Big Biology Podcast Episode 92: A journey into the brilliant abyss (with Helen Scales)

SPEAKERS

Art Woods, Marty Martin, Helen Scales

Art Woods

Hey Marty, a question.

Marty Martin

Hit me!

Art Woods

What part of Earth contains the least well understood ecosystems?

Marty Martin

It sounds like a trick question, but I'm gonna go with Antarctica or the Amazon. Very different places, but both are biological frontiers.

Art Woods

Decent guesses but wha, wha wrong. The answer is, of course, the deep sea.

Marty Martin

Ah yes, the bottom of the salty stuff that covers 70% of the Earth's surface. I should have known.

Art Woods

Actually, you did. But no matter.

Marty Martin

Because of the challenges of working at depth, we know more about the surface of the Moon than about the floor of the ocean.

Art Woods

And the depths here are just staggering. The average depth of the seafloor is 3700 meters.

Marty Martin

About 12,000 feet.

Art Woods

And the bottom of the Mariana Trench is almost 11,000 meters.

Marty Martin

Which for you steadfast imperial unit users, is 35,000 feet.

Art Woods

And it's hard for us terrestrial primates to grasp numbers like these.

Marty Martin

You know, we can illustrate them by converting ocean depths into units of Empire State Buildings, or Mount Everests.

Art Woods

But consider instead the world record depths for human free divers.

Marty Martin

In August this year, a 26 year old Frenchman named Arnaud Jerald set the world record in the Constant Weight Bi -Fins category at,

Art Woods

120 meters.

Marty Martin

During which he was underwater for three and a half minutes.

Art Woods

Holy crap!

Marty Martin

But to put that in perspective, 120 meters is only about 1% of the way to the bottom of the Mariana Trench.

Art Woods

Not a challenge if you're listening, Arnaud.

Marty Martin

In fact, Arnaud made it only partway through the topmost layer of the ocean. What we call the epipelagic zone.

Art Woods

This zone contains about 90% of known aquatic life, and it stretches from the surface to roughly 200 meters deep.

Marty Martin

Which is the maximum depth that sunlight can penetrate.

Art Woods

Meaning that below 200 meters there's no more photosynthesis.

Marty Martin

So things get well…dark.

Art Woods

And weird. In these depths are vast ecosystems of bizarre and often undescribed forms of life interacting in crazy ways.

Marty Martin

As you said earlier Art, the Earth's least well understood set of ecosystems.

Art Woods

And exploration of the deep ocean is really just beginning.

Marty Martin

Aided by new technologies. Now we and our robotic proxies,

Art Woods

Or James Cameron,

Marty Martin

Can go there.

Art Woods

For example, you may have heard of the Alvin. The submersible operated by the Woods Hole Oceanographic Institute.

Marty Martin

And disclaimer, Woods Art has no relation to Woods Hole.

Art Woods

After a recent overhaul to extend its depth range in July this year, the Alvin took a crew to nearly 6500 meters.

Marty Martin

That depth puts about 99% of the world's sea floor within our reach.

Art Woods

And remote control robots are going even further. Some to the very bottom of the Mariana Trench.

Marty Martin

These trips are revealing an unexpected wonderland of evolution and diversification at the bottom of the sea.

Art Woods

At these depths animals, plants and microbes have to cope with extreme pressures and temperatures. Profound darkness, weird chemistry and intermittent or very low food availability.

Marty Martin

Our guest today Dr. Helen Scales recently published her guide to the deep ocean titled The Brilliant Abyss.

Art Woods

Helens started out as a traditional marine biologist, but after completing her PhD she shifted the popular science reporting and writing.

Marty Martin

In our chat with Helen she recounts her journey from academia to author and passes on bits of scicomm wisdom.

Art Woods

She also talks about the sheer immensity of the ocean.

Marty Martin

How we're learning more about its biology

Art Woods

And the species and ecosystems living on the seabed and up in the water column.

