

# The Great Simplification

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Nate Hagens (00:00:02):

You are 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):

Today's guest is ocean fisheries expert Daniel Pauly. Daniel is a marine biologist who teaches at the University of British Columbia. He is also the founder of the ocean fisheries project, the Sea Around Us. Daniel's the author of numerous books and over 500 academic papers. He's quite simply one of the world's foremost experts on the relationship between humans, oceans, and fish, and on the state of the earth's oceans and the fish that live in them. Today, we talk about why fish are migrating northward because they need more oxygen due to warming water, about the world passing peak fish, and about farm-raised salmon and many other topics not often discussed. I expect you will enjoy and learn from this conversation with Professor Daniel Pauly.

(00:01:40):

Dr. Pauly, good to see you, sir.

Daniel Pauly (00:01:42):

Good to see you too.

Nate Hagens (00:01:44):

We haven't seen each other in a couple of years. I have enormous respect for you and your work. You are not very well-known outside of your circles, but everyone that I know who knows you refers to you as an ubermensch, someone who's dedicated to the oceans, and a brilliant scientist. I have a lot of questions for you. Let's dive in.

(00:02:09):

Many of the listeners of this podcast have heard of the concept of peak oil, but probably fewer have heard of the concept of peak fish. You're an expert on global fisheries. Can you give us, just to start this conversation, a view from the stratosphere on the state of the world's fisheries? Has global fish catch already peaked and is declined? What's the situation?

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Daniel Pauly (00:02:32):

Indeed, the world fish catch has peaked in '96, quite precisely in '96. Actually in the North Atlantic, for example, where fisheries became industrialized, the peak was achieved in 1975. But worldwide, it was achieved in '96. And basically, you have in the countries of the world that have good statistics and active fisheries, industrialized fisheries, the peak was reached early. And the catches are continuing to increase, some really and some as an artifact of statistics that have to be optimistic.

(00:03:11):

And we have made a global review of our fisheries in the world and we have corrected statistics in so far as... This is specialized, but when countries submit the statistics to the UN, which is the only organization that compiles world's global statistics, when the statistics method improve, they don't correct retroactively the catch that they have. In other words, they don't cover certain fisheries. Now, they cover them but they don't retroactively cover, reintroduce statistic, the capture of fisheries that were not covered before. So you have an increase that is not real. And when you correct for this point, then you can see that we caught earlier much more than now.

Nate Hagens (00:04:01):

So there's two things going on. We are 25 years past the peak in fish catch globally, and also the decline from that point is understated because of statistics.

Daniel Pauly (00:04:14):

And the UN or the Food and Agriculture Organization of the United Nations in Rome, because it doesn't correct the statistics retroactively, it has peak catch that is not very pronounced. But our reconstruction of the world catch has a very pronounced peak in '96. And since then, the catch declines about 1 million ton per year.

Nate Hagens (00:04:40):

Out of how many total?

Daniel Pauly (00:04:41):

Over 120, 125. And depends what you count, whether you count the catch that is discarded or not. So the official catch that FAO, the UN, produces is 80 to 90 million tons per year. And the real catch of the world is about 130 million tons per year

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because lots of fisheries are not monitored by the countries that are members of FAO. And the FAO doesn't correct the statistics that they submit.

Nate Hagens (00:05:13):

So using the best scientific guess of statistics, how much of a percentage drop is the global catch today versus 1996?

Daniel Pauly (00:05:24):

About 10 to 20 million.

Nate Hagens (00:05:25):

So 10 to 20%?

Daniel Pauly (00:05:27):

No, it is a little bit less than 20%.

Nate Hagens (00:05:31):

15? Yeah. Okay, 15% or so. And is that all ocean fish or does that include freshwater fish?

Daniel Pauly (00:05:35):

It doesn't include freshwater fish. The freshwater statistics are even more messy, and we are in a process of looking at them and we expect the catch statistics to be much higher than reported because African and other countries do not monitor very well the fisheries. See, when you have to do that in space which you do with freshwater fisheries as opposed to monitoring them along the coastline, it's more difficult.

Nate Hagens (00:06:03):

You are a world expert in the health of and the risks to global fisheries. And we're going to get into your work a little bit later, but how did you first get interested in this topic, in fish and the oceans?

Daniel Pauly (00:06:17):

I didn't really get interested because of love for the sea or something. I was studying in Germany with a firm intention of working in developing countries because I was

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biracial. I still am actually biracial. I was biracial in Europe and my identity was always questioned, and I didn't want to live my professional life in Europe. I started studying agronomy, but the faculty of agronomy was People's Will or Nazis. And the not figuratively Nazi, the real thing. They were in the '60s, late '60s, early '70s, still occupying lots of position and I didn't like this situation.

(00:07:04):

And I moved in the same university to the Department of Oceanography and Fisheries which was very good and very reputed, and I grew into that. My intention again when I studied agronomy and later fisheries was to acquire a skill that would be useful in developing countries. And I have realized that I did my master in Ghana in '71. I did the field work for my... And then I did, after I had my master, I worked two years in Indonesia. And then after my PhD, I worked 20 years in the Philippines. And from the Philippines, I was working in tropical countries in general.

Nate Hagens (00:07:44):

Taking a step even further back, if I recall correctly from our discussions over a couple dinners, you were an orphan. How did you actually get interested in science even before you got interested in fishing?

