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Well, I think there are two important things to remember about the oceans – they cover 70 percent of our planet and they are the cradles of all life. It's now pretty clear that life originated in the oceans billions and billions of years ago and only migrated to land about 400 million years ago. We're the only planet in the solar system that is covered with liquid water. It's quite clear that it's essential to maintaining the stability of climate over the billions of years, and it was that stability – relative stability – that enabled our complex life to evolve. So as Arthur Clarke once said, "You know, you really shouldn't call this planet Earth; you should call it Ocean!" He said, "You get up there in space and look at it, its primary color is blue." I think it's the most important single feature of the world's environmental system.

The Hippocratic Oath is "Above all, do no harm." And so this means you approach the oceans and all the living systems, ecosystems everywhere, on land, on the ice, in the oceans, you approach them with the same respect that you would approach a human being. The complexity and the mysteries, interior (inside the body) are not a hundred percent clear to anybody but we approach every human being with respect. You should approach every ecosystem with respect and at all times endeavor to make them better and stronger.

Well, I think that the first thing about the ocean that's important to understand is that before we can work to cure some of the ocean's ills, we have to understand the ocean. And so it's important, not only for scientists to do their work, to understand the ocean in great detail; much of the ocean bottom still remains unmapped and not-understood. One of the most inaccessible places in the solar system to explore is the deep ocean. We must continue to work and understand the science of the oceans. But medicine – if you take the analogy with medicine for a bit longer – medicine is also a public endeavor. The patient is involved. And society is involved in asking for and demanding cures and building hospitals and institutions. And society does this because it understands the importance of human health; it doesn't yet understand the importance of ocean health, or ecosystem health.

Part of the problems with the oceans, of course, is that you can't see beneath the surface. And so for most of us, when we visit the coastline, we still see this beautiful blue expanse of water stretching out over into the distance, connecting us to distant lands. But we can't see underneath, and underneath it are problems that are developing that need serious attention. This means then that scientists can't stop with just understanding what's happening beneath the ocean. It's now important for all of us to communicate, in the best ways that we know how, to people around the world what is happening beneath the ocean, so that they will begin to develop the same concern for the ecosystems in the ocean that they do for their neighbor's health.

The oceans are the richest depositories of undiscovered life on the Earth. Of the 21 phyla –major types of life – 13 are found uniquely in the ocean. The ocean is an immense reservoir of biodiversity, much of which is not understood. The oceans have the greatest diversity of microscopic and microbial life. And so the first things to state is that the oceans still are the cradles of life. They are full of life. And the life that we care about and we know most about of course are the ecosystems that are so productive along our coastlines that provide the fish we eat, the fish we like to look at in the aquaria, the wonderful habitats in kelp beds and corals and the great undersea beauty that appeals to so many people.

And this is what most people think about, the wildlife. But a scientist will say there is a tremendous diversity of undiscovered life. Because the ocean is such a different environment than the Earth that the creatures that have evolved in the oceans have evolved many different strategies for living that differ from the creatures that we see on the land. We can learn a lot from them. And I have developed a tremendous respect for the power of nature to produce such a diversity of living things in the ocean.

Well, I think one of the things that we all have to come to grips with is the tremendous development of human society in the last 50 years – the rise of the great economies in Asia, the rise of consumption in Europe and America and the great increase in population that occurred in the last century. All of these are human factors that have contributed to altering the surface of the Earth and at a speed and in ways that are, I believe, unprecedented in the history of the Earth that we can reconstruct.

It's not any surprise that with this tremendous intensification of human activity around the globe that the Earth's systems are responding and are changing because of what we humans are doing. It's no surprise that in the last 50 years there are concerns about greenhouse gas accumulation and the potential effects to dramatically change the climate. It's no surprise that over the last 50 years the concerns emerge. It's no surprise that we learned about an ozone hole 20 years ago when a simple chemical called fluorocarbons were discovered to cause a decline in the ozone layer that protects us from ultraviolet radiation from space. It's no surprise that in the last 50 years there's been a growing awareness of the worldwide decline of marine life in our coastal waters and particularly our fisheries. It's no surprise that over the last 20 years that the 17 largest species for which we hunt and fish have declined by 90 percent. It's no surprise that 25 percent of the bird species disappeared in the last century.