Marty Martin

Her basic message is that we still don't know much about life at depth. How many species live there, much less how they do it.

Art Woods

She also emphasizes that deep ecosystems are very different from one place to another, each with its own species habitats and challenges.

Marty Martin

The deep ocean is not the dark, desolate wasteland we once thought it to be.

Art Woods

And last tidbit Helen unexpectedly revealed Marty's fear of submarines to find out more. Stay tuned.

Marty Martin

I'm claustrophobic Marty Martin.

Art Woods

And I'm Art Woods.

Marty Martin

And this is Big Biology.

Marty Martin 00:00

Helen, thank you so much for joining us on Big Biology. We're really excited to talk to you, about your work, and especially this book that you've written called The Brilliant Abyss. But let's first sort of talk about how you got to writing that book. How did you get to where you are today? What was your path to writing popular science?

Helen Scales 00:16

So I started out as a marine biologist, very much kind of science and conservation science were my focus. Since I was a teenager, really, I learned to dive and fell in love with the underwater world and set off down that road of being a kind of field scientist, a conservation biologist. I worked in various parts of the world, had some incredible adventures and been incredibly fortunate to study and live in various places in, in Malaysia, and Madagascar and various other spots. And then kind of just by surprise, it really took me by surprise, while I was actually a grad student, I suddenly, like really quite suddenly, realized that I could see the power of storytelling and of words to communicate ideas about the ocean. And I genuinely hadn't thought of this before. I was okay at English at high school, but not, you know, I wasn't the top of that class. I wasn't the kind of person you'd have said: "she's going to be the one who writes books". Like, no way. But suddenly, it kind of felt like: "oh, actually, this could be kind of fun". And, and I had a go at it. It was, for me, it was, it was a fortunate time for me to have this sort of revelation, because as a grad student, there was a lot of opportunities for me to try it out. So I was writing for the student paper, I started doing like, you know, the student radio station. So I did that kind of reporting as well and had a go at it and realized I enjoyed it. And I wasn't bad at it. And also kind of had this sense that if I did more of it, I could get better. So by the time I finished my PhD, and actually, by the way, I quite enjoyed the writing part of the PhD, which I gather is a bit rare. And sometimes that sort of was....

Art Woods 01:43

That's on the tail end of the distribution.

Helen Scales 01:46

Certainly here in the UK, that you have to write this massive thesis, which is like more, you know. It's the size of the books I write now, if not a bit bigger, I guess. And people generally don't enjoy that part, but I really did. So by the time I finished that, I was also having in mind that I'd really like to write a book that more people would read then just my examiner, my supervisors, maybe my husband, if he's really being friendly. So yeah, so I came out of grad school with a very different view to what I went in with, which was actually I'd like to do more of this communication and see where that takes me. So it was the beginning of like a whole new journey that I had not anticipated at all.

Marty Martin 02:19

Was there something that you read or some particular inspiration that said: "Oh, I can do that."

Helen Scales 02:25

It was a mixture. Like I definitely started reading, and I think I had been for a few years since probably undergrad years, reading and really loving nonfiction, popular science books. People like Carl Safina was a huge inspiration for me. A Song for the Blue Ocean, I think I read that, and I was like: "Oh, maybe I could do something.." Yeah, that for me, could I do something like that, like that sort of feel of a book, I really enjoyed. So there was that. And I think it kind of blended in with also just other communicators, not scientists. I remember very clearly like watching kind of reportage of, what was it at the time, one of the big conflicts that was happening. And anyway, I was like, oh, you know, these, these war correspondents are very brave people. But they're playing this incredibly important role in telling us what's happening. So, you know, maybe I could be the equivalent for the ocean, like the oceans war correspondent. But that sort of idea of like, the power of communication came to me from different different places.

Art Woods 03:16

Yeah. Yeah. So, So was it hard at all to walk away from sort of basic academic biology? Or, you know, do you do you look back with regret at having left that behind, or relief or happiness?

