The Great Simplification

Nate Hagens (00:00:02):

You're listening to The Great Simplification with Nate Hagens. That's me. On this show, we try to explore and simplify what's happening with energy, the economy, the environment, and our society. Together with scientists, experts, and leaders, this show is about understanding the bird's-eye view of how everything fits together, where we go from here, and what we can do about it as a society and as individuals.

(00:00:33):

Humans have had a long and complex relationship with the ocean, but one that is ultimately dependent on the deep blue, mysterious water that covers most of the surface of our planet. The effects of industrial pollution on Earth's seas and oceans, including, but not limited to, CO2 pollution, are not typically discussed in mainstream environmental discourse, despite the critical role that oceans play in creating and sustaining life on Earth.

(00:01:08):

Joining me today to discuss the future systemic risk to Earth's ocean are professor Daniel Pauly from the University of British Columbia and also the Head of the Ocean Fisheries Research and activist portal, the Sea Around Us. Antonio Turiel, a theoretical physicist and a marine systems expert from the Autonomous University of Madrid, Spain, and Professor Peter Ward, a paleobiologist, an author of 17 books on prior mass extinctions linking Earth's ocean to historical events. All three of these scientists were previous guests on The Great Simplification. This conversation was intense and dark, but I feel it is important one. Without further ado, here's reality round table number four on oceans.

(00:02:18):

Welcome, Bienvenidos to another episode of Reality Roundtable. Here with me today are ocean scientist, Antonio Turiel, a paleobiologist and ocean expert Peter Ward and ocean fisheries scientist who runs the project, See the Sea Around Us, Daniel Pauly. And you three to my knowledge have never met each other before right now. So you have in common that you are friends of Nate and you care deeply about the oceans and what is happening and that's why we're here today to discuss what the heck is happening. Great to see the three of you.

Antonio Turiel (00:03:01):

Yeah.

Daniel Pauly (00:03:03):

Indeed.

Peter Ward (00:03:04):

Yeah, thanks.

Nate Hagens (00:03:05):

So we're still feeling out the format of these little round tables. What I asked you each to come up with is a five or six minute opening statement on what is the most pressing issue in dealing with the world's oceans, that you as a lifetime scientist studying the oceans would like the general public to understand. And then the others will ask questions and then we'll have an open discussion. And Professor Pauly in British Columbia, let's start with you sir.

Daniel Pauly (00:03:45):

All right. So I have a standard lecturer give to lots of people from specialists to non-specialists about how human, the human conquest of the ocean or the earth and the ocean. And basically human came out of Africa 70,000 years ago, at least some, and became spread all over the place. And the spread was accompanied with the killing of the megafauna in all continent and all islands where humans reached. And then agriculture was invented. And also then the plants that suffered and desertification spread and now it is continuing and it's frightening. Then fisheries, and fisheries, we have traditionally fished since ever, since forever, but with the launching of the first steam driven trawlers a new episode in the story of fishing came and this was equivalent to the hunting of the large mammals in our continent. And these steam trawlers were the civilian equivalent of the warships that were developed at the time, the first steam driven and steel hulled warships.

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And they made a short thrift of the fish that were accumulated around the British Isles and then spread throughout the world. And the spread, I participate in it because

in '74 and '75 or rather '75, '76, I was in Indonesia helping to introduce trawling into Indonesia. And basically industrial fishing has replaced artisanal fishing or supplemented and competing against it throughout the world. And these boats and the device they use to find fish and to locate themselves have been developed for warfare, warfare against submarine, for example, by the British Navy during World War I and World War II. And this industrial fishing is equivalent to a war against fish and we were winning it. So the fish are declining everywhere, especially big ones.

(00:06:52):

And this decline of the fish have spread from industrial area, from industrialized countries, now to the whole world. And what maintains it is not necessarily the demand. The demand that is increasing because our numbers increase, but it is subsidies and government subsidies that are given to fleets even when they don't work profitably. See industrial vessels, fish resource within 10 years, 15 years, it is essentially gone and from a 100% it would be reduced to five, 10% of what it was before. And at that point the fishery becomes uneconomical, but it is maintained by subsidies. And so about one third of the income derived from fisheries is subsidies and industrial fisheries. And these subsidies maintain the overfishing situation and maintain an industry which compete against small scale fishers, which are by some notion sustainable. So industrial fisheries are inherently unsustainable and they can operate and continue to fish devastated, collapsed stocks because of subsidies. So we have to get rid of them if we want to have any chance of really establishing something that is sustainable.

(00:08:45):

Then the big problem of our time though is global warming and climate change. The small population that we have, we have reduced the stock to five, 10% of what they were before has created the situation of the genetic variability that was there in the stocks is not there anymore. So the result of this is that the stocks and the ecosystem as a whole have little resilience. So we will not be able to handle all the stocks, rather than ecosystem will be endangered particularly by climate change because the genetic diversity that would have allowed some of the adaptation to Darwinian mechanism isn't there. So that's why, and that will be my concluding point, that's why there is a strong push to create marine protected areas throughout the world where the stocks could rebuild themselves.

(00:10:01):

So the big challenge is temperature that is too warm for the fish. They have a big problem getting enough oxygen in their body when it's warmer both because there is less oxygen in the water and because the metabolic rate increase, the need for oxygen increase. So we have a real problem on our hands and it can be solved only really by reducing greenhouse gas emissions always the same story. But for fisheries specifically, subsidies have to go.

Nate Hagens (00:10:44):

I think this conversation may go from slightly depressing to moderately depressing to incredibly depressing. I'm taking the initiative here that rather than to ask follow-up calls of Daniel, let's just go to the next one of the scientific panelists and then we'll have follow-up questions after. Antonio, would you like to go next?

Antonio Turiel (00:11:10):

If I'm going next, this is going to be very depressing actually.

Nate Hagens (00:11:13):

Well, but you haven't met Peter yet.

Antonio Turiel (00:11:17):

Okay. Okay. I am a physical sonographer, so I'm working on the physics of the oceans. And I think that currently our concerns, the problems are that we have many different concerns. Some of them seem to be really accelerating, especially this year, even if those things have been in March, I mean has been going on since so long ago. The fair question has been also raised by Professor Pauly regarding temperature. The ocean temperature now is arriving to incredible heights. We have observed this year the sea surface temperature, the average of the sea surface temperature all over the world is completely off chart. We are now almost one degree above the typical values for this time of the year. And there are specific zones at which this value is incredibly high. For instance, in the Mediterranean it is three degrees Celsius above the average. And in the case of the North Atlantic, it is now 1.4 above the average, which is very large taking into account that we're discussing about a very large area.

