a long time. But there are now efforts to restrict their use to situations where they're absolutely essential and all the trivial uses of these forever chemicals, called PFAS, is now being reduced. As a result, a recent study published just this year, 2026, they looked at the liver and the muscle of pilot whales and found detectable declines in the concentrations of these forever chemicals.

We talk about them as being forever chemicals, and it feels so hopeless. But here's in black and white, these graphs, you can see either going up and down or going down steadily. A number of these forever chemicals as a result of actions we've already taken. It's not hopeless. If we do something about these things that are in the environment, we can get rid of them. It may kick a while, but we can do it.

Then the third thing in terms of removing things is barriers. This is a picture I took, it's near where I live in Maine. One of the things that we were very good at is building dams in the United States in big rivers and small rivers. The problem with these dams, although they served a useful function, at least originally, and some of them still are quite important in terms of generating electricity. But the problem is they block the passageway between the ocean and freshwater.

There are a number of really important fish, some of them we care a lot about like salmon, but some that we might not know so much about like alewives that actually are very important in terms of food for things like striped bass and bald eagles. They also go back and forth between saltwater and freshwater. They live in saltwater, but then they go to freshwater to breed. When you have all these dams, essentially, these populations of all these fishes collapse completely.

You can see that on the right-hand slide, the alewife is a small fish that is very important in the food chain. You can see on the left is all the early years where there were essentially no alewives at the Kennebec River. Then with the removal of these two dams, which is where the arrows are, you can see suddenly the numbers increasing. Now, near where I live, during the spawning season, you can just see alewife after alewife with the air fly jumping over the rocks right where I took that picture.

As I said once to an audience, that trees are really dripping with bald eagles, so anxious to have alewives for hunch. Now, turning to rebuilding, one of the things we've been actually quite successful at is rebuilding mangrove forests. Now, mangrove forests have been really decimated by people cutting them down either to build shrimp ponds or to actually turn the wood into charcoal, places where people don't have that much in the way of economic resources.

The result has been a collapse in mangroves, really around the world. People were talking about mangrove being as one of the most endangered ecosystems on the planet as a result. What's remarkable is over the last several decades, we have stopped doing a lot of the cutting down of mangroves, and we started replanting mangroves. The result has been a remarkable recovery in many parts of the world, which you see on the graphs on the right.

Now, it's not uniform. Like the graph on the lower left is southern and eastern Africa, and you can see that mangroves are still going down there quite dramatically. But in many places in South America, in South Asia, and China, combination of restoration efforts, planting of mangroves, and also the natural resilience of the mangrove ecosystem. In other words, if you have salty mud flat that is in a place that's suitable for mangroves, just let things alone.

If there's some mangroves in the neighborhood, they make baby mangroves and those baby mangroves turn into a mangrove forest. It's a combination of human replanting and actually just the natural regeneration of mangroves themselves that has made this recovery possible, and as a result, this paper that was just published, again, this year showing that we are at net no change in mangroves, which may not sound that positive, but compared to where we were, which was a steady decline in mangroves, we have now stabilized mangroves.

We are having as many new mangroves growing as are being lost, and that really opens the door, ultimately, for a rare return of mangrove forests where they've still remained lacking. Similar story can be told for oyster reefs. This is a plot on the right, shows the number of oyster restoration efforts. One of the interesting things about oysters and actually mangroves, for that matter, as well, in fact, all of these rebuilding efforts I have one more to share with you, is the role science has played in doing it right.

It's possible to waste a lot of money planting the wrong mangrove species in the right place, or the right mangrove species in the wrong place. Similarly, if you don't know what you're doing when you're trying to rebuild oysters, they essentially get covered in mud and smother and die. But we now have the science that tells us how, in fact, to best recreate these to make sure that water movement is proper for the mangroves and also the size and configuration of the replanting for the oysters.