Daniel Pauly (00:07:58):

I was not an orphan but I was taken from my mother who was not married. My father was a passing GI, African-American soldier, and I was raised as if I had no parents. But I do have parents and I met them when I was 19, my mother. And later when I was 23, I came to the US and met my father. I was raised in a Dickensian context, very difficult circumstances. But I was not an orphan.

Nate Hagens (00:08:30):

I misspoke. But how did you get interested in science then?

Daniel Pauly (00:08:33):

Well, basically I was when I left Switzerland where I grew up with this weird family, I ended up being... I worked one year for in hospital. And as a volunteer, they fed me. But after that, I had only the option of becoming an unskilled worker, and that is not a good prospect. And in Germany, they had at the time in the '60s a program of

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encouraging people from the working class to get back to high school in the evening from 5:00 to 9:00, five times a week, for four years. And I did that. I switched from French, which was my first language, to German. And then I did this course. Four years, I got German-ified a bit. And then when I was finished with it in '69, I had the degree that enabled me to go to university.

(00:09:27):

And so I transited from being mistreated kids from working class background to being a budding scientist. And basically I evaluated that physics was not for me because I'm not good enough in math, and chemistry is too small. The things that you deal with are too small, the molecules and atoms too. I don't like that. And I don't like microbes either. They are too small. And so I wanted to do agronomy because it's important, especially in the developing world, growing food. And then I ended up doing fisheries, which is also important in the developing world.

Nate Hagens (00:10:06):

Thank you for that. Can you give us a brief history of humans and oceans and fisheries? Didn't most of our ancestors lived near seas or oceans at one point?

Daniel Pauly (00:10:15):

Yeah. When humans moved out of Africa, the first Homo sapiens and people in the world, they probably moved along coastlines because coastline are never that cold compared to the inland. And the technology for living in the cold had to be developed. Also, coastline, very rich in all kind of food items and stuff. So the hunter-gatherers that we were, the people, the world along coastlines, and in a process, they exterminated all the large defenseless animal that they could reach. And when they penetrated finally into the inside the continent, into the continent, our ancestors in all continents wiped out most of the large mammals. We know that from North America where the mammoth and the mastodon and all kind of giant sloth were eliminated. But it occurred in all continent, in Australia, in Europe also the mammoth were exterminated by people. And we know that also from islands, especially in the Pacific where Polynesians, every time they came to a new island, they would wipe out the large animals, the moas in New Zealand and so on. So that's what we do.

Nate Hagens (00:11:36):

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But it's harder to wipe out things in the ocean because they're more diffuse than on land.

Daniel Pauly (00:11:41):

That's right. And that's precisely why we are doing that in this century and not in previous centuries.

Nate Hagens (00:11:47):

We saved the hardest for last.

Daniel Pauly (00:11:49):

Yes, it's very true, actually. As we first as hunter-gatherers, we wiped out the large mammals and other humans that were not our species. And then we've invented agriculture which wiped out much vegetation that was there, the vegetation we didn't like, and replaced it by vegetation that we like. A wheat field instead of a forest, kind of. And then we invented the use of fossil energy. And I think that the big transition is the use of fossil energy started with the steam trollers in 1880 about in UK. The use of fossil energy is the big transition in fishing. And this allowed us to punch into marine ecosystem to remove lots of things we were whaling before. But whaling is the large animal exposing themselves because they have to breathe is one thing, but getting fish from one kilometer depth or one mile even depth, that, you need heavy technology. And this technology was developed in the 20th century.

Nate Hagens (00:12:59):

So getting back to my first supposition, could peak oil reverse peak fish?

Daniel Pauly (00:13:07):

Actually, I wrote a paper like that in Science in 2003 or something like that. If you look at peak oil, it's very similar to peak fish. The shape is very similar. And I was stupid enough to make a prediction, which you should never do, that fisheries would have to be running down when fuel costs become too high because the fuel cost render fishing in the high seas unprofitable. But I had not counted with the key factor, subsidies. Fisheries, big industrial fishing in the depth and in high seas could not be conducted without subsidies. But they are subsidized big time, and that's the reason why they continue. But they're heavily subsidized.

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Nate Hagens (00:13:52):

Why are they heavily subsidized? Because that's a cheap way of getting protein to the populations?

Daniel Pauly (00:13:58):

No. The reason is that the big fleet owners, they play golf with the ministers. That's the only reason.

Nate Hagens (00:14:04):

You're kidding.

Daniel Pauly (00:14:06):

No, I'm not. The subsidized fisheries do not produce fish. They fish for subsidies. They don't fish for fish. You could replace the subsidized fisheries that we have by artisanal fisheries and smaller-scale fishing that would not be subsidized and we produce as much fish as the present fisheries that are subsidized would produce. This would only require that for a while, the older fisher are permitted to retire and you would have less, fewer fishers because they are now super efficient compared with before. And they would rebuild the stocks that have been decimated and that are at very low level. Then you could, without subsidies, produce catches that are bigger than now easily. But the subsidies are a purely political decision by the elite of various countries.

Nate Hagens (00:15:01):

And is there a activism fight against that?

Daniel Pauly (00:15:05):

Yes, there is. In fact, there has been several initiatives that almost succeeded at the WTO because it's not only the left politically or the conservationist group that are against subsidies, but also market fanatics. They don't like subsidies. People who think that the market should self-regulate, they don't like subsidies either. So there have been several initiative at the WTO to get rid of that. And last, various colleagues and various scientists had succeeded in making such a stink that the WTO was going to make this its major emphasis. And Omicron came and the impetus was lost. But it is possible that the WTO takes a big chunk out of subsidies.