(00:12:32):

And this, of course, is affecting sea life in general because the increase of thermal stress for the species and also because it is decreasing the solidity of the oxygen in the water so they have less oxygen and also more thermal stress. And this is causing a great mortality of species. But for us, which is, I mean us as a physical sonographer, one of our main concerns regards the effects on climate on the large and the possibility of attaining some tipping points in the climate change. So something that has been discussed very extensively during the last days is the possibility of a sudden interruption of the AMOC of the Atlantic branch of the meridional turning current, which is a huge system of currents that goes around all the world and distributes heat and moisture over the world. And what we are observing is compatible with slowing down an even eventually detention interruption of the Atlantic branch of the meridional turning current.

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If this happens, it would imply that all the Northern Hemisphere will be colder and drier, especially in Europe. At the same time, the accumulation of heat on the ocean surface will make more likely to have huge storms. Something that by the way is what is happening in Europe this summer. We are observing unusual phenomemon. We could not say this has not happened before this has happened, but the question is that we have increasing recurrence of tornadoes or very large tempests, almost hurricanes that is not so usual, especially in this big amount in Europe. The problem with the possibility of an interruption of AMOC is that this is one of the tipping points in climate change. Something that will unchain a process in which the climate of the Earth will radically change and make it not recognizable according to our current standards. But the problem is that this also could pull other tipping points and force the change of other parts of the climate system.

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For instance, accelerating the deforestation in the Amazons or forcing also change in the rains all over the world. So we are very worried because this situation seems to be more and more likely. Something that also we have recently discovered is that the climate models by IPCC are too conservative regarding this possibility and the succession of events that we have seen during the last year. Some particular this year

are indicating that the models are not actually conservative and not able to describe the situation. And right now the possibility of having this sudden change in the climate seems to be very likely during this same century. And just to start with, I think this is enough.

Nate Hagens (00:15:54):

Thank you. Thank you, Peter?

Peter Ward (00:15:57):

Well, yeah, we have major changes. Well, the Earth and the history has always been about major changes. Clearly past is prelude and referring to the AMOC, which I love that term because the Atlantic Meridional Overturning Circulation or AMOC, it really is running amok, if you will, by slowing down. So we have seen this in the past, which is the sad thing as recently as near the end of the Pleistocene 10 to 12,000 years ago, this particular current shut down. But this isn't something that is just a Johnny-come-recently effect on the planet. We have seen the changes of what they called conveyor belt currents and think about what a conveyor belt is. Ocean currents we think of as something like clouds. We can see them sweeping over the top. They seem to be working in a flat dimension, but think of what an escalator does. An escalator will carry you up or carry you down, but those steps have to then dive back down, go all the way down below again before they come up again. So think of the planet's ocean, not just as a flat series of currents, but also as the vertical currents. And this is the type of current that we're looking at and fearing will stop. It does very important things, the AMOC takes oxygen from very cold surface water, drops it down near Greenland where it is carried back along the bottom of the Atlantic, back towards the tropics. This particular conveyor belt carrying stuff down below is taking the oxygen necessary to keep marine communities on the deep sea and in mid water alive when this current stops, oxygen no longer makes it to the bottom. The worst case of this happening coincides with some of the greatest mass extinctions in history.

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The most recent was that the end of the Pleistocene, the PETM, Paleocene-Eocene thermal maximum when planetary temperatures went up six to eight degrees globally and the oceans lost most of their oxygen on the bottom mass extinction. But even

bigger effects happened at the end of the Permian and several times to the Mesozoic. When these currents stop, it leads to the formation of hydrogen sulfide rich bottom waters, which begin to rise to the surface, killing marine life on the way up and then extruding into the atmosphere. So this really is to me, one of the most dangerous aspects of the coming century. Why is it stopping? It's stopping because Greenland, well, for many reasons, but one of the major reasons we think is that Greenland is melting because of higher temperatures. It is dumping fresh water into the North Atlantic. So why would a surface current that's going to go down as an escalator sink in the first place?

(00:19:07):

This is part of the Gulf Stream. Warm, warm, tropical water. And as we've seen going by Florida, we're seeing a hundred degree Fahrenheit water off the Florida Keys unheard of. Well, this stuff was carried up the coast, east coast to North America. It makes places beaches in New Jersey, tropically warm. So unlike my West coast or even down to the middle part of California, if you jump in the water, it's really cold. That's an Alaskan surface current coming south. Well, this current goes up and then it leaves North America and heads towards Europe, as it does so it gets in the colder and colder climates. The water as it gets colder, starts picking up more oxygen. Warm water carries less oxygen than cold water.

(00:19:53):

So this gets ever colder water picks up ever more oxygen, it gets heavier and heavier and it finally sinks. And this is the conveyor belt part, the vertical aspect sinking down oxygen rich water hits the bottom of the Atlantic and it works its way back again, conveyor belt over and over. Every time this particular, on a global scale set of currents and it's not the only one, the other really scary one is off Antarctica, the same thing is happening. And when you're having enormous land-based ice sheets melting, you're dumping fresh water in that reduces the density of this cold North Atlantic water. Greenland is melting, is causing the cessation of this current, the warming of the planet is going to shut off these currents and there will be literally hell to pay.

Nate Hagens (00:20:48):

There's a lot of ways I could go with this, but let me ask you three, particularly this follow-up question. It seems like a lot of people are suddenly aware of climate change,

not as many as need to be to make effective socioeconomic changes. Why do the ocean issues seem to not be addressed? What the three of you just said is rarely shown in the media, yet the ocean represents the vast majority of livable habitat on this planet. Why is the ocean just such a distant thought in our scientific and public discourse? Yes, it's changing, but given what the three of you said, it's hella important, this needs to be heard and understood by lots more people. Does anyone have any thoughts on that?

Daniel Pauly (00:21:40):

Well, my thought on this is that we are a terrestrial species and that's the basic reason why we don't understand the ocean. The relationship of most people to the ocean is on beaches and on cruise ships maybe, but the depth and its dynamics are not understood. Another point is, and this reflects my present work and work, not so much on fisheries, but on the physiology of fish. And I encountered a complete failure to understand that it is extremely difficult to breathe water. The biologist even have problems with that because to us breathing and moving in a medium that is very light, very easy is a natural thing. And it's very difficult for us to imagine how it is to breathe water. There is far less oxygen in the water as you would get two times the height of the Everest. So we know what it is to ascend a mountain and not be able to breathe. Well, there is very little, oxygen. It's far less than on top of Everest, but it's in water. And water has to be moved across the gills of fish for them to be able to breathe. So the big problem is that they cannot breathe, and they have problem breathing. And so you mess up a little bit of their requirement or their demand or their supply, their supply because it's warmer, is less oxygen, or their demand because the water is warmer, and they are in deep trouble.

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And that's the reason why the fish move to the north on the Northern Hemisphere and to the south in Southern Hemisphere because they cannot handle the temperature in the place where they lived before. And so they move. They move toward the poles on both hemispheres. The documentation of this, the presentation of this was 20 years ago. You could demonstrate that, you got a paper in Science. And now you don't because it's trivial. Everybody knows that fish are now moving north in the Northern Hemisphere, and in BC we have fish that we didn't have before. In Mexico we have

even giant squids on Mexico, stranded, and people freak out. So it's very difficult to imagine, to know, for the public at large, what the ocean is.