It's no surprise that we're appropriating half of all the fresh water in the Earth's global fresh water cycle for our own uses. It's no surprise that humans are putting more air pollution particles – small particles – into the atmosphere, ten times more than nature is doing. So all of these effects, which are side effects of the great increase of intensification of human activity and prosperity, these side effects are now taking on global proportions. There were always side effects from human activities, but they were always small compared to the scale of nature. And now we are altering the planet on a global scale.

Well, there are different kinds of links between human poverty, human prosperity and the environment. I think one of the most interesting things is that realization that global population – the rate of growth of global population – is actually going down. And as much as anything we believe this is due to the increase in prosperity in poor societies around the world, particularly when they devote some of their resources to education, especially of women. So when these things happen, the rate of population growth does slow down. It is beginning to slow down around the world and we can look forward over the next 50 years, perhaps even to a stabilization of the global population. Right now the UN would estimate that maybe the world's population is about six billion – might level off at nine billion.

But we get to the first condition of sustainability, which is a stable population, only by providing a good life, education and economic hope to the people around the world. And so the whole question of global sustainability can be boiled down to a very simple question: The conditions for a stable global population require economic opportunity and education for people around the world. Will that level of consumption required to sustain a stable population also be in equilibrium with our global environmental systems? And right now, the answer to that question is not clear, and the kinds of answers that scientists are developing give us an ominous warning: We have not stabilized the relationship between our growth in human opportunity, economic growth. We have not stabilized that relationship. We have not stabilized the relationship between human opportunity on the one hand and economic growth on the one hand and environmental stability on the other.

The state of the oceans? It's not even my words – the two great national commissions – the National Ocean Commission and the Pew Ocean Commission – both start their reports with a simple sentence: “The oceans are in trouble”.

How do we make people care? Those of us who work in the environmental science and love to unravel all the complex interrelationships that are taking place and derive great pleasure from it still, and we get fascinated by the scientific questions – but really, we all have to remember that the most important question in environmental science is, “What's going to happen to me? What's going to happen to my children? What's going to happen to the things I care about?” For example, if you think about the issue of global warming, right now we scientists love to talk about the potential increase in the globe's average temperature over 50 years: maybe two degrees. What does that mean to anybody? It means a lot to a scientist but not much to anybody else.

It's our job as scientists to begin to make regional predictions of global change-to say what will happen to the snow packs in the mountains around us. What we think will happen to the stream flows. What we think will happen to the growing season for farmers. What we think will happen to the fire season for the fire management agencies. What we think will happen to electricity consumption for the power companies under the conditions of climate change, both natural and human-induced. We have to make it clear what climate change means to what people care about

People think there have been five major natural cataclysms of a global scale that led to a systematic decline of a major fraction of the number of species on the surface of the Earth and their abundance. So it's some global cataclysm that causes much of life to go away and it then has to regenerate. The clearest extinction – mass extinction – that we now understand in considerable detail is the cataclysm that occurred some 65 million years ago when a very large asteroid hit the earth off the Yucatan Peninsula and caused enormous earthquakes, tsunamis and changed the climate by lifting all sorts of dust into the atmosphere.

It's quite clear that this led to a major extinction of large, land-based creatures: the dinosaurs. Marine animals followed along and life radiated out in the years after that. That is a mass extinction of life that has taken place from the outside, a cataclysm that affected the whole earth. Right now what we are seeing is a major decline in the abundance and types of species over the surface of the earth. And it's pretty clear that we are losing species because of human activities.

We are in a new kind of situation in which the Earth has not seen. It has seen climate change in the past and it has seen climate changes that can be larger than the ones that we will get in the next century, but what we are going to get and what we are creating as human beings is a potential change in climate that will put us out of the range of behavior, the range of situations that we encountered throughout the last two million years of alternating ice ages, which is the geological period that we're living in.

And, we're changing the climate at the same time when our activities are altering the surface of the Earth. Our land use practices are fragmenting the landscape and making it much more difficult for the creatures who, between the ice ages and the warm periods like now, survive by migrating. They move to places where the climate could support them as it got warmer and colder. But as we break up the landscape it becomes harder and harder for that primary avenue of adaptation to take place. As a result of the combination of climate change and of fragmented landscape, as a result of introducing into our environment chemicals that species never encountered at any time during their period of evolution, it's entirely possible that there will be at a "perfect storm" of effects we are creating that might lead to a major decline in species, both in number and in diversity over the next 50 or 100 years. Our job to disentangle, to prevent that perfect storm from happening, to sort out what the separate causes are and to work as human beings, like a doctor working on a sick patient, to work to cure our ecosystems.