We're much more successful now in rebuilding oyster reefs and mangroves than we were before. Then finally, in rebuilding, it's not that we think of rebuilding in terms of planting things, planting oysters and planting mangrove seedlings. But sometimes you actually have to plant animals. I know that sounds a little weird, but puffins are a really good example. They're a lovely bird. I hope all of you haven't seen them, you get to see them. Sometimes they're very funny and cute and very important seabirds.

The problem is we hunted them to near extinction in Maine. I think there was one breeding pair left by about 1900. An act was passed that protected really a lot of different seabirds, including puffins, but they didn't come back. It turned out that puffins are a little bit like people, that they go to a rock and they don't see any other puffins. It makes them nervous, and they think there must be something wrong with the rock.

Steve Kress, amazing scientist of the Audubon Society, realized that what he needed to do was create an environment where the puffins felt comfortable. He would put up speakers that played puffin songs, and he put wooden puffins on the rocks so the puffins wouldn't feel lonely. Then he translocated a limited number of nestlings from places further north where there were puffins. As a result, there's been a remarkable recovery of puffins in Maine.

Now, people go on boats to see puffins and not only have the puffins recovered, but this model of how to restore socially breeding birds is used on all different species to great success around the world. Finally, managing, it's really important that we not only protect the things that we want to just leave alone, but also that we properly manage our use of the ocean. Much of our food comes from the ocean, and it's really important that we have that food be produced sustainably.

I'm going to give you just a couple of examples of how we're making progress in managing our fisheries. This is another example from California. I've deliberately included a bunch of California examples, and I thought you might be interested in them. In California, they set up marine protected areas for the spiny lobster fish in Southern California, actually. The idea was to create these marine protected areas like I alluded to with Enric Sala's work in pristine seas.

But people who are in the fishing community sometimes are really suspicious of marine protected areas because they think, you're telling me I can't fish here. As a result, I will catch fewer fish overall because you're preventing me from catching fish in this place. Turns out that if you protect a certain

place, the things in that place grow big. They make lots of babies, and those babies spill out of the protected area and repopulate other areas.

As a result for the spiny lobster fishery, reducing the fishing area using marine protected areas by 35% resulted in a 225% increase in the total catch after just six years. That's a really good example of how marine protected areas are not just a way of saying, no, you can't fish here because we want this place to be pristine. No, you can't fish here because we want you to be able to fish more effectively, more efficiently, more profitably outside this area.

We also have to manage bycatch. That's catching things we either didn't mean to catch or really shouldn't catch. Here are two examples. One is the using cheap LED lights on nets. They have to be cheap in order for them to be widely used, of course. A recent study showed that putting these lights on the nets reduce bycatch of all things from various kinds of sharks and turtles and things that fishermen weren't trying to catch. Reduce the biomass bycatch by 63%.

But in addition, because there wasn't all this stuff in the nets that wasn't supposed to be in the nets that had to be taken out of the nets, it was improved the efficiency, the handling time, and it didn't reduce the catch of what the fishermen are trying to catch. It's a really big success. Then another example from California, in 1994, people realized that putting gill nets, which are really good at catching fish, nearshore was catching all the passive mother fish who are trying to come in and lay their eggs.

They banned nearshore gill nets in 1994, and the result has been slow but steady recovery of the giant sea bass in California waters. Then finally, it's also possible to manage coral reefs in a way that keeps them going. Coral reefs, as a coral reef scientists, I can say, it's probably one of the hardest ecosystems to really keep healthy, but we are making progress, and there are, as I mentioned earlier, with respect to the Hawaiian Islands are places where coral reefs are doing pretty well.

This is another place where coral reefs are doing reasonably well, and that's Bonaire in the Caribbean. Really nice work by Bob Steneck has shown that through a series of efforts, the Bonaire government has really been able to keep coral reefs in a healthy state. First, they initially, in 1971, they banned spear fishing, and then eventually they set up a general controlled area for fishing. They created a tagging system so that tourists had to pay a certain amount to go in the waters in Bonaire, and that helps support the conservation efforts.