(00:24:36):

And it's unfair, I think, to expect the public at large to know and to care because, to our neoliberal politics, we have a problem that most people, even in rich countries, are struggling to end the month, and they have to have two, three jobs. And because of this, and in the background of increased productivity, we produce more, and yet people have no money to end up the month and pay the rent and pay the... So I am not surprised that people shouldn't be concerned about the ocean because they are forced to have other problem. And the forces that make people have problems are the same forces that pollute our world. That's the problem.

Nate Hagens (00:25:36):

Peter or Antonio, would you like to add anything there?

Antonio Turiel (00:25:39):

Yeah. I have my own take on this subject. I think that there are several reasons for which maybe we have not paid as much attention to oceans as we should have. First, well, the oceanography community is not the largest community in the scientific world. So we are, let's say, a minority, and there are several reasons for this apart from tradition, and so what I am talking, maybe from a European perspective, which is probably different from American one. So the question is we are not that many. We are not few, but we are not that many, first.

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Second, the ocean has always been very hard to sample by a few reasons because it's very hard to take measurements. It is much easier to take measurements on the air about the atmosphere than on the ocean. You need to install systems that can be destroyed, can be lost, whatever. And you can just sample for a limited amount of time.

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And then something that I know well by working with the European Centre for Medium-Range Weather Forecasts is that the typical approach to oceans in

meteorological models, in operational models is quite simplistic. So many physical processes which are important are oversimplified. And for instance, something which is crucial in the case of the slowdown or even interruption of the AMOC is a variable that is not very well described. It is well known, for sure, but it's not available on this scale, which is salinity.

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In polar region, salinity is having a very huge role, the price to having measurements of the salinity. And typically, methodological models tend to underestimate the role of salinity, the concentration of salt in ocean water. And this is affecting, also, climate models. So overall, we have been paying attention more probably to the atmospheric part on one hand, and also the question that, well, oceans have found to be much more complex that we thought or, I mean, the public perception of them.

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And then, for sure, there is the same point that we have with climate change, in general, because at the end when you are reporting that there are problems, that the human activity is affecting our environment and this can have consequences, so there is a tendency to try to move out from the topic to not want be very willing to discuss this because of the consequences that will have in the economy at large. But this is very similar to what happens with many other topics that overlap, that concerns the arrival of the limits or the way of physical limits of the planet.

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So at the end, we will need to organize ourselves in a different way. And this is very hard to be heard by, in general, politicians, authorities, administrations, also big enterprises, and, as Professor Pauly has said, for the people that has problem just to pay the rent. You cannot go there and talk them about the difficulties proposed by the slowdown of the AMOC because they're going to say, "Okay, I have many more pressing matters right now, and I am not interested in what you're talking about." I think it's a mixture of all those things.

Peter Ward (00:29:03):

Yeah. This is an interesting topic. And for instance, to me, growing up, I was raised on a fabulous book bought by my mother for me by Rachel Carson, the Sea Around Us.

And it was Rachel Carson, of course, who then later began really telling us how badly we are polluting the ocean and therefore nature. But the problem with understanding and getting the public to worry much more about the ocean is, as my colleagues have alluded to, the visibility aspect.

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Everything seems to be going on down there. It's very difficult to see anything going on there. We can see rapid climate change. We can see Arizona and Phoenix going through a month of over 110 degrees. We can't see the raised temperatures in the ocean where even a three or four degree rise in temperature is just as catastrophic or more so. We can't see it.

(00:29:56):

Secondly, I think we all have this belief that the ocean, it will save our collective bacon in some way. Yes. There are changes coming, but we have the sense that for sea-level change, everyone, I think, recognizes this would be a bad thing. But look, we have these estimates where a meter in maybe 70 years, well that doesn't sound so bad. That's just an itty-little bit per year. But what the ocean does, that I think people don't appreciate, it undergoes enormous state changes in ways that are very non-intuitive.

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Now, perhaps the most common one that we might think about are La Niña and El Niño. These big current changes that affect the global climate. They happen relatively quickly. Within a year or less we've changed the state from one to another, and it doesn't happen over centuries. It's a very quick change. This is the greatest danger facing us. The ocean is going to go... It's going to undergo a state change, from what we are now seeing as the state change that we are used to in a very cold climate, we have ice sheets, we have lots of ice in the water, to a change where they're gone.

(00:31:15):

And they go relatively rapidly to an entirely different type of ocean, a stratified ocean where we don't have oxygen everywhere, where we only have oxygen in the very top surface area. Look at the Black Sea. There is not a great fishery. There isn't a lot of food coming out of the bottom of the Black Sea. It has undergone a state change to a stratified system that cannot... As my colleague said, "It's hard to breathe underwater."

It's even harder to breathe under water when your oxygen is completely gone. So we have a sense that the things are going to unfold slowly.

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As we go from a day to a night, we can see a hot day slowly recede into coolness and then a cool night slowly turn into warmth. But what we don't recognizes is how quickly, on a global scale, major climate regimes can transition one to another. This, to me, is what the public needs to know, that slow and gradual is not how major climate change works. And we have already put so much heat into the ocean that it's now a sense of what can we save rather can we go back to the state that we were in?

Daniel Pauly (00:32:32):

I said that I don't know Peter Ward, but I was wrong. I use your book all the time. That's crazy. I just didn't connect at all.

Nate Hagens (00:32:44):

Yeah. Well, he has like 17 books.

Peter Ward (00:32:48):

I'm disconnected most of the time, so it's perfectly fine.

Nate Hagens (00:32:53):

Peter, let me ask a follow-up to that. And all of you can speculate on this. I'm not an ocean scientist, but I've seen a lot of graphs. Today's July 31st, and we see the sea temperatures are like five standard deviations of the typical anomaly. One of you mentioned the temperatures off the coast of Florida are 100 degrees. There have been some explanations. El Niño is causing some outgassing of heat. Maybe the Saharan dust storms have something to do with it.

(00:33:28):

But is it possible that we are undergoing one of those state changes right now? Can you speculate on that? Does anyone have any clue? But the things seem different, and maybe that's my availability cascade because I care about the oceans and climate, and so I'm emotionally applying what I'm seeing to my own priors. But what do you think? Start with you, Peter.

Peter Ward (00:33:51):

Well, I'm glad I have a colleague from British Columbia here because we both, I think, two years ago underwent one of the most surprising climate effects that I've ever known. I was born and raised in Seattle, Washington. I did my PhD in Ontario, but I've lived most of my life on the West Coast of North America in this Northwest corner. And we have seen temperatures, over the last couple of years, unlike anything over my 74 years of life. Since a Seattle resident, there every year, I've never seen anything like this, change of that magnitude where parts of BC were so unbelievably hot, as was Seattle and the entire Northwest, and yet we're seeing this all over the planet.