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Nate Hagens (00:15:54):

Let's assume away climate and ocean acidification for the moment, which is not a good thing to assume away, but we'll get back to that. But I read somewhere that if totally left alone, that an ocean fishery could completely recover in seven years. Is that true?

Daniel Pauly (00:16:09):

Well, the seven years is probably very optimistic and certainly it would be true for short-lived fish such as anchovies and sardines. To recover fish like rockfish and cod, you need a bit longer, say double that, 14 years. But yes, in principle and in reality as well, if you don't fish or fish very lightly, the stocks will recover. Nate, an important point, the only country that has successfully rebuilt stocks based on legislation is actually the US. The US has one of probably the best fishing policy in the world and they have rebuilt lots of stocks that were devastated previously. But the US alone is not sufficient. And in fact, other countries like Canada and Europe, the European countries, they have similar legislation but they don't implement it, and the result is that the stocks don't recover.

Nate Hagens (00:17:11):

I wonder how much of that is due to our economic privilege that we can afford beef and other things and other countries don't have that luxury.

Daniel Pauly (00:17:19):

And also the privilege of importing 80% of the fish that is consumed so you can afford to.

Nate Hagens (00:17:25):

So this is a fish version of NIMBY. You invented the term shifting baselines, which I use a lot in my college courses. Can you explain what this means and how this relates to fisheries?

Daniel Pauly (00:17:38):

Basically, shifting baseline is the notion that when something changes over several generations, say any generation perceives the change that occurs only during their lifetime, their own. In other words, young people, they become self-aware, become



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aware of the world around them, and that becomes the baseline that they will use in the course of their life to evaluate change. And they will complain and maybe they will fight to maintain what they had when they were young. But they don't have the same relationship to change that happened to their parents or their grandparents because these changes are not subjectively perceived. They are not real.

(00:18:23):

So every generation resets the baseline that it used to evaluate the world. It shifts that baseline. And so you can have a situation where in one film that is amusing, there is a young man who says, "Oh, caught this big fish," about and shows something that is about one meter. And on the same dock, in the same, an old guy is talking about the same fish, all the way talking about two meters. He talking about swordfish and swordfish of one meter are small. They are juvenile. And to that young man, these were big fish because he didn't know that that swordfish get to be four meters tall.

Nate Hagens (00:19:11):

But this is so relevant, not only to fisheries but our entire natural world. This applies to many things in our society. We only look at things day by day. And even when I was a child, we had windshields full of bugs that would hit our windows and we'd take it for granted. I have vague memories of that. But it makes me worry, Daniel, that the largest animal in the world when young people are my or your age is going to be a cow and people are going to be happy when they see a squirrel.

Daniel Pauly (00:19:45):

There is a thing that I also use a shifting baseline for teaching purpose. And the example with the windshield, actually I do remember the windshield of cars being covered with dead bugs. This is an amazing thing. And this is particularly scary with global warming because people get used to this normal. And this is terrifying if you think about it because every generation has another standard, and young people will not want to get back to the cold winters that we had when we were young. They will not even if they could.

Nate Hagens (00:20:22):

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I'm happy. When it gets really cold here, knowing what I know, I actually get emotionally happy because it feels normal to me. So how do we try to counteract the effects of shifting baselines? Is there any strategy?

Daniel Pauly (00:20:34):

The only way we can deal with it scientifically is by identifying periods for which we have lots of data so that we can construct a world that is credible, that has various dimensions, and use this as an anchor point to assess change. The climatologists do that. The oceanographers do that. They choose different periods because it depends on the data that they have. You cannot use a period going back... For example, I know a journalist, George Monbiot of Great Britain. He has a wife who is a paleontologist and they talk about elephants and rhinoceros in Britain, and they talk about that would be nice to reintroduce them. It's never going to work. But for the kind of work that you work on, you have to have a solid baseline.

(00:21:31):

And in fisheries, a solid baseline, stupid because could be earlier, but it is 1950. Why? Because 1950 is the time where industrial fishing had not restarted from World War II and where lots of countries became independent. This, before they became independent. So you have pre-neocolonial situation. And also this is the first year from which the United Nations published annual review of the world catch. So for our work, it's crucial to use 1950 as a baseline. But people who do so-called stock assessment for managing fisheries, they use the last 20 years. And that's a big problem because the last 20 or 30 years is a period where the big stocks have all been wiped out.

Nate Hagens (00:22:27):

Right. So you see a 10% increase and you think it's a huge success, but it's still 90% down from 80 years ago.

Daniel Pauly (00:22:34):

Exactly, exactly. And then you have the testimony of young people being utterly ridiculous. You would see them, young fishers, they would say, "I've never seen so many. The stocks has doubled in size." Yeah, it moved from 2% of what it was before to 4%.

Nate Hagens (00:22:54):

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Right.

Daniel Pauly (00:22:55):

That's real. That is brutal. That happens all the time.

Nate Hagens (00:22:59):

Yeah. Well, here's another complicating factor, is you've probably seen in my work I talk about as humans, we have discount rates. We care about the present more than the future. So a discount rate, like climate change, we don't think about the year 2100 because it's too far ahead. But when you're talking about a shifting baselines is we also, the discount rate goes backward and we can't remember the distant past. We only look at the last few years or the last 10 years or whatever.

