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Regarding aquaculture, on the worse end are things like catching wild blue fin tuna which are very depleted in the ocean, penning them up and then feeding them really large quantities of wild fish that could otherwise go to feed people. But on the better side are fish that are being fed with soybean-derived diets. Other fish actually can be fed things like scraps from farming. That's really a lot better — and then many shellfish, like clams and oysters and scallops, can be grown by just hanging them on racks in the water. You don't have to feed them anything. They filter their own food out of the water and in many cases that's good for the water because it helps filter out the water and improve the clarity of the bays.

In some places people actually kill dolphins, intentionally slaughter dolphins for things like food or even I've heard pet food, and we might think about whether we should be outraged by that kind of thing. I certainly am. I don't think that there is any good justification to convert a wild dolphin into pet food and there's nobody in the world who will starve if they don't eat dolphin meat. But I think it's almost as outrageous is what we have done to the ocean in general. Not just because we have been fishing but because we have been overfishing. I'm not at all against using what is in the ocean but I am against using it up and that I think has been a terrible tragedy that we have repeated over and over and over again, and we still do so on a daily basis.

It's human nature to kind of overdo a good thing. The history of fisheries is pretty much boom and bust. You find one thing and you drive it down, deplete it and find some new thing, drive it down and deplete it and that's happened over and over again. So who is the bad guy in that? The consumer who is indiscriminate just assumes that what's there is ok. People who fish are not thinking long term. But many of them really do know what's going on. They see the waste. They know how hard they are fishing. They know they are fishing harder to catch what they used to catch. The managers whose job it is to put the brakes on, the scientists who provide the information but then aren't there really insisting that the information be used? Or the general public and the watchdog groups whose role in it is really to say these are public resources, these are natural resources; these are our children's future? So everybody has a role, everybody is responsible and everybody really can and needs to be part of the solution.

I don't think it's good to ask whether we should be optimistic or we should be pessimistic. That's like betting on the outcome. We should be asking how do we each play a role in making things better. That's like guiding the outcome and what we need to do is guide the world toward a better destination than the one that we've let it go in.

Oceans are vast and it seems like we can't really hurt them and when you look out over them, it's not like looking at a forest that's been clear-cut. If they have been depleted of fish, they still look the same but we simply need to know and understand that beneath

that cover the oceans really have changed and they have changed greatly. I think part of the magic of the ocean is simply that it's full of life and life is magical. I think another part of the magic of the ocean is that a covering of water creates literally a deep mystery and people are always drawn to mystery.

Pop culture is a mixed bag. It's created some very misleading impressions and it's created some very helpful impressions I think. One thing pop culture does is it helps people to see that what are swimming around in the ocean are wild animals and some of them really do have lives of their own in ways that we can relate to. When we start to understand through something like the old television show "Flipper", that dolphins are very intelligent, that they understand things that they can form relationships, that's true and it's helpful.

On the other hand the book and the movie *Jaws* really demonized sharks and sharks are no more demonic than lions are. They are predators, they are animals that can be dangerous and at times kill people. There is no question about that. The reality is that around the world, on average, sharks kill ten people every year. Compare that to things like cars, smoking, lightning strikes. Pigs kill more people and falling coconuts (kill more people) than are killed by sharks. So you know we just need to put these things into perspective. When the movie *Coconuts* comes out then we'll see put pop culture up against *Jaws* and we'll see who wins.

It's sometimes very easy to get depressed about a lot of bad news in the ocean. The oceans are sick but they are not dying yet. They may be down but they are by no means out. There is still a tremendous amount of vitality in the oceans. It's really important to understand that it's worth mentioning the sense of hope. I define hope as the belief that things can get better. It's different from wishing. You can wish for something and that's very passive, but if you hope and you believe things can get better then you can start to think about what you can do to actually make things better. If you have hope then you have a reason to act and a basis for action and with action you really can turn a lot of things around and make a lot of things better than they are.

At this point in history ocean animals have really suffered from the onslaught of mostly European technologies. Around World War II, a lot of military technology like sonar and radar were developed and then brought to bear on fisheries, so fisheries changed tremendously at that time. There were some fish depletions earlier but they really occurred in the second half of the 20th century and up to the present and a lot of the population of fish in the oceans are at historic lows. In a few places where people have tried to manage for recoveries, some populations are either flattening out, looking like they may start trending upward, and a few are recovered. So we know that it can be done.