(00:34:39):

We are seeing these crazy temperature changes, and it's even more concentrated, in many cases, in the oceans. I've had the good luck of using baited remote underwater video systems for the last 20 years in the South Pacific. We put down these camera systems to 300 meters. What has happened to the oceans down there is a combination of very oxygen-poor water, very warm water, but the complete disappearance of big fish. I've been diving in those waters. I used to be afraid for my life in Papua New Guinea for sharks. The last 10 years I haven't seen a big shark. So we've denuded the world of its fish, which is rapidly changing, but it's hand-in-hand with the temperature and oxygen changes down there.

Daniel Pauly (00:35:33):

I remember very well the heat wave that happened two years ago. And interestingly while in Seattle, which is about, the Seattle area, the size of Washington, oh sorry, of Vancouver, while there were about 50 people dead, there were 5 to 600 in Vancouver because people don't have air conditioning here. And they were surprised, the social services and stuff, old people, like us, being stuck in their apartment and being surprised by the heat.

(00:36:12):

And I just worked a number of travel in Belize. I was in Belize, and I almost choked in the fieldwork. And the Belizean who are used to the heat, and most of them are of African ancestry, they said that they had never seen anything like that. I was in China, in Hong Kong and in Qingdao and Xiamen, and it was intolerable. And the people in

China were saying, "We've never seen anything like this." So it is happening on a grand scale. I cannot imagine that these temperatures can keep on increasing, creeping up without massive

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... death because I'm old, and I could see that I was at the edge when I walked out in the sun. And I can imagine that it's not in 20 years or even in 10 years that it's going to be in deep trouble, but in a few years.

Nate Hagens (00:37:21):

Antonio, do you have any comments on this?

Antonio Turiel (00:37:23):

Yes. Well, regarding the question of what is happening, especially this year because this year seems to be a bit special, I recently prepared the report for the Spanish Ministry on this. There are several possible explanations, causes that may be... Well probably, they are influencing the situation right now. But the question is that we don't know yet to which extent and which is a relative impact of each one of them.

(00:37:56):

There is something which is clear, is that the eruption of the Hunga Tonga volcano past year that projected a lot of water vapor in the stratosphere may have had an influence because it has increased significantly the amount of water vapor in the stratosphere. But also, it should be recalled that the stratosphere is not the place at which the majority of the water vapor is. So the variation is relatively small when you look at the whole of the atmosphere. But this may be causing an increasing of the energy which has been trapped, the greenhouse effect, and so leading to an increase of the temperature. I don't think this is very large, but it's something that needs to be examined, for sure.

(00:38:47):

The other reasons that could explain part of the things that are happening, something that we have observed particularly in the case of North Atlantic, is that there is a significant anomaly with winds, with wind stress. So winds are blowing less in the North Atlantic, and this is leading to an increase of stratification, less mixing of ocean

waters. And so this could lead to the forming of a relatively thin warm layer of warm water on the surface. But in case that these winds are established, they could mix again, and then the temperature will not be so dramatic in the case of the ocean water, in the case of North Atlantic specifically.

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But the problem is that then the question is why the winds have decreased so much in speed, no? Regarding El Niño, I don't think the El Niño is a leading cause because, first, it doesn't seem that this El Niño is going to be as large as, for instance, the 2015-2016 El Niño. It seems it is going to be relatively normal. And also we are in the onset of El Niña that will peak by December. Of course, it has an influence, but it doesn't seem to be one leading influence.

(00:40:12):

But I would like to point out something that was puzzling scientists some years ago, is by the beginning of this century we observed that climate models were forecasting an increase of temperatures, of air temperature, which was not really according to what we were observing. So the increase in the temperature of the air was not as fast as foreseen in the models. And some years later we discovered that all this extra heat which will being accumulating in the first 600 meters of the ocean, and so the question was that this heat has been trapped there.

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Something that may be happening and something which is also a matter of concern is that either we are saturating the ability of the oceans to accumulate heat in the first 600 meters, because of course it is large, but it is not infinite. And also it depends on some processes that have given efficiency. So the amount of heat that you can accumulate depends on the ability of this process to store the heat inside the ocean. And also our problem that may be happening is that we also know that there is some cyclicity in the processes of pumping heat into the ocean and pumping out from the ocean. So the problem is that maybe we are changing this cycle that seems to have a periodicity of about, I don't remember, 40, I don't remember, 20 or 40 years. I don't remember actually.

(00:41:52):

And maybe we are in the opposite side of the cycle. In this case, the ocean is returning us the extra heat that he has been accumulating, no? So there are several things that can be influencing this particular year. But as they have said, what is quite worrisome, is that it's not a local phenomenon. It's a real global phenomenon. It's a global phenomenon that is accompanied also by other things which are very worrying, as for instance, droughts because the prevalence of droughts all over the world is leading to a failure of the crops in many parts of the world. So this is leading, for sure, to a diminution of the amount of grain, of cereals, of wheat, of all the things that, the basic staple for human and cattle food. And this is going to be very bad, actually, and this, for sure, combined with all the other problems that we have. For instance in Europe, we are very concerned with the problem that now Ukrainian grains cannot exit Ukraine, and this is going to affect many countries, especially in Africa and other places.

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So well, everything that's said conspires for the worst in that case. But just to see that there are several causes that could explain what is happening this year, we're going to examine all of them in detail. We are going to try to determine what is really going on. But we cannot rule out the possibility that we are starting a process that can last for several years. And the problem is that if we go ahead increasing the temperatures, this is going to be very tough for many people in many parts of the world, for sure.

Nate Hagens (00:43:40):

So let me ask a follow-up, Antonio, and then get also Peter's paleo perspective on this. How does the top 600 meters become saturated? And what happens if it is saturated with heat, and it cannot absorb anymore? And then, Peter, after he answers that, are there historical analogs when the top layers of the ocean absorbed all they could, and then there was a phase shift where it released it? Antonio, do you have any answer there?

Antonio Turiel (00:44:10):

Well, the question is that, at the end, and the capability of the ocean to trap heat is, well, it's completely associated to the mixing at the end. I mean, by the ocean surface, you have a transfer of heat. I mean, the normal process is, it has to have two different

things in contact. You have the water, you have the air. They have different temperatures. And then it depends on the ability of the wind to generate waves to mix.

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And take into account that when you have very intense winds, so you have a mixed layer, so in which all the water in the column is mixed. That extends for 20 meters, at the very least, and they can have 100 meters. And in some cases, you have very, very intense winds. The effect of the mixed layer can extend up to 1,000 meters. This is not the usual situation. But let's say, to say something, that in many places... It depend completely on the place of the world, but it typically extends several 10s of meters and sometimes 100, 200. This is completely normal.

(00:45:08):

So the ability of the ocean to gather this heat is strongly mediated by the capabilities of... Maybe it was mediated by the mixing. It's the main thing. It's not the only one, of course. You have convection. You have diffusion. You have many, many other processes that are important in the long run. And this saturation effect will be more related to the changes in the global winds, I think. I think. I'm not completely sure on that.