(00:23:29):

So more broadly, how have humans, and maybe it's just our modern culture, become so untethered to the state of the oceans. Because even in climate change circles, the large risk to the oceans, ocean acidification, sea level rise, declining oxygen, the Atlantic meridional ocean current slowing down the risk to a Canfield Ocean. These are all distant seconds in the media to fires, rainfall, temperature on the land.

Daniel Pauly (00:24:01):

Yeah, I agree, I don't think this is we have become untethered. Because if you look at the older literature, people have never been familiar, at ease with the ocean.

Nate Hagens (00:24:12):

Is that because we just live on land and we rely on land?

Daniel Pauly (00:24:14):

Yes, that's because we live on land. For example, look at the older literature, about 150 years ago. The coastline was not seen as something that you wanted to live in, that only poor fishers were living on the coastline. The idea of looking at the coast and looking at the sea and liking it is a modern idea. And there have been people who have written about that. Our love for the ocean is actually a new thing. If you read the Odyssey, again, the Greeks, they didn't like the ocean. They didn't have an emotional

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relationship to it. They feared it. It was a dangerous place. It was inhabited by sea monsters. It was not a world where people felt comfortable.

Nate Hagens (00:25:01):

So we are one of the few generations of our species to understand that there's more living area in the oceans on this planet than there is on earth. And we're learning this at a really late date.

Daniel Pauly (00:25:16):

Yup, exactly. And our relationship with the ocean and with water, is that really wrong? For example, I work on fisheries but I also work on the physiology of fish growth. And you could say that's very esoteric. But fish breathe water and there is very little oxygen in the water. So they have to work their head off to get the water across their mouth that they can extract the oxygen that they need. Now, that is the work that they have to do. And on the other hand, for them, for fish, it's very easy to grab something to eat. But once they have eaten something, a smaller fish, they still have to burn it, link it with oxygen where they have to extract from the water. So the big work is not catching a prey. The big work is getting the oxygen out of the water into their bodies.

Nate Hagens (00:26:12):

And every time they take, their gills move, how much oxygen are they extracting? What percent?

Daniel Pauly (00:26:21):

The gills are very efficient. About 80% is being extracted. But moving that water is lots of work. What I want to say is you find that in biology, the people have projected our mammal consideration, which is we have to eat lots of food in order to maintain our own temperature at a high level. Why? That's the reason why we are not like reptile eating every six weeks. We need to eat all the time. And so food is the thing. But fish, it's not the thing. The thing is for them is breathing. And you can see the problem they have with breathing in that they are moving now rapidly toward the poles because the temperature gets higher.

Nate Hagens (00:27:03):

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Well, I'm no expert on this. I'll just ask you, isn't it the ocean oxygen content has already dropped 2% and much higher than that in the shallows?

Daniel Pauly (00:27:12):

But there is the thing. There is the thing. It's true that there is less oxygen in the water, but the important thing is that fish don't have their own temperature. Their own temperature is that of the water. And then the water temperature increase, they need more oxygen.

Nate Hagens (00:27:28):

How much has the water temperature increased in the last 20, 30 years?

Daniel Pauly (00:27:33):

One degree, say. That means they have to consume 10, 20% more oxygen.

Nate Hagens (00:27:39):

Because there's a multiplier, they don't have to consume 1% more oxygen. It's 10 or 20% more?

Daniel Pauly (00:27:44):

Yeah.

Nate Hagens (00:27:46):

Is that what your work, is that called gill-oxygen limitation theory?

Daniel Pauly (00:27:50):

Yes. And the problem is not so much there's less oxygen in the water. It's true. But the big problem is that they need more when the water is warm. So they have a double whammy. They need more oxygen and there's less in it. Now, you find though that most doctor work and thesis work that students do is about food. It's about the fish feeding. Well, the problem is breathing. And now, it's being realized now because of global warming that fish have a problem breathing. And that's the reason, for example, while they move toward cooler water, water that remains cool toward the poles.

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Nate Hagens (00:28:33):

Because it's like a behavioral homeostasis. They don't know about climate change. They're just trying to be in water that fits their oxygen absorption capacity.

Daniel Pauly (00:28:43):

Exactly. But in the literature, you find all kind of questions that people ask themselves. Are they moving in the north hemisphere toward the north? Are they moving because there is more food there? No, they're moving there because they just want to breathe.

Nate Hagens (00:28:58):

So this is a dumb question, but we're around 1 to 1 1/2 C, depending on the boundaries, warmer temperature in the earth. Does that temperature equate with the 1 degree increase in the oceans? Are they commensurate?

Daniel Pauly (00:29:14):

Most of the ocean is getting warmer and that causes the fish to want to move poleward in the south. And you can see this. I don't know if it's 1 degree here or there, but in the US you get fish now in New York that before were in Florida. In BC where I live, you get fish now that were before in California. In Australia, you get in Sydney fish that were before in Brisbane.

Nate Hagens (00:29:43):

Historically, when there was big bursts of CO<sub>2</sub> at volcanic provinces and previous eras, were all the fish near the poles?

Daniel Pauly (00:29:53):

They probably were floating dead on the water surface. In other words, this moving toward the pole, poleward, is a reaction that is a slow thing that they do. But if the warming is sudden like in a heat wave, they die.

Nate Hagens (00:30:09):

When we met the last time or... Yeah, you're right. The only time that we met a few years back, you weren't talking about this. This sounds horrible to me. I was unaware of this.