Then finally, they essentially banned the fishing of parrot fish altogether. Parrot fish eat seaweed, seaweed tend to overgrow and smother corals, if nothing eats them, and so it's really important to keep parrot fish in the system so the corals don't get smothered. The result has been not only coral reefs that have lots of coral and very little seaweed, much like Palmyra and Kingman that I talked about earlier. But very importantly, both after a big hurricane and also a major heat event which caused this phenomenon called coral bleaching, which kills a lot of corals.

I'm sure you've read about it. The recovery of these reefs in Bonaire was quite rapid as a function of the fact that they had healthy coral communities with relatively little seaweed.

Nancy Knowlton: Finally, I want to talk a little bit about win- wins. Some of what I've been talking about has implied win-wins, for example, the work on the reducing bycatch with lights, which allowed the fishermen to fish more efficiently, and also the role of marine protected areas and resulting in higher catches of spiny lobsters. But it's really important to think quite explicitly about how people can benefit from marine conservation, because if people don't benefit, then in the end, the conservation methods simply won't succeed. This picture is actually a very troubling picture. To me, this is the opposite of a win win. If you can see it clearly enough, you can see this person. He's very, very thin in his boat. It really doesn't matter if the coral reef underneath this boat was completely healthy, this would still not be a victory for marine conservation.

You can't have people starving to death in order to keep coral reefs healthy. I want to talk a few more examples about examples of win wins in marine conservation, explicitly shining a light on how people are benefiting. This work comes from the work of Octavio Roberto, who is here at CMBC at Scripps, as I mentioned with a student who I mentioned his work in the context of mangroves. He also has done a lot of work on areas, including in Cabo Pulmo. Some of you may have heard of this work, but there was a very poor fishing village where there has been so much unregulated fishing that essentially there were no fish left. They banded together. These are, small village of really poor people, really, very little resources, and took the very brave and difficult step of setting up a marine protection area, which ultimately became a national park.

It's a huge success, and you can see how successful it is in terms of the fish abundance on the right hand graph, the far right bar, is what the amount of fish in Cabo Pulmo after protection. You can see it on the left as well. The result has been a really transformation of the economy so that people are in Cabo Pulmo are much less dependent on fishing and get much higher incomes as a result of tourism. If you Google Cabo Pulmo, it's one of the top five sites anywhere in the world as a function of the success of this protection. He calls these instead of marine protected areas, he calls them marine prosperity areas or marine prosperity zones. Is a place where not only are the fish doing better, but people are doing better as well. Here's another example of a win win.

This is a restoration of seagrasses done in Virginia, and really the transformation in terms of science was figuring out how to be able to collect seeds of seagrasses, and use them to sort of reseed these beds that had been decimated by a variety of different causes. They eventually wound up with 70 million seeds distributed through these environments, and the result has been the creation of 9,000 new acres of seagrasses, which you can see in the picture. You can also see that graph on the upper left sort of rising very sharply. That's the acreage of seagrass as a result of their efforts. But what's really interesting about this example is not just that they were figured out how to regrow seagrasses, but it's also that the invertebrates and the fish have been increasing, including fish that are commercially important.

Also, seagrasses are very important because their roots, capture carbon and nitrogen, so they can reduce pollution, and they can capture greenhouse gases, sequester carbon and contribute to the solution of climate crisis that we face as well. The seagrasses it's a win win. It's a win for the seagrasses in the organisms within the seagrass, it's a win for climate, and it's a win for people. Then here, again, closing with California the story of sea otter recovery, which is a really amazing story. Again, a species that was thought to be extinct. It was so rare. Eventually, there were a few found on islands off of Big Sur, and they were protected, and now they're, of course, a huge tourist attraction.