Nate Hagens (00:45:39):

And the currents, the AMOC, like you guys were talking about before, that too.

Antonio Turiel (00:45:43):

Well, the question with AMOC, yeah, for sure. Because the question with AMOC, as Professor Ward has explained previously, is completely related also to winds because winds are the main factor in order to make water dense, because they are favoring the diminution of the temperature in the water

(00:46:03):

parcel. And what it is, it has reduced enough, you are still working with a very salty water parcel because these waters come from the Gulf of Mexico, from tropical areas. They are very salty, they have a lot of salt inside. And when the temperature decreases, this makes these two get very dense, very heavy, they'll say, and they sink. So you have a lot of overfloating freshwater coming from the thawing in Greenland

and the sea ice and so on, but mainly of continental ice. So this very fresh water, so almost no salt, very low salt, it's very hard to be sunk. And this, of course, also is contributing to reduce the efficiency in the release of heat from the ocean to the atmosphere and also in the possibilities of mixing the first meters. Everything is connected and sometimes, there's something which is typical in the climate system, everything is coupled. So you change something in the ocean and this has a feedback effect on the atmosphere, that has a feedback effect on the ocean again and again. So sometimes it's hard to say, okay, this is a starting here. No, it's something that which initiated some part of the process, but this is a loop and this is affecting in a secret way. And sometimes, unfortunately, we have these positive feedback loops that tend to increase the problem instead of solving it.

Nate Hagens (00:47:32):

Peter, I'm going to let you weigh in on this, but in addition to the question I asked before, I'll append this part two, can you define a Canfield ocean? And I know you are no way capable of doing a peer review speculation on it, but just as a human, as a scientist, what are the odds you think that someday we will have a Canfield ocean due to the aggregate of human activities?

Peter Ward (00:48:01):

Well, Don Canfield was one of the really great scientists in my field as well as in climate science. He was a great chemist. The interesting thing that he looked at, he came out of Yale, I believe, and he was able to think clearly about deep time. And so instead of looking just at the now, and so many climate scientists today are really, students of the present, and the advent of ice cores has truly revolutionized our ability to look back tens of thousands to hundreds of thousands of years. But ice cores only go back a hundred thousand in most cases. And Canfield and others are able to look back millions of years. So a Canfield Ocean equivalent is, let's think of, what's the nastiest swamp you know of. So a swamp is someplace where we have very warm water, very little oxygen in it, big bubbles of swamp gas come out, methane rotting material and material stops oxidizing. You used up all the oxygen and the bottom starts producing these bacteria that grow only in the absence of oxygen. And one of their byproducts is hydrogen sulfide, this very toxic, nasty poison.

(00:49:23):

Well, Canfield and others began to think, "Gee, maybe in the past, especially during the great mass extinctions, take that swamp model and stretch it to the global ocean. Could there be a case where we don't have overturn, that we have a warm surface and a warm bottom with no oxygen throughout?" Well, we have seen cases in the deep past where that has been the case and it's come about by the study of biomarkers. One of the really great clues was the discovery that many types of bacteria, in their body walls, the fat of their cell walls, leave fingerprint like molecules. And there are such things. There are some nasty, I call them nasty, bacteria that are photosynthesizers. They need to live in sunlight but they cannot live if there's any oxygen in the ocean. And they produced a long biomarker called Isorenieratene. This is the product of green sulfur and purple sulfur bacteria. Again, these things need light to live, so they have to be in the shallow ocean, but they can't have oxygen around them.

(00:50:37):

So we have evidence now, during the Permian period, 251 million years ago, of a majority of the global ocean that was also dropping sediments. So we're talking about shallow water deposits where there were surface bacteria indicating the surface waters were without oxygen or very low concentrations. This is totally unlike anything that our planet has seen. Even the Black Sea, next to the surface, there's enough wind, there's enough mixing that there is a mixed layer of oxygen at the top. To get these big bacterial blooms of the Permian, you would have to have a very, very different world than today. And this is where this idea, the concept of uniformitarianism, that the present is the key to the past, totally breaks down. There's nothing in the present that can get us to understand what's going on in the Permian on a global scale. It was really different. And of course, it led to an enormous extinction of oxygen loving organisms. The big mass extinction killed off the oxygen breathers. The world became a global swamp. This is the direction we're moving now.

Daniel Pauly (00:51:51):

So, one thing that could have been mentioned up to now, is that, it was mentioned several times, that the winds are diminishing overall globally. And the reason for this, is that the pole are warming faster than tropics and then the wind is nothing but a

balancing act between these two. And therefore, there is overall less wind because the gradient is less. And it's also the reason why the jet stream, instead of being fast and straight, is now meandering around the globe, which is falsely labeled as polar vortex in the US. The public doesn't understand what it means. It means that in California you can be cold and in the east coast you can be very, very warm. And this is because one of the meanders goes straight to the US and there is such meanders also over the Black Sea and over Asia. And I've never seen in the TV programs any explanation, any simple explanation, for this meandering, which is straightforward.

(00:53:21):

You can explain it as, because it's flat. Because it's flat. And the point about the Canfield ocean that I want to say is, we already have little Canfield oceans, and they are called dead zones. In the Mississippi Delta, in Oregon, in the East China Sea, in various places of the world, there are about 500 dead zone. In the Baltic Sea, the Black Sea and so on, they are dead zone. But they are increasing and they're increasing in duration, in they are seasonal, they are increasing in scope. So what is worrisome, is that if they become permanent instead of being summer event, if they connect with each other, then we will have the beginning of a Canfield ocean. We could have that locally in a part of the ocean and then it would spread like a disease because once the animals start dying, they rot and they contribute to the spread of this. So it becomes a self-feeding process.

(00:54:47):

So I would not argue that we cannot have ever something resembling the Permian extinction because actually we're on our way and we are helping by killing the animals before they have a chance to choke to death. And this warming thing, it very well could become self accelerating and the ice melting can actually prevent this thinking of that Antonio talks about and the renewal of the deep water. And so I had physical oceanography as a minor and I understand all of this and this is scary as hell.

Nate Hagens (00:55:45):

There's a lot of different ways, gentlemen, that I could go right now. But if you'll recall my invite to you a couple of months ago, we were going to have a fourth panelist, DJ White, who co-wrote three books with me and was one of the original founders of Greenpeace. And he wrote a question, a long one that I'm going to read here to get

reactions from each of you. This is from DJ White. My big paralyzing worry, as one who has gotten to know dolphins as people, is that food web collapses occurring in the coming 1000 years, but locked in this century, which scour the seas of most K-selected species which are generally fairly vulnerable in food webs. The loss of coral alone would do huge damage to ocean food webs and that is no longer even controversial, now is happening within a human lifetime. Loss of calcifying plankton, increased energetic difficulty of animals with calcium endoskeletons to exist, all happening at the same time that human pollution messes with them and there's a tragedy of commons war against sea life. It's too much.