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Daniel Pauly (00:30:20):

Basically, my work on this oxygen problem was my dissertation about 40 years ago, and it was totally ignored. And now, it's because of global warming that it's being revived and it's getting some attention. It breaks your heart because the other stuff that I do about shifting baseline, about fishing down mine food web and so on, these are obvious things. These are trivial things in a sense. But the oxygen thing is the most subtle thing. And you can think about it only if you get rid of this mammalian bias that we have that food is everything.

Nate Hagens (00:30:57):

So does this scale with the size of the fish like cetations? Is the 1% change in oxygen 10% in the-

Daniel Pauly (00:31:05):

No, no, no. They don't have problem, cetations. They don't have that problem because they breathe air. They don't have that problem.

Nate Hagens (00:31:11):

Okay, so what about large fish?

Daniel Pauly (00:31:14):

Large fish are the ones that have most trouble because the surface area of the gill divided by the weight is lowest.

Nate Hagens (00:31:22):

So in a short-term, self-interested way, are people in Russia and Alaska listening to this podcast happy because they're going to have more fish moved into their fisheries in coming decades?

Daniel Pauly (00:31:35):

Yeah. The Norwegian are quite explicit about it. This is one country that is located in high latitude that will see for a while an increase of the biodiversity and an increase of the major stocks of fish. Whereas other countries, for example in your tropics, they are the losers again because the fish that leave the water are not being replaced by any.

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Nate Hagens (00:32:03):

So does this get into the difference in the fishing industry between developed and developing nations? And again, the poorer nations around the equator are going to be at the short end of the stick from their fish catch in coming decades?

Daniel Pauly (00:32:18):

Yeah, certainly. Basically, if you present the fish catches, predicted fish catches in latitudinal zones, the cold-tempered countries will benefit and tropical and subtropical countries will be devastated fishery-wise. And you can see that on, for example on our coast, the salmon in California are wiped out. They are gone. In Washington and Oregon, they're not doing well.

Nate Hagens (00:32:48):

Is that because of this gill-oxygen limitation?

Daniel Pauly (00:32:50):

Yes, because temperature is going up. And in BC, they're not doing well. But in Alaska, they're doing very well. And in Arctic Alaska, there are salmon runs that are establishing themselves and we don't know about them because they didn't have salmon before.

Nate Hagens (00:33:09):

Oh my god.

Daniel Pauly (00:33:10):

So it is happening. This transition is already happening. And with salmon, it's very visible because there is a major industry built around salmon.

Nate Hagens (00:33:21):

So we could argue and everyone would argue on ultimately how climate change will warm the earth. On the one hand, I think the fossil fuel availability forecasts are way over optimistic. But on the other hand, I think the biological feedbacks are probably way underestimated. But if we do go to 2 C, 2 1/2 C, doesn't that have a massive implication based on your gill-oxygen limitation for another?



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Daniel Pauly (00:33:54):

Yes, but this is not will. This is already happening. If you go to a country like Britain, they fish now fish that way before in Spain, and the Spaniard fish before that way in Morocco. And in other words, the composition of the catch has already changed. And we published in 2013 a paper in Nature which we call the mean temperature of the catch, the concept. And basically, you assign to each fish species a preferred temperature which is very stable, and you can compute then the mean temperature of the catch, which is the catch multiplied with the temperature of that fish. And you average it over all species. And you can see in all countries of the world, in most countries of the world, the mean temperature of the catch start picking up in the '70s, the '80s.

(00:34:51):

The fish were very much smarter than us. They picked up very early. And the hockey stick, the famous hockey stick that man and others, you can see the fish doing it. And we have reproduced this for example with Chinese colleagues. They have the Yellow Sea which is cold, the East China Sea which is medium, and the South China Sea which is tropical. You can see this effect in the Yellow Sea and in the East China Sea. But in the South China Sea, you don't get this effect. Why? Because the fish that leave are not replaced by fish from even warmer temperatures because there is no hyper tropic, right? So this effect, you can see it everywhere. And we have colleagues in Greece that have reproduced that result. And we have recently another paper come out that described, contrasted Japan, Australia, with Indonesia. Indonesia, the mean temperature of the catch doesn't change. And in Japan, it goes up. In Australia, it goes up. Meaning all countries now are experiencing change in the composition of the fisheries catch that are due to migrations.

Nate Hagens (00:36:02):

Well, this changes one of the questions I had planned to ask you. I was going to ask you what are one or two major things that could be improved about our current fishing practices and industry? But it gets back to the climate thing.

Daniel Pauly (00:36:17):

Yes. If I may, this movement of the fish that are caused by temperature, they can be anticipated. And the first case that comes to mind is negotiation between Norway, the

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Faroe Islands, and Iceland about a stock of mackerel, a very important stock of mackerel that they had to share because it was intermediate between their waters. And the negotiation took five years. During the five years, the mackerel moved and ended up only in the exclusive economic zone of Iceland. And at the end of the five years, they had an agreement but the Icelanders says, "We are not going to do it because we don't need to. They now are in our waters."

(00:37:02):

And this problem, it sounds like a totally esoteric problem. You have it also in the US because the coastal, say in South Carolina, you have a management by the state of the coastal fisheries. But the stocks are now found not in South Carolina. They're North Carolina.

Nate Hagens (00:37:24):

Oh my god.

Daniel Pauly (00:37:26):

And so they cannot spend five years renegotiating an agreement of fishing them because in five years, they would be in New Jersey.