Helen Scales 03:28

It's a real mixture, actually. And I've been really lucky that I've been able to carry on with kind of a bit of one foot still in that world. Not only because of the work I do means I get to speak with and also visit and kind of work with, I guess, a lot of different academics, including in the field, but I have managed to kind of keep a little bit of that going in my own work, too. You know, and I also teach, so I sort of have that kind of academic side as well. But, but I could note, I couldn't confess to being a full time academic by any means. So I don't know, I think, you know, we all make choices about which directions we're going to take. And there are certainly days when I think: "Oh, you know, wouldn't it be wonderful to be a full time research field biologist, as I had originally sort of envisaged, although I now know that that's not really the reality of it. And that, you know, a lot of that time is spent doing other things than swimming around with fish and having a lovely time. And so I don't know if, I don't know if I would have been that good at it either. I think, I genuinely think the way I went towards, I was drawn towards communication was because I did feel like I was quite good at it. And I'm not sure, I'm not sure if I would have made a brilliant academic. I don't know. I'm not, I don't know if that's where my, my real talent lies. Because I spend a lot of my time now, I read and consume a huge amount of academic literature. That's a lot of what I do in my books: is figuring out what's going on, and I'm not sure I could write those papers anymore. You know, like the details involved. I quite, I realized what I do is I read them and then scoop out the story and that's, that's where I get excited. But could I do the maths behind it? I'm not sure. I'm not sure.

Art Woods 04:59

Yeah. Marty and I are quite late coming to the, you know, public sci comm world, just just doing this podcast. And it's just been great. And, you know, we're still doing our sort of regular academic thing, but I think I mean, I shouldn't speak for Marty, but for me, you know, this is one of the most fun things that I do. And it's just, it's just great to talk to people that are outside of my normal field and to have these conversations that are not, you know, about trying to figure out what statistical test to do on your data and tearing your hair out, you know, but taking a sort of bigger picture.

Marty Martin 05:29

Yeah. So Helen, we want to jump in to the book, but just one more question about your, your sort of path to where you are. There's a lot of graduate students and undergraduates and things that listen to the show. So I mean, it doesn't sound, you didn't tell us, I think, anything about formal training to get you from the PhD to what your job is right now. Is that true? Or sort of how did you polish those skills, develop the skills, to get to the point of writing books professionally?

Helen Scales 05:53

Oh, yeah, it's, uh, I guess, maybe it's shocking, or, or maybe enlightening, I don't know, to admit that I do not have any formal training. Again, I guess, going back to the idea that I started this all off as a grad student, and therefore, my training was on the job, I said, essentially, in various different ways, in different formats. I managed to get myself in a situation where I could try things out, and I could get feedback and practice. You know, and I have a lot of people to thank for letting me do that along the way. So for instance, I mean, on the radio side of things and making podcasts and stuff like, I have a huge debt of gratitude to the Naked Scientists. I was a Naked Scientist for about 10 years, I guess. And in that time went from someone who was completely terrified at the idea of a microphone in front of me, let alone it being live and connected to the world to, you know, to someone who.. I just love doing it now and absolutely, you know, adore the opportunity to speak to guys like you and all the different things I get to have in my life. So that's it. And I do think, I'm sure there is, there definitely is a place for formal training, least of all, because you can try things out and you know, meet people in the industry, depending on what we're talking about, whether it's a master's degree, or, or whatever it might be. And I'm sure there's things that I've had taken a lot longer to figure out because I've had to kind of do it myself. But equally, I think there's so many parts into doing what I do. There is definitely not one route. And you don't, no one has ever said to me: "show us your qualifications." Like where are your sort of, at least your sci comm qualifications. I think in my case, it obviously helps that I have that scientific expertise that I'm basing it all on. So people see me as being a, you know, a voice of authority in that sense, or at least someone who knows how science works. So it did help for me to get to that PhD stage. But equally, that's not necessarily, you know, the thing you have to do, because I mean, I am a specialist as well, like, you know. I specialize in ocean communication. And there are tons of other people out there who are much broader and who cover much wider beats. So I guess my message is just if you, if there's something you want to do, just try it and see what you're good at and see what you like, and you never know where it might lead. Because you know, this world is full of amazing opportunities now with all the different platforms and stuff. So it's it's super exciting time to be trying things out and seeing how it goes.