(00:56:59):

Most of the high self-aware species of earth are not apes like us. There are maybe 50 species of pelagic citation peoples or more, and we're setting up their likely extinction. The fact that nobody is really talking about this as an immediate concern, is very scary to me. Turning it around, just how would a species of pelagic dolphin be expected to survive all this stuff at once with niches simultaneously being claimed by very effective opportunistic simple organisms? I think we're committing the biggest crime it is possible for a conscious being to commit the seas represent something between 97 to 99% of earth's living habitat. The part we care about is a rounding error. We only think about the oceans in terms of how they affect us and what we can extract in the extreme short term. That's a pretty strong statement from my friend and colleague, DJ, but do each of you have any thoughts on either the science or the emotion behind that?

Daniel Pauly (00:58:07):

So in the Med for example, in the Mediterranean, they catch tuna, the juvenile tuna and fatten them in cages and for export to Japan. And they are fattened at the tune of 10 to 20 kilogram of fish for one kilo of tuna. And this has led to a hunt on the last sardines in the Med, sardine and similar small fish. And they are literally, taken out of the mouth of people because sardines are, in Spain, for example, when I was a kid I ate sardine in a bun and it was the best thing in the world for kids. And they are not available anymore for people to buy because the mafia, and this is really a mafia operation, that sells this tuna to the Yakuza in Japan, other gangsters, they have completely monopolized the availability of sardines.

(00:59:24):

Now that has led to a situation where in the Eastern Med, the dolphin that are there, the common dolphin, this is something that I had never seen and I never thought I would see it, the dolphin that swim have nothing to eat. So you can see the ribcage like a mangy dog. And that, I have never seen before. A dolphin, you can see the ribcage because they have nothing to eat. And that is the case in the Eastern Med and I presume also, in the Western Med, that the marine life has nothing to eat anymore because it all goes into tuna fattening operation.

(01:00:14):

And that is one example of the madness of it. In West Africa, the same thing is happening. The sardine that were eaten by people go into fishmeal that is exported mainly to China and to produce a form of aquaculture that actually consume fish because it used relatively cheap fish to produce expensive fish. And the destruction of large marine mammal population will actually be accelerated by plastics because they really suffer from plastic that fills their gut. And so, I don't know which of these forces will be first, that the plastic problem will cause the population to be reduced or they will have no food. And this is also the case for sirenian, the sea cow, the manatees in Florida, they have nothing to eat and there is a program to give them lettuce. They put tons of lettuce in the water for manatees to eat because the sea grass is gone. So all these things together mean that marine mammals, a huge amount of marine mammal, will be lost.

Nate Hagens (01:01:54):

Peter or Antonio, would you like to comment on the ocean food web query by DJ?

Antonio Turiel (01:02:00):

I will say just two things because I am not a biologist, so probably, Peter could have more interesting things to say. But just two things that I have been evoked by that question. First, about this simplification of ecosystem. This is something that we are seeing in some parts of the Western Mediterranean right now, in which we have very simplified ecosystems in which we have almost nothing on the floor. A species... I need to look to see how it is said in English because I don't know. And you have jelly fish on surface. So these are very, very, very simplified ecosystems and it's something that is

happening in many places because we have this overfishing and we have these factories for fattening the tuna fish, we have a couple here in Spain, and this is as he has said, so the word I was looking for sea urchin. So we have sea urchin-

Nate Hagens (01:03:06):

Sea urchin.

Antonio Turiel (01:03:07):

Urchin, exactly. Sea urchins on the floor and we have jellyfish on the surface and that's it. It's a very simplistic ecosystem. I don't know how it can even work, but it is something that we are observing many places in the Western Mediterranean right now. The other thought that was coming to my mind, something that is happening, is quite anecdotical, but it's also interesting, is that we have observed during the last months, a continuous series of attacks by killer whales against yacht. So they are breaking parts of the yachts, so making them not possible to navigate. And this is continuous for some reason, probably one killer whale was hit by one of the yachts and it learned to attack it and it has taught this to other killer whales. So now they are the devoting their force to try to interrupt the transitive of yachts, mainly across the Gibraltar strait. So dispatched from the main transit to Atlantic. Well it is, it probably is quite anecdotical, but I think it's also a powerful message there. Say they-

Nate Hagens (01:04:26):

They're fighting back.

Antonio Turiel (01:04:27):

They're fighting back. Yeah, in some sense. Well, this is quite romantic view of the theme probably, but simpler than that. But it is interesting anyway,

Nate Hagens (01:04:36):

Peter, on the trophic food web question.

Peter Ward (01:04:39):

Yeah, I guess, one of my hats I sometimes wear is the term astrobiologist, trying to think of Earth as just one planet that might have life. If you start thinking about, as some of the astrobiologists have done, try to decouple diversity, the number of species from abundance of life. So we could look at life in terms of productivity, you can measure that. But what if we just had a simple measure of the number of kilograms of living matter on the planet. When would it have been highest? The idea about mass extinction is, that like a Gary Larson cartoon, you go walking in front of all the homes of the dinosaurs and the little sign up on their doors, "Extinct. Extinct. Extinct." Everybody's gone. Desert world empty. That's totally wrong. I guess some of the calculations I've been playing with is that biomass increases in mass extinctions because you go ever lower down the food chain, you get more and more bulk.

(01:05:43):

We worked in Western Australia at Windjana Gorge, this fabulous Devonian reef, which has been left stranded without any sort of tectonic effect on it. It's a giant barrier reef that is 360 million years old and as you walk through the gorge cutting through it, you see beautiful coral reefs that there's a rapid extinction. You see the black water, the oxygen poor water, the sediment, the biomarkers indicate that we had one of these Canfield oceans and then we have, the reef lives, it continues. But it's no longer produced by animals, it's a microbial reef. And they keep building and they even build bigger reef than before. There's slime. There's slime that can produce calcium carbonate. That is the ocean we're moving towards. So one of the laughs for me, I love cephalopods and this big fight, global fight, all through geological history, the fish and the cephalopods have been duking it out.

(01:06:47):

Well, in 2014, a team from University of Adelaide, where I was for that year, became a very influential paper. The cephalopods are increasing. As we wipe out fish, there's more and more cephalopods. But all you need to do is walk on one of these Triassic, Jurassic, mass extinction boundary in England or anywhere else, or at the end of the Cretaceous or at the end of the Permian, the first thing out of the gate are cephalopods. And I was, luckily enough, went off to Papua New Guinea in 2022 and spent a month at Kavieng, New Ireland. And our cameras go down there. There's nautiluses everywhere down there. No fish, lots of nautilus. There they are. Save the nautilus. Well, we're saving them by killing all the fish. There's plenty of them down

there. The cephalopods are doing fine, thank you. But we are going into a case where diversity is dropping, but abundance to life on the planet may not be.