Nate Hagens (00:37:37):

I was going to ask you what can individuals do to support replenishing the world's fisheries. And what I'm hearing, what I'm intuiting is the answer is not to eat less fish. It's to use dramatically less fossil fuels.

Daniel Pauly (00:37:52):

Yes. At the end of the day, everything that we do, if we don't reduce the fossil fuel and the emissions and we should add also now the methane from the tundra and so on. But if we don't tackle that problem, the other stuff would be completely useless. Now, I should add though that every individual fish has another preference. Say a species of fish is about 15 degrees Centigrade. Well, there will be some at 13 and some at 17 and so on. And the more fish you have in the water, the more variants you have. And we know that from COVID, right? The more people are not vaccinated, the more variants you have. And it's also true for fish in the water. So if you had lots of fish in the water, you have some that can handle the higher temperatures.

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Nate Hagens (00:38:46):

What are the type of fish that are selected for in higher temperatures? Can you give some examples?

Daniel Pauly (00:38:51):

Oh, the groupers and snappers on Florida can handle high temperature much better than cod in Canada. That's an example. But also within the species, there is also variation. There are variation between us humans. We are small ones, big ones, brown ones, and white ones. And so you have a distribution around these means. And if you have an temperature increasing, there will be variants that can handle this temperature. But if your population is very reduced because you have overfished it, then there will be fewer variants. And so what we can do and should do is reduce the fishing effort that we have, reduce the fishing quota. We will have more fish. We can fish them more economically, more profitably. We'll make more money. We'll supply markets better, and there will be more fish in the water that can handle the heat.

Nate Hagens (00:39:57):

So by throttling down our consumption of fish and the overfishing, we will, A, increase the diversity of the fish which makes it a higher likelihood that some fish will make it through this bottleneck to maybe replenish and heal the fisheries, and also maybe buy us time to solve the climate emissions, et cetera.

Daniel Pauly (00:40:20):

Yes. But Nate, at this point, what I tell people is yes, we must reduce consumption. But the individual root, I must tell my friends and my buddies, doesn't work. What works is not this horizontal, that friend to friend protest and action. What works is vertical action. We go, we raise hell, and we distribute leaflet in front of a supermarket. That works. And we change the politicians. Politicians, we address them. We cannot limit ourselves to acting as consumers. We must also act as citizens, especially if we live in democracy.

Nate Hagens (00:41:03):

Yeah, I've come to the same conclusion. So if someone is listening and they care about the oceans and the fisheries and the future, setting aside the emissions question which

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is a really difficult one, what can individuals do to support some of the things you've been discussing in there?

Daniel Pauly (00:41:22):

You join an environment NGO. You join a group that fights for these things that you believe in. And depending on your disposition, you join radical group or less radical group because they're all needed. Like in the Civil Rights, Malcolm X was needed and Martin Luther King was needed and both were needed. And in an environmental front, there is a group that push and a group that then settle agreement, that do agreements. And you need both. And depending on your temperament, you join them. And the point is that you cannot as individual working on your consumption hope to affect anything because your consumption is... Much of it is virtual displaying. Much of it is virtual displaying and it has no effect.

Nate Hagens (00:42:14):

That's what I tell my students, is rather than minimize their impact, they should try to maximize their impact in whatever they're passionate about. Given your temperament and if you were somehow the benevolent dictator and your sole goal was to improve the health of ocean fisheries, what wishlist of changes would you implement?

Daniel Pauly (00:42:37):

I would immediately abolish subsidies that are directed at making fishing effort cheaper and fuel subsidies and other subsidies. If the fishing industry had no subsidies, they would immediately stop fishing in remote areas where they use lots of fuel. Certain destructive method like trolling would be immediately abolished because they are not profitable. And the people who'd use this method are fishing really for subsidies, that the subsidies are very important.

(00:43:14):

And another point is that I would set up the network of marine protected areas that we talked about all the time but don't do. Again, the US has done it in various parts of the world, but like France, it's done mainly in the Pacific away from nasty fishers that will protest. Though in California, there is a good network of marine protected areas. Without areas where you don't fish, you won't have the big fish that maintain a population. You need so-called big... what is it? BOFF. Big old fecund females that

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produce the eggs that will replenish a population. And they happen to be trophy fish also, right? What the anglers want to have is BOFFs and they then go after the source of replenishment of a population. So you need areas where there's no fishing.

(00:44:16):

And with these two things, you would actually really have fisheries doing much better. And then I would all over the world impose a system similar to the one that you have in the states where an old fish stock has to be rebuilt within 10 years. And you have this legislation, it's called the Steven-Magnuson's Act. And if other countries were having the same, we would be in much better shape. And then I would stop looking at fisheries because we have a much bigger problem.

Nate Hagens (00:44:49):

Is there any chance, Daniel, that you envision in the next 30, 50 years where world governments and leaders are populated with ecologists and biologists as opposed to economists? Could such a future exist?

Daniel Pauly (00:45:03):

Yeah, I can imagine it because if you compare World War I with World War II, in World War I, they drafted everybody, scientists and non-scientists, and sent them as cannon fodder to be killed in Flander and in France and so forth. In World War II, all governments had the sense to say, "Well, wait a second. Do I really want to use my scientist as cannon fodder? No." You use them like Turing and the others to decode, to develop radar systems and so on. So it was understood in World War II that scientists can help deal with a crisis. And I think that our civilization has the option now of destroying itself or beginning to look at what the science, the various disciplines offer. And there is a good part of the population and the political part in your country but in other countries as well that have decided to not listen, to go crazy.