Other problems in the ocean include the effects of climate change, which are really looming, not just the way the ocean has been warming but also what the carbon dioxide does to ocean chemistry making the ocean more acidic. These are really some serious issues that we are going to have to really face and grapple with.

In terms of fishing probably the most famous decline was the destruction of the northern cod both in Europe and off the eastern coast of North America, the Canadian waters and the New England waters. Over there it was really the richest and the most valuable fishery in the world for hundreds of years and in the last 50 years it's just been really battered so badly that Canada closed most of its cod fishing. The United States closed about a third of Georges Bank, the most important cod fishing area. Many smaller cod populations seem to be extinct. They are missing from areas where they used to breed and that's the most famous one, that's the one that's most talked about. But I have also seen in my lifetime the demolition of some of the tuna, especially the blue fin tuna, which was a very abundant fish, and a very large fish, one of the biggest fish in the ocean, weighing up to 1500 pounds. They have declined really precipitously, especially in the last 25 years, probably down over 90 percent. Data on catch rates of big fish in the world's oceans shows an average decline of around 90 percent in catch rates.

On the good side, we have seen that the deep depletion of north Atlantic swordfish was turned around as a result of the consumer boycott that led to the adoption of reduced catch quotas and a recovery plan. We also had to sue the federal government to close some areas off the southeast states, some large areas where juvenile swordfish congregate so that they could grow and not be subject to fishing mortality and then be discarded because they were too small to bring to the market. Those things not only stopped the decline of swordfish but brought it up significantly from where it was. Also on the east coast of the United States, striped bass, which were very sparse in the mid 1980s, have recovered tremendously. So the pressure that we bring has a tremendous effect, one way or another. If it's a lot of pressure, it has a tremendous effect in driving big populations down. And if we let them recover, they often do --unless we have driven them down too far to begin with.

A lot of fishermen seem to have been in denial for a very long time; often saying there are plenty of fish and their main problem is regulation. But much more recently fishermen have started to really admit that there are real declines, that they are faced with a lack of fish in many places. Many of them will admit that the catch rate has gone down and things in general have gotten tougher. As management tries to put the brakes on, the fishermen tend to complain about the restrictions, which of course is the only way that some of them can try to stay in business. It's kind of a nasty cycle and it mainly has resulted from negligent management that has never been able to get ahead of the curve and bad politics surrounding fisheries so that scientific advice often tends to get ignored.

Scientists will say that you can catch so many fish, and the managers based on the lobbying of the fishing industry and the politics will say, we will allow them to catch twice as many as the scientists say and we will hope the situation is better. But for the most part those declines that the scientists say are real and a lot of fishing businesses have gone out of business as a result.

The salmon populations on the west coast are generally very low compared to their historic levels but there the main problem has been on the habitat side. The dams and rivers have blocked access of salmon too much if not most of their natural spawning areas. The fish ladders that they put in place, so that the adults can't get up, don't change the fact that behind the dams are very big lakes in which the juveniles can't get down very effectively. Many of them are killed as they come over the dams or through turbines or they just delay too long and their internal changes from little river fish to salt water fish get out of sync with the salinity changes that they are expecting.

So what's happened is rather than the dams coming out and rather than getting control of the logging which has clear cut many of these forested slopes and has just allowed the rains to wash mud into the streams and destroy spawning habitat, the managers and the government have generally reacted by shutting down fishing, which in the case of the salmon is the least of the salmon's problems. It certainly is a contributor and maybe if everything was great and we didn't have all the dams and we had wise logging practices, we'd have to deal with overfishing at some point. But the main decline of the salmon has really been from destruction of their habitat.

Salmon leave the river one size and they come back another. And the difference is that they gather the nutrients of the open ocean through their food into their body, so when they come back, they deliver a lot of what is valuable nutrient-wise from the ocean. Another thing that they deliver is pesticides and metals and other toxic chemicals that they have also been gathering through their food. So salmon become delivery systems not only for very valuable nutrients that feed things like bears and eagles and nourish trees and all these other positive effects, but they also bring pollution from the ocean into the rivers.