Nate Hagens (01:07:46):

Well, there would be an abundance of life just far less complex, large life.

Peter Ward (01:07:51):

Yep. Yep. Lots of microbial slime.

Nate Hagens (01:07:55):

So is this, gentleman, ocean scientists and activists, is this the ocean version of the movie with Leonardo DiCaprio called Don't Look Up? Is that's what's happening here is, we won't do anything until it's so obvious, the disaster that's happening to the oceans, that it'll be too late to do something?

Peter Ward (01:08:17):

No, my sense of it, this is Medea hypothesis. This is Medea. This is not Gaia. This is the black evil twin of Gaia. This is life doing it to itself. We humans are life. Well, life is really going to constrict itself here from complexity to simplicity. So the trouble is, too many people haven't been looking, Don't Look Up, don't look down, don't look anywhere. The problem is, people have not been looking into the ocean, as my colleagues so eloquently said.

Nate Hagens (01:08:52):

So let me ask you guys this. A lot of the things that we would, as a global culture, do to help avert the worst of climate-

(01:09:03):

To help avert the worst of climate scenarios would also help the ocean situation, but are there things we could do separately to help the oceans that would be distinct from the climate action and mitigation? Are there things we could do to help the ocean situation? Daniel, you want to start?

Daniel Pauly (01:09:24):

Yeah. I mentioned when I made my introductory speech that subsidies are one of the motors of overfishing, and overfishing is one of the causes for the lack of resilience of marine ecosystem. If you could get rid of subsidies, then you would have some stocks bouncing back. We have also produce propose, and it's not impossible to close the high sea to fishing because it's essentially a place where you can go only if you are subsidized. This sounds like a crazy idea, but the suggestion that countries should have exclusive economic zone extended 200 miles off shore was also crazy when it was proposed by some Latin American countries, Chile and Peru. 20 years later, we had the United Nation Convention on the Law of the Sea, so I think these two goals could be helping, at least from removing the fisheries, because let's face it, the various things that we talked about, they're not designed to kill marine biodiversity. But fisheries is. Fisheries is designed to kill marine animals and to remove them from the ocean.

(01:10:57):

So if we could get rid of subsidies... The agreement at the WTO, or the World Trade Organization, is a lousy agreement, but it is possible that a better agreement come because the right wing market first fanatics are also against subsidies, not only the conservationist. So we could get rid of subsidies, and maybe we could also get part of the high seas closed to fishing. We could monitor that easily, and these are measures that have nothing to do with the global emission of greenhouse gases. It would help the ocean a lot.

Nate Hagens (01:11:42):

Daniel, let me ask a follow-up question to you. I had sent you an email a few weeks ago. I didn't understand this, but there's some science that shows that totally healthy rejuvenated ocean fish populations themselves would have a positive effect on climate change. Can you explain that, what that means?

Daniel Pauly (01:12:05):

I'm not a good chemist, but essentially, teleost fish, bony fish excrete in the fishes, calcium carbonate, I think, or something that remove some of the carbon from the sea. So they themselves would contribute, and also, in an age, in a time when tuna were dying of natural causes, their carcasses would drop to the floor. There's an entire

community of animals that eat whales and carcass fall and tuna that fell to the floor to the bottom of the sea. We have these fluxes that remove carbon from the atmosphere. We have interrupted them and turned them around, so if we had lots of fish in the sea, they would actually contribute a little bit to offset the effect of greenhouse gases.

Nate Hagens (01:13:15):

Peter, Antonio, are there any things we could do ocean specific leaving climate aside that would improve the ocean's chances?

Peter Ward (01:13:24):

Well, yeah. We do the reverse of the movie, The Graduate. Our poor hero is asking an adult, "What should I go into?" And the answer is plastic. Well, I think we do need to reverse the plastic, as my colleagues have stated. The ocean is being strangled by plastic. One of the saddest things for my life has been working every year in the Philippines, and of course, when you go out on a field trip, you need lots of stuff, sundries. In the Philippines, in every drugstore, every item you buy, let's just say it's tooth mouth, toothbrush, or Band-aids or whatever you get, they put every single item in its own plastic bag. So even a small shopping accumulates 20 or 30 or 40 plastic bags in a big plastic bag. They all end up in the ocean, and they break down under that sun. Now we know from the deepest part of the Mariana's trench plastic is everywhere.

Antonio Turiel (01:14:24):

I would like to add something on top of this in the same sense because I think that something will be very useful is to review all the inflow of plastics going to the ocean. We know that the majority of microplastics are coming by the rivers, and there has been some interesting experiences, even in California, just controlling what is going down the river because typically what happens that people abandon a plastic object or whatever. At the end, by the way in this finish going to the river, and from the river, it goes to sea. There are some relatively easy ways to contain this plastic before arriving to the sea in which it will be reduced, broken up until it becomes very small.

(01:15:07):

Another significant thing that can be done for sure is to reduce the use of plastic. Plastic is still widespread. It's completely absurd. It makes no sense. It's not useful, and in fact, plastic, I think, is too valuable to be used the way it is used because there are some specific uses in that industry in which it will be preferable to have this plastic for that. Something also which is important has to do with clothing. The vast majority of microplastics arriving to the ocean come from the microfibers that are getting out from our clothes when we are putting them in the washing machine.

(01:15:44):

This is important because these microplastics are directly entering the food web. It's affecting all the life in the ocean. It's affecting ourselves also, so we should change the way in which we are making clothes because we should do it a very different manner. Maybe using more cotton, I don't know, or maybe not elaborate in the way in which they are elaborated. Also, to compliment the things that Professor Pauly has said, something that we know for sure is that healthy ecosystems are very helpful, precisely in capturing CO2 because there are many ways in which the ocean captures CO2. He has indicated several. It's not only the skeletons of the fishes, but it's in general also the exoskeletons of algae, the microscopic algae. There is a continuous balance between organic carbon dissolving in the water, inorganic carbon dissolving in the water.

(01:16:50):

When you have a healthy ecosystem, the ocean acts as a real trap for CO2, so just allowing the life in the oceans to thrive is also very interesting from the point of view of fighting climate change and from the carbonization. For that reason, it is very important when we are planning doing some industrial activities on the ocean that we should not be disrupting ecosystems even more. I think in here about, for instance, some offshore wind farms that are planning places which have a lot of biodiversity. These are not the place to place this kind of facility, and also especially ocean mining, which for me is a completely absurd thing because it is too energy intensive, so it's too costly. But they are still thinking about this kind of stuff, and even if they probably are not going to operate in the larger scale, this is the kind of things that you should not do if you want not to disrupt these ecosystems that are so valuable on themselves and also for our own interest of fighting climate change.

Nate Hagens (01:17:57):

Is there anything on the geoengineering front involving oceans, like green sand or things like that? Olivine crushing? Is there anything that is potentially viable on the horizon, or are they all Frankenstein sorts, out of the frying pan into the fire? Daniel, would you like to comment?