(00:46:05):

But the alternative is that science is embedded more and more and more. And why do we need science all the time? Because we always with a pushing at the edge. We are pushing everything to the edge. For example, we have huge population in huge cities in terms of human protoplasm. This is an ideal place for parasites to bugs and viruses to grow. So you have to do lots of signs to maintain this population healthy. Food, same thing. We have the system that we have no reserve. We are at the edge. So how

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do we not fall from the edge? By using science. So I think the more we push toward the edge, the more we will need science to prevent going over the edge. Science will actually play a bigger role or we will go down the tube.

Nate Hagens (00:47:08):

I actually agree with you. And that's why I'm having these conversations, because there's so many issues. Many people are aware of climate change. Not so many people are aware of your area of expertise. And then there's economics and biodiversity and social media algorithms and energy depletion and now geopolitics. It is the science, the system science of our predicament is really complex, but it does fit together and it does make sense. So can you talk a little bit about your work? You run an organization called Sea Around Us as in ocean and sea. We'll put all the details on the website, but can you give us a one or two-minute overview of your-

Daniel Pauly (00:47:50):

Basically, I'm a great admirer of Rachel Carson. And you know that Rachel Carson could write her book, a most important book, the Silent Spring, only because she became financially independent of necessity and she could because she had written a successful book. So the Sea Around Us made Rachel Carson in lots of ways. The Sea Around Us is mine, a name that I gave to a research initiative that I founded with a generous funding from The Pew Charitable Trust in '99. And we were, the first two, three years, we were floundering. "What are we going to do with all these possibilities that we have?"

(00:48:35):

But we developed then this idea of documenting all the fisheries of the world in a standard way. And basically, there is in much of the world two economies. There is a formal economy that is embedded in statistics and in the formal markets and financial markets and so on, and there is informal economy that is well-known. And in fisheries, this is also the case. There is throughout the world industrial fisheries that well or badly managed, and there is small-scale fisheries, artisanal fisheries, subsistence fisheries, and recreational fisheries that are not managed and not even monitored. They are pooled together under the heading of small-scale fisheries. And small means you don't have to care. But actually, small-scale fisheries make up about a third of all fisheries of the world when you account for them.

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(00:49:37):

So we put them on a map. We put on a map the fisheries. For example in the South Pacific, there is lots of small island states that get the foreign exchange by allowing Spain and China and other countries to fish for tuna. But the population doesn't eat the tuna. Population eat reef fish that are caught around the island. But the Ministry of Fisheries when they have one or the Department of Fisheries doesn't care about that, and it doesn't record what they eat. This for example, we know this because the WHO, the World Health Organization, studies what people eat. And what people eat is fish, but the Department of Fisheries doesn't report any fish being caught.

(00:50:26):

So by linking different type of sources, we were able to reconstitute these fisheries that exist. In the US for example, the fisheries that are run by the states within three miles, they are not reported to the FAO as existing. Also, the subsistence fisheries in Alaska, which are quite substantial, are not reported. And all countries, even developing countries, developed countries with good statistic system, they don't report fish.

Nate Hagens (00:50:58):

Does that mean that the amount of catch is underestimated? Does that imply that the amount of fish left is overestimated?

Daniel Pauly (00:51:09):

Yes and no. The underestimation is real. It ranges from 10% in the US, 3, 4, 500% in various countries. For example in Central America, they report only fish that they export. The other fish, they don't care. So they don't know. In Guatemala, in Honduras, and so they don't know what they catch. And so the impact that all these fishing has, they have no idea what it is. So when they are people, we have also in fisheries denialists the same way that you have them in climate change. So the denialists, they look only at fisheries catches and they say it's a good shape in developed countries, in rich countries. But if you look-

Nate Hagens (00:51:59):

So they could be getting the wrong signal on what's really happening?

Daniel Pauly (00:52:02):

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They are getting the wrong signal. They are getting the wrong signal. And you have in fisheries the same kind of struggle that exists in climate change. Exactly the same.

Nate Hagens (00:52:12):

And so that's what your work is calling attention to that delta between. Okay, that's excellent. While I have you and before I get to my final questions that I ask all my guests, I'm just curious about two things. Salmon is at the grocery store and I eat salmon. Should I, A, not eat salmon at all? B, eat farm salmon? Or C, eat wild-caught salmon?

Daniel Pauly (00:52:38):

I live in British Columbia. It's one of the few places together with Alaska where you get more wild salmon than farm salmon. But we are also haunted by this industry which is driven by Norway. And they have polluted a good part of the coast and also in Chile by producing salmon. And they have polluted also the intellectual world in that they think, the people believe that aquaculture is reducing the pressure on fisheries and farm fish are supposed to reduce the pressure. But it's true when it is the fish, for example tilapia or other herbivores, but it's not. Or when the fish are not fish and they are mussels and oysters and so on. But when the fish are carnivores, which is the case for salmon, what you have is they have to be fed. And what are they fed with? They are fed with fish.

Nate Hagens (00:53:45):

Other fish.

Daniel Pauly (00:53:46):

And this, the other fish, the other fish are edible. They are good fish. Anchovies for example are very much liked in the world except in the Anglo sphere. The descendant of British settlers everywhere, they don't like fish. Not really, not sardine. But the Spaniards for example, they love sardines and anchovies and so on.