Most of the developments in fishing in the last 50 years have been to fish bigger and harder. And a lot of fishing boats are more like an approximation of a floating factory. However there still are a lot of people who are trying to eke out a living and the big boats are really competing with them. Also rich people are competing with them because if boats can catch fish and get a better price by shipping them to the United States or to Europe or to Canada or to Japan they will certainly do that. They won't sell them cheaper in more local markets just because local people are hungry and because the local fishermen can't catch enough fish because the big boats got to them first.

There is a big problem with illegal fishing, which is called poaching or fish piracy. And that's basically just boats that don't want to have anything to do with the attempts that the countries are making to regulate fishing and they don't want to report their catches. And they re-flag to some small country where they really can't police the fishing. They go fishing very distant places where they are hard to detect like in the waters around Antarctica or somewhere in the open ocean. As northern waters have been depleted some of the fishing boats from places like Europe have turned south and have started fishing very intensively off African countries. They also play the countries off against one another. Rather than the countries being sophisticated enough to get the most money

possible for allowing access to their ocean resources, many of them will take whatever deal they can get rather than see it go to another country. There is also very little monitoring of what is actually caught and a lot of depletion resulting, and a lot of that is in direct competition with the needs of local people who are hungry in those countries.

A lot of fisheries, in fact, almost all fisheries, catch some things that they don't want to catch whether it's a lot of very small fish or unmarketable fish or things like sea birds and turtles and even dolphins or whales. That's called "bycatch" or "bykill" and a lot of it goes overboard dead. There is enough mortality to actually drive down the populations of albatross species and many of the world's sea turtles. And about a quarter of everything that is caught in the ocean, not wanted or not marketable or not as valuable as some of the other catch, goes overboard while the boats try to fill up on whatever it is that they can get the most money for. One exception to that pattern is that in recent years people have been keeping more of what they catch mainly because they are not catching enough of what they really want. And also about one third of everything that is caught and kept goes to feed farm animals like pigs and chickens. So even if you don't like fish and you never eat seafood you probably really are eating it through things like pork and poultry.

All of the sea turtles in the world are listed as endangered but that doesn't mean all the populations are doing equally poorly. In fact in the western half of the Atlantic Ocean, sea turtles that nest on beaches in the Caribbean and Florida and the Carolinas are actually increasing as a result of a lot of hard work by a relatively small number of people over quite a few years. That's allowed the populations of some turtles that seem doomed like the ridley turtle to actually nose upward and start to really increase significantly. Loggerhead populations have been increasing, green turtle populations have increased a lot and leatherback turtles have been increasing in that part of the world. This is due mainly to the fact that on beaches they are not as subject to poaching of their nests. Conservation workers often will move nests that look like they may be invaded by high tides or possibly at risk of predation from things like raccoons and foxes that will dig up the eggs.

Because shrimp nets used to drown lots of turtles, the United States (because of the Endangered Species Act) now requires that shrimp nets be equipped with a grate that will stop the turtle and shunt it out a trap door. That has stopped a lot of the drowning in this part of the world and has allowed the ocean to really start to see a lot more small turtles that are surviving and growing.

That's really in contrast with the Pacific where the hawksbill turtle, the loggerhead and the leatherback have all declined really rapidly, declines of around 90 percent in just 20 years. And for an animal that has lived a hundred million years to decline 90 percent in 20 years is like putting a drop of water on a hot skillet and hearing that thing go like that. That's how fast. But the big difference is that they are not extinct yet. And that means that we can work on it. Some of the things that have been applied in the Atlantic that have worked are starting to be applied in the Pacific. So the hope is that these declines

will start to flatten out and be arrested and maybe we will start to see recoveries in the next 20, 30, 40 years.

In Florida, which is now the most important nesting area in the world for the loggerhead turtle, the turtle faces challenges even though it has been doing a lot better. Those challenges include lighting from all the increased development, as well as the changes imposed by rising sea level as a result of climate change. Now the beach lighting is bad for turtles because when adult turtles are approaching a beach, if the beach is too lit, they often won't come up and lay eggs, and when they hatch, when the little babies hatch, they will look for the brightest area of the sky to head toward. That usually means in a natural setting that that's where the ocean is because the jungle or the dunes behind them look dark. But if they come up onto the surface of the sand and the clouds are lit from below by the town or there are lights from buildings behind them, they will go toward town rather than toward the ocean and of course they will wind up running out of energy or getting squashed by cars if they do that.