Why do people care about species? Well, there's one species on Earth I care about: they're called human beings. And I'm one of them. And I care about what's going to happen to my grandchildren and me and I care about this civilization that we are all collectively building. I want it to continue. And each individual species, you could say, "well, so, that's too bad, but..." but when you start looking at a systematic disruption of the conditions for life and when you understand that in many ways our life and our civilizations depend on the productivity of our environment and depend upon the health of our ecosystems. Then you begin to worry when you see a systematic disruption of the

conditions of life for the creatures around us. If that's happening to them, how long do you have?

I was talking then about how the species move on the land. Similar responses to climate change exist here in the ocean. For example even in short terms when the ocean temperature goes up during an El Nino year off the coast of California, we see different warm-water species during an El Nino period than we do at other times. And so the creatures move around to follow the places in the ocean where the habitat is favorable to their conditions of life and we know they do that in short terms. As the ocean warms up, we expect there to be continued change. Some species can't move. The corals are tied to the bottom, the kelp beds are tied to the bottom and we know that both major types of marine ecosystems are extremely sensitive to increases of as little as a fraction of a degree of the temperature of the ocean's surface. So those ecosystems can't choose the solution the fish do, which is to move.

Regarding the loss of Cod: When the first explorers arrived off the coast of Canada, those cod were seven and eight feet long. They were enormously abundant. They provided food for the natives, they provided food for the whole Colonial civilization and now they are gone. And part of the problem is that you can't see – most people can't see those big bottom-feeding cod and so they don't quite know what it's like – maybe divers do, but think of it in different ways. Suppose you went to the Serengeti and all the big animals were gone and all you could see was the grass? Then you would be able to see, if you could imagine that situation, that's what's happened to cod.

About a hundred years ago one of our great Presidents, Teddy Roosevelt, began to have a concern about the major disruptions in the ecosystems in our American West.--the loss of the buffalo, the loss of the American Indian, the loss of the passenger pigeons. His response was to create national parks where life had a greater chance, where wildlife had a greater chance of surviving. But he had a sustainability ethic. He understood that those parks would only survive in our human civilization if they offered and provided pleasure, recreation for human beings. And so I think the same principle applies in the oceans. If you have a space where fish can live and you don't kill them, there should be more. If you have a space where they can live until they grow to maturity and lay their millions of eggs, it stands to reason there should be more fish in that space. And so I think the real issue then is pretty obvious. You set aside some place and let the fish grow. They will grow and they will become more abundant.

When fish become more abundant, they could leave the marine reserves and then people could catch them and I think the fishermen will eventually be happier. I think that, where marine reserves have been tried, they have been successful. I think it's important to design them carefully with human beings and human needs in mind, to design the networks of marine reserves so that the little baby fish that escape from one reserve have a chance to get to the next one and grow up or that the fish eggs laid in one area, actually some small fraction of them will get to another reserve and then the fish will also grow up there. And I think we have, with modern understanding and management of ecosystems we have ways of doing it. So I'm very optimistic that if we could set aside

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nurseries for undersea wildlife that they would serve their function; they would be nurseries and the wildlife would be more abundant.

I guess I'm a realistic optimist. You can point out the enormous problems that are facing our global society to achieve sustainability. And they look overwhelming. But if you were to go back several hundred years and ask, "Could you create a democratic society, could you create the level of prosperity that we now see?" the answer, would be nobody would have believed it possible in 1850 that we could be where we are now. Nobody could have conceived of the Internet. So I'm a realistic optimist.

You have to be realistic about the size and scope of the problems. They are unprecedented. But it's also the size and scope and strength of human civilization that's unprecedented. So I believe, my optimism is that we will eventually see the nature and the global scale of these problems and at that point people will insist on developing and really working on solving the problem, just as they insist on our making our a systematic effort to solve the problems of human health. Those of us who work in the universities here know that that time will come. We know that eventually, either because of advocacy and building of public awareness, or maybe just more disasters, eventually the global public will call for a solution. And here in the university, when that call comes, will we be ready? Will we have the science? Will we have deployed or understand the technology to deploy? To make the science effective. And most importantly, will we in the university have trained people who understand how to solve the world's environmental problems and the problems of the ocean.