Daniel Pauly (01:18:23):

These techniques are all dangerous because imagine we would put sulfur particle in the sky. We would have a fleet or plane darkening the skies, and then we would continue with the emission, obviously. The ocean would further acidify and everything, and then we would have a reduction of the temperature for a few years, if it worked. Then the whole thing would be exploding when the system is pushed to some limit, and I would like to add a little thing. I'm a friend with lots of people from the aboriginal communities here, and in the north of British Columbia in so-called Haida Gwaii, a bunch of crooks, some from California, came and sold to the village elder the notion that he would grind up a few Volkswagen and throw them in the water and this would produce lots of salmon.

(01:19:35):

They got from these people from the tribal council 1 million buck, and they went away with it. Obviously, you couldn't distinguish what they have done from the normal spring bloom of zooplankton, and this was a bunch of hucksters. This stuff, I see it as the same thing a giant on a global basis.

Nate Hagens (01:20:06):

Peter, Antonio, on the geoengineering topic, any words?

Peter Ward (01:20:12):

I don't know enough to know, other than I certainly thought that the idea of putting sulfur in the atmosphere, as was just mentioned, is such a terrible idea, and I think it's equivalent to what people have said for trying to help out the oceans. At this stage we don't know enough to know what these things will do, and in all probability, they can just make it worse.

Antonio Turiel (01:20:33):

Well, the question is that putting sulfur in the atmosphere, when it combines with water, it gives sulfuric acid. This is acid rain. Also, this creates a lot of health problems in the ecosystem, so this really a very bad idea. In fact, we have done the opposite experiment because since 2020 we have enforced the new maritime regulation that forces the ships to use fuels that create less SO2 emissions, less, well, the emissions of sulfur. What is happening in places that were heavily contaminated at, especially in Europe, is that the sulfur was creating adenine, so this was creating a screen between us and the immediate layers of the atmosphere. So we were not experience it in all its intensity, the climate change. Now that we have removed all the sulfur, the temperatures on land on Europe have increased probably because of that, and also in parts of the ocean for which the seas were passing continuously.

(01:21:41):

In general, it is very dangerous because you are not aware of what we are doing. You can trigger out a lot of other processes that you don't know, all those intended consequences. The chemistry of these substances tend to create something which is very bad, and in general, it's a very bad idea. There are other kind of geoengineering which is specific of the ocean that has been discussed quite frequently. It's fertilizing the oceans using iron because the product that we have in the oceans is that there are a scarcity of several specific chemical elements, and iron is one which is scarce. So when you are disseminating iron dusts in parts of the ocean, you can generate artificial blooms of algae, and this algae, in line and in principle should be capturing the CO2 because in the exoskeletons they are formed by carbonates. So they are capturing this and going to the floor of the ocean. So this will be good. This is the idea behind this.

(01:22:46):

The problem with this is that you can create such a big amount of blooms that you can really kill a lot of ecosystems. It's a very nasty idea, and you can, at the end, create... you can create a collapse of all these ecosystems. Then even if you wanted to go ahead fertilize those and to create more blooms, maybe this is not going to have any effect because probably you have not the algae there. So in general, these things about geoengineering, I think that they are very dangerous because we are under the

impression we have in the control of the situation, but we are not. There are many unintended consequences. There are many process that we don't know, and we wouldn't go for doing something the larger scale without having test this before. This is very likely to happen, and this is very likely to turn on the worst side.

Nate Hagens (01:23:40):

Yeah. I mean, the arc of the story of the twilight zone that we're living in suggests to me that once we get desperate, we will try something systemically blind, like the things you guys were just mentioning. I want to be faithful to the time estimate I gave you all because I know you're very busy. I have one final question to ask you. I could keep this going for four hours. You guys are all separately heroes of mine that you've spent your life work and life force on behalf of understanding what's going on in the oceans and the science, so I really am grateful to you as human beings for your dedication to this. A closing question for each of you; if there was one question that as an ocean scientist you would like to ask society, those people watching and listening to this program, for them to consider in order to solve a problem in an area of your specialty that you're working on, what would that be? What question or issue would you like listeners to consider?

Daniel Pauly (01:24:56):

I was in Hong Kong and in China a few days ago, and the same question came up. Basically, the question was that in Hong Kong the people see the ocean only via food, via seafood. This is the only way they appreciate the ocean, and the point was being made that the ocean is not a ladder. It's not only a provider of food, and in fact, if we see it only as a ladder, we will lose the food provisioning that the ocean provide. I would say we have to learn. We have to try to get the people to see the ocean as more than a provider of food, and, thus we have to reign in the fisheries, especially the overfishing, in order to maintain the ocean doing its own thing because its own thing is maintaining life on Earth.

Antonio Turiel (01:26:17):

I could say something on that. I am now thinking more on the physical part of the ocean. I think that if I should pose a question to anyone regarding the oceans and

what is happening, something to make they then think about it is, do you want to fear the ocean, to be scared of the ocean? Because, for instance, here in Spain, we have a lot of population living by the ocean, exactly which is general of all the countries that have coasts, and the problem is that, for instance, in some areas here in Spain, the water now in the Mediterranean is so hot that it just starts to be uncomfortable even to take a bath there because it's very, very hot actually.

(01:27:02):

The question is that as the amount of heat stored in the ocean increases, this makes that any tempest, any storm coming from the ocean is going to be more and more violent. In fact, we want to live by the oceans because there are many values of living by the oceans, but we don't want to be destroyed by the ocean. The kind of tempest that we're discussing are really becoming very dangerous. It's not the typical tempest that we see here. So for me, the question is, do you want to be able to live by the ocean? Do you want to have the ocean as an habitat at which you can live by the side, you want to be there, or you'd want to live a life in which you will be scared for anything who comes with the ocean in the form of these huge storms and so on? This is something that I think that people should think about, which kind of environment we want to have, even for ourselves.

Peter Ward (01:28:04):

Yeah. I think about the greatest single threat that I see to current human civilization is going to be a lack of food, and a lack of food is going to be coming from, already as we've seen, overfishing. But also as we melt the continental ice sheets, Greenland and Antarctica, sea level rise is taking out low level rice fields everywhere. I mean, salt goes sideways. Hungry people are politically unstable people. Warfare. How much carbon dioxide has gotten into the atmosphere because Russia attacked Ukraine? The US is building armaments like crazy. The Russians are. We have stopped this sense of a global sense that climate change is really the biggest problem, now dealing with yet another global war. We've got to save the ice sheets. We've got to keep ice because if we lose ice, we really lose sea level and we lose food. Then we lose peace.

Nate Hagens (01:29:08):

Thank you all. I am really reluctant to end this call because you all have such scientific knowledge to contribute and also human vulnerability and honesty, and maybe we could do this again because there's a lot that we didn't cover about the importance and risks of world's oceans and seas. Thank you to the three of you. Maybe the three you now that are introduced could write some mind and future changing academic paper together.

(01:29:45):

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