The other thing is that as sea level comes up, people who have built expensive homes along the edge of the ocean want to keep those homes there. They don't want their homes washed away and so they will build sea walls or put concrete armoring and effectively remove the beach, not just from turtles but from people as well. Over the course of time beaches have come and gone, sea level has gone up and down. And as long as that happens naturally and slowly and there is a beach there, turtles don't care. All they care about is that the night is dark and that the ocean ends at the beach. But if the night is bright and the ocean ends on a concrete apron or a sea wall then that's a problem for the turtle.

Sea otters are not only really beautiful but they are also really important. Along with things that they eat are urchins, which live in the giant kelp forest, which is the undersea forest of the Pacific coast of North America. The urchins like to eat the kelp and if nothing is eating the urchins they will eat essentially all of the kelp and if the kelp goes everything that lives in those forests goes. It's like the urchin clear cut the forest and there is no room for any of the wildlife that lives there including the fish and many other things. So by eating the urchins, by having that as part of their diet, sea otters allow their habitat and the habitat of so many other animals to exist and to remain.

Coral reefs around the world are under a lot of stress and the stress has come from a range of things, but clear cutting of forests on land that washes silt in the ocean and increases the fresh water run-off from rain are both bad things for corals. They stress them. As they get stressed they are more vulnerable to diseases. People fish in coral reefs not so much with nets because nets get hung up but by using explosives to blow the reefs apart and catch the fish that are stunned and float to the surface. Obviously people are not thinking that one through too well. Because when they come back there's no reef there. And they also use poison like cyanide; divers will go and they'll squirt in the crevices into the coral that the fish are hiding in and stun the fish. The fish come looping out, and they can catch them but it also kills the coral.

And the other thing that is going on with corals is the effect of carbon dioxide — the same carbon dioxide that is warming the world is changing the pH from the ocean. As the pH declines, the carbonate ions in the water that are what the corals use to form the coral skeleton, what you see as the reef, become unavailable for the corals to use. If this trend continues, eventually corals will not be able to build their skeleton structures and the coral reef as we think of it will actually start to dissolve in the ocean.

If the ocean's water wasn't there hiding all these things that we're doing, a lot of us would really be appalled just as we were appalled when we learned about the fact that the buffalo herds were being destroyed, or the fact that the flocks of passenger pigeons and water fowl that darken the skies were no more or were just in little tatters of what they had been. We have really done exactly the same thing to the ocean and just as at the end of the great buffalo hunt, people were killing buffaloes just for their tongues, we now kill millions of sharks just for their fins. It's the same exact mentality. It's just moved away from the land, where it has already largely depleted of a lot of its wildlife and its forests into the sea. If we could really see what is going on, we would be as shocked.

One twist on overfishing is that in some Asian markets, especially in China, it's very popular to have the fish coming in live because the sea food lovers there are real connoisseurs, they really want the very freshest and the very best. But as a result you see these beautiful fish come into these markets alive where they haven't been fed for a long time, they are crowded and cramped and they really look like prisoners which is exactly what they are, just awaiting execution and of course all fishing really amounts to much the same thing. But the time between capture and killing for those fish is a lot longer and it's kind of a hard thing to see.

Increasingly around the world fish are being farmed, and some of them are grown in captivity, in hatcheries, in cages. Others are caught from the wild as small fish, then moved into pens and raised and fattened. That might seem like a good solution to some of the problems but it creates some other kinds of problems. For one thing fish are not cabbages - they don't grow on sunlight. They need to be fed. And most of them eat other fish. Tuna eat fish, salmon eat fish, even shrimp eat fish and so there's still a lot of fishing that goes on to provide the food. In fact you have to catch more fish out of the ocean to provide food for fish that you are farming because the conversion rate is not one to one.

It's not one pound of what you catch out of the ocean per every pound of what you get out of the farm. You may have to feed 2 or 3 or 4 or 5 pounds of wild fish to the fish that you are raising so for these things that are very high on the food chain, like giant tuna that are being fattened in pens, it's like raising leopards and lions and tigers on farms for food. It's so inefficient that we don't do that on land but the market forces have so far allowed that to happen in the water. People are willing to pay phenomenal amounts of money for fish, but ecologically its very unwise and it also takes food directly from the mouths of

people who could have eaten many of the fish that are caught to convert into feed for these farmed fish.