But they also turns out they are really important in terms of saving salt marshes, and that's because they eat the crabs that otherwise disturbed salt marshes, and so they again are contributing a climate solution and an economic benefit to people, as well as, of course, the sea arts are doing better as well. Finally, to wrap this up, I do want to emphasize once again that, I'm not saying you should ignore the bad news. There's plenty of bad news to go around. These are just three examples. When I think of bad news, I think of setbacks, even in the context of these success stories that I'm talking about, setbacks, things that seem to be going well and then suddenly aren't. Trade offs, things where one thing going well hurts something else that you care about, and also the projections.

What we've already lost in the projections of what we might lose in the future if we continue on the path that we're on. The three examples that I chose, these are just there are quite a few of them. I'm not saying ignore these things. I'm just giving you three examples. It's very important to remember that these are here. One is about Tampa Bay, where this is a different set of seagrasses, where actually used to be one early on when I was giving my talk about success story, we always used the example of Tampa Bay. Because what happened was that communities around Tampa Bay got together and figured out that their seagrasses were all dying. Tampa Bay was getting really

disgusting.

Nothing was living in it, and they needed to get rid of the sewage inflow into the bay in order for things to turn around, which they did. It was announced in 2016 or 2015 that Tampa Bay seagrass had recovered to 1950s levels. This was a huge success. The thing that drove me crazy about this success was not only was it a huge success, but when I asked even scientists, if they knew about the success, they said, no, I've never heard about this success. I went to a meeting once in Tampa, and it was about the Gulf of Mexico, and there were 200 people in the room and I said, how many of you people know about what's going on outside with the recovery of seagrasses? 200 people. 4 Scientists raised their hand. Oh, my God, the scientists don't know about this.

How is the general public ever going to know? But after that big announcement for three years, seagrasses started to decline. In fact, declined by 30%. Things seem to be turning around again. Things seem on the better more positive trajectory. But a couple of things happened that basically erased some of the gains that they'd made, and you have to pay attention to that thing. In terms of trade offs, one of the biggest trade offs that people talk about is the race for all these things that we need for green energy and what it does to the environment, including the marine environment. Indonesia, there have been a number of stories about the incredible pollution associated with nickel mining in Indonesia, which is something that's real and it can't be ignored.

Then finally, in terms of horrifying projections, I have to say the projections for this year's El Nino were pretty horrifying. For a variety of reasons, including droughts and fires, but also, for example, coral reefs, some of the biggest coral die offs that we have records of essentially always associated with El Ninos, to have a super El Nino on top of all the other things coral reefs have been dealing with is pretty depressing and boring. These are real. You can't ignore them. But it's really important to remember that things can be bad and good at the same time. I love this example from a guy named Max Roser, who started this website called Our World in Data. I don't know if you're familiar with it, but if you want to know something about what's happening in the world in terms of the numbers, I really urge you to see it.

It's amazing information about all sorts of things. Here's the examples he uses. He says, You can say the world is awful. But it's also true that it used to be much worse. In other words, it's much better now. Then there are bright spots which show that the world could be overall much better still. The example he uses that in the past, 50% of all children died. We forget about that shifting baselines. We forget that it used to be 50% of all children die. But we focus instead on the fact that overall, about 4% of children still die across the world. That's way too many. That's a very depressing statistic, but it's a lot better than 50%. Moreover, in Europe, only 0.45% of children die. That's what we should be aiming for.

That's how I view these conservation setbacks and trade offs and projections in the context of the examples I'll be giving you today. You have to remember that, yes, things are still pretty bad. They were in some ways, a lot worse in terms of how we were managing our ocean resources, and there are places, the places I've been sharing with you tonight where things are much better, and that's what we should be focusing on in terms of learning what went right, how to make more of it, so that more of the ocean is healthy. Result of this, focus, I mean, I'm not the only one who talks about bright spots, fortunately, anymore, I think, because it was lonely for a while, but now there are a number of other people that do it as well there's a lot of resources that you can draw on.