Nate Hagens (00:54:11):

So is it better for me to eat anchovies instead of salmon in the same way that it's better to eat soybeans instead of beef?



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Daniel Pauly (00:54:19):

What you would end up is getting the fish are tastier, the fish more sustainable in the generic sense, and they contain more of the goodies that you can get from fish there, the omega-3 and so on. All of this is better in sardines than in Norwegian salmon to which you add also colorant because they would be gray.

Nate Hagens (00:54:45):

They don't naturally look that orange.

Daniel Pauly (00:54:51):

They don't, yes.

Nate Hagens (00:54:51):

That is so weird to me. So are sardines also subject to gill-oxygen limit?

Daniel Pauly (00:54:54):

All fish, all water breathers.

Nate Hagens (00:54:56):

Okay. So sardines are going northward?

Daniel Pauly (00:54:59):

Yes.

Nate Hagens (00:54:59):

Maybe not as badly as a swordfish or a mackerel.

Daniel Pauly (00:55:03):

No, they also do. And in fact, I just saw a paper last week or something about the sardines in the North Sea became smaller. They're getting smaller because this is also, besides migration, this is a reaction. The fish gets smaller.

Nate Hagens (00:55:21):

Oh my gosh. So when we spent a few days together, I remember you and I had a very long dinner and some wine because you-

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Daniel Pauly (00:55:31):

No, I don't drink wine.

Nate Hagens (00:55:32):

I was having wine. You were talking and I was very fascinated because you have so many experiences all over the world. You speak four languages and worked with all sorts of different people. Do you have a favorite memory or experience that you have from all this and/or any lesson that you'd like to share?

Daniel Pauly (00:55:51):

Oh gosh, I should have thought about it ahead of time. I was dreaming when I was a kid or when I was a young man of working in developing countries where I would be useful. Because this was the thing in the '60s, you wanted to help the people and be useful, right?

Nate Hagens (00:56:07):

Well, boy, I wish we could have that again, right?

Daniel Pauly (00:56:09):

Yes. And you know what? I've been able to realize this. I've been able to be recognized as somebody who has helped empower people because I have developed tools and concepts that people can use to do their own research, and that makes me feel really good about what I've been able to achieve to empower people. And I continue to try to do that. And for what it's worth, I had 70 PhD and masters students. And for what it's worth, 80% were women. That's another point. My student are mainly from developing countries and women. And this empowering thing, I take seriously.

(00:56:59):

Now, there were some difficulties and the point is that if you want to be an innovator, you have to have a hell of a thick skin. And because people will attack you for anything. Because essentially if somebody has not found something and you find something, whatever it is, you are not saying it but they think that you're saying that they were stupid. So every time you come up with something, there is somebody who is aggravated by the fact that it's not them. And so you incessantly have to fight to legitimize what you do.

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Nate Hagens (00:57:41):

You're preaching to the choir. You can imagine the podcast I'm having on here with Paul Ehrlich and Dennis Meadows and other people. It is lots of things that people don't want to hear. So thank you for your lifelong continued work and empowering people. So what kind of advice would you give to young people today, Daniel, that discover and understand not only the state of fisheries but nature, climate change, the economies, what's happening, the general human predicament?

Daniel Pauly (00:58:11):

I would say get involved in fighting what is not tolerable and you will discover who you are in the process. Nowadays, the emphasis on yourself and your identity and your personality and stuff is probably misguided because you can at best discover that you're ready to do something. So you might as well do it.

Nate Hagens (00:58:35):

That's great. Here's a personal question for you. What do you care most about in the world?

Daniel Pauly (00:58:41):

For myself, I would like to be able to maintain work. And for the world as a whole, I think I would be like the contestant in beauty contest, peace. Peace in the world is what we need. I grew up in Europe that was reeling from World War II and I'm very conscious of this. And the notion that we are doing this in during the second or first day of new land war in Europe is profoundly disturbing. What we need is peace. What we need is peace and then we can sort out the problem we have which are big and which require that we work together. And a war is the worst that we can do in this context.

Nate Hagens (00:59:27):

What are you most hopeful about in the coming decade or so?

Daniel Pauly (00:59:31):

Well, basically we are faced with the option, with a possibility of the destruction of our civilization. We are faced with the potential of that. And maybe we won't do it and that will be marvelous. Imagine if we make it. All the good things that will have to be

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done so we make it. And that is the thing that I hope for, that the Greta Thunbergs and the other people with wonderful ideas and ideals will have the chance to expand and to grow and to be.

(01:00:12):

Because the alternative, which is that we are now in the late 30s with the Nazi coming up, it is hard. It's hard to swallow that because it's completely atrocious. We don't need any of this. We don't need war of choice. We never needed war, really. But the notion of a war of choice is disgusting. Not enough people talk about peace. It is as if it was naive to speak about peace. I remember one time somebody was arguing against the European Union, and this person did not understand that it is the only thing that had prevented European countries from fighting war against each other for 60 years. We never had 60 years of peace in Europe before. Never. And now we can see that two countries that are outside of European Union are at it.

Nate Hagens (01:01:13):

Ukraine and Russia.

Daniel Pauly (01:01:13):

Yeah.

Nate Hagens (01:01:15):

Yeah. Thank you so much, Daniel. We will be in touch and I hope many people look at Sea Around Us and your work. And we'll have all kinds of references on the website.

Daniel Pauly (01:01:26):

You're welcome.

Nate Hagens (01:01:27):

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