These are just a couple of the books, including the one I mentioned by Ayana, but also books on climate, Not the End of the World, Saving Us by Katherine Hayhoe very interesting discussion of how communication about climate can help make the climate problem more tractable. Actually, one of the early books that were viewed would focus on bright spots, although they weren't called then in this particular book by Andrew Balmer, a colleague of mine in England called Wild Hope, and that's not

really about the ocean particularly. But these are all examples, and there are now many more that document places and people working. Places that are doing better and how people are working to make more of them. I'll leave you with a couple of quotes that give me hope even when I read about something that's really upsetting.

The first is by Voltaire, don't let the perfect be the enemy of the good. It's really easy to say, yes, but. Yes, things are better, but they're still bad. One of the things that was done in the summer course at CMBC was to bring an improv artist one of those of you who know improv realize that they all they use this technique called yes am and to keep the conversation going. In other if you think, yes, but it shuts everything down a yes am, so I prefer a yes am and yes, things could be better, and we are working on it. Just don't let what we haven't done diminish what we have. The second is Bill Gates. We overestimate the change that will occur in the next two years and underestimate the change that will occur in the next 10.

Of course, it can go both ways, but it's amazing how quickly electric vehicles are taking off around the world and how solar energy and wind power taking off in the world. Right now, in the United States, we're not necessarily moving in the right direction, but the rest of the world is moving in the right direction. An African proverb, if you think you are too small to make a difference, you haven't spent the night with a mosquito. You don't have many mosquitoes here. When I moved back to the East Coast, remembering how many mosquitoes we have on the East Coast. But it's many of the success stories that I talked about today were started by people with very little resources, just determination to do something about something they felt was just couldn't be accepted the way it was.

Then finally, action is the antidote to despair Joan Baez, a hero from my 1970s years. I think it's really important to essentially do what you can to make the world a better place. I want to say thank you not only to all of you for listening, but this is the 25th birthday, and I won't make this a big Oscar speech, but there are a couple of people I really want to say thank you to. The first are some of the early people who made CMBC possible. Charlie Kennel, who I've mentioned, Penny Doherty, who I've mentioned, Lisa Schaffer, who was responsible for creating the master's program, Sarah Mesnick who did a lot of the early work on diversity at CMBC and also on fisheries and connecting with the Southwest Fisheries Science Center.

Enric Sala who I've mentioned, and of course, my husband, Jeremy Jackson, who ran the summer course and kept me going in many ways. Then later leaders of CMBC, including Jeremy, Lisa Levin, and now Stewart. In addition to and then also actually Russ Chapman, who worked with Sarah Mesnick to really make a difference in terms of diversity. I mentioned Charlie Kennel, also, Margaret Leinen did an enormous amount of work as the director of Scripps just before the new director to keep CMBC going. Then the various Scripps faculty who taught in the classes, the Southwest Fisheries Science Center, people who didn't really have to do anything with CMBC because they're part of NOA. It's not their job.

But many of them contributed, including Dale Squires, who basically taught many of us in the early days what we needed to know part of what we needed to know about resource economics when it came to fisheries. Then, speaking of economics and the economics faculty, amazing support we got in the early days, particularly from Ted Groves and Richard Carson, who came and taught our students who most of whom knew nothing about economics, and they walked them through what they needed to know in order to use economics effectively in conservation. Then, in terms of development, I forgot to mention Lawrence Bailey. He was the person who helped raise a lot of the early money that kept CMBC going, and the amazing students and the early donors.

These are the people that I interacted with, and they are really responsible for CMBC getting to where it did in the early days. It wasn't that easy turning CMBC. It's really easy to have an idea, it's really hard to make the idea actually work. I'm giving you a little bit of the history from my perspective, but

mine was the idea, but the people that really made it happen are all those names that I just listed, and I'm incredibly grateful to them. Without them, we wouldn't be having a 25th birthday. With that, thank you, also to all of you, to the students now, to the current donors, it's just amazing to see what's happened and makes me smile. Thank you very much.