Art Woods 08:07

Well, let's start into the contents of your book. And I just have to say it was, it was just mind blowing repeatedly. Marty and I just really enjoyed reading it. It was just so fun to hear about all of the, you know, physical aspects of the ocean and all the biology that's happening. And then you know, at the end of this conversation, we'd like to get to some of the threats that you identified to deep sea ecosystems. But maybe let's just start by characterizing what is the deep sea? So how do you define it? And how much of the Earth does it take up?

Helen Scales 08:34

So we're talking about anything beyond? Oh, wait, first of all, can I talk in meters? Is that alright? Do I need to think in my head? Do I have to convert it to feet?

Marty Martin 08:43

I think meters, meters is fine. Go for it.

Art Woods 08:44

No, no meters is good. Yeah, Yeah.

Helen Scales 08:45

Excellent. Okay. I'm never quite sure. And sometimes I get, I'm like, they're trying to figure it out in my mind as I go because I'm a meters person, obviously, being British. So technically, I mean, generally, certainly, deep sea biologists all agree that the deep sea officially begins at that 200 meter mark. So you've got the top bit, which is the sunlit zone, the top 200 meters where the sun still shines strong enough to power photosynthesis. And that's really why we've got that division. And it's not the same everywhere in the world. Like it does vary depending on the seasons, depending exactly on the water quality, that kind of thing. So it will go up and it will go down. But in general, we're talking 200 meters. And below that is where this, there's so much absorption of the, of the sunlight, that little bit of blue light that's carrying on down. And that's not enough to power the photosynthetic machinery of algae. So that's the kind of big change that we're talking about biologically, and then yeah, all the way down to the bottom average depth, about four kilometres maximum depth, just shy of eleven kilometers in the deepest ocean trenches in the Mariana Trench and a whole bunch of others that go beyond 10,000 meters. And the thing, I think, that I discovered really, while writing the book and thinking about all of this is just how big that space is. I mean, we can say, you know, you've got that kind of common effect about how the surface of the Earth is covered in 70% ocean, and it's like, okay, seven tenths, that's a lot. But if you multiply that up by that massive depth, you know, it's enormous! I mean, I think it's something like a billion cubic kilometers, which is ridiculously...It's impossible to think how big that is, but it's like most of the biosphere. Ninety-five percent or more of the space for life to exist is the ocean, is the deep ocean.

Art Woods 10:17

And just to say, so the contrast is with terrestrial biomes, which are stuck on this, you know, effectively two dimensional plane, right, right, right over the dry parts of the earth. So, we're going from two dimensions in terrestrial to three dimensions, essentially, and in the ocean.

Marty Martin 10:30

Yeah. It's so hard. I mean, I love that part of the book. The statistics, reading these dry statistics sometimes, it's just, over and over again, it's like: "okay, yeah, I get it". But the magnitude of these things... It is mind-blowing of a sort that reading other kinds of statistics doesn't resonate the same way. So I want to say it again, 95% of the Earth's biosphere is the deep. To say that in different terms, and I'll use feet because I can't do the meters conversion. Although as a professional scientist, I'm supposed to do that. So apologies. The total volume of the deep ocean, these are your words, everything below that threshold is 240 cubic million miles. So that means, in your words, the Amazon River, spreading out a cubic miles-worth of water every five and a half hours, it takes 150,000 years still to fill up the entire deep. That is insane! It's just unbelievable, what we're talking about.

Helen Scales 11:20

But it really is. And then I think that's why, you know, we always hear that statistic about, well not statistic, that fact about, we know more about the moon than we do about the deep sea bed. And I'm like, sure, but there's a very good reason. There are very good reasons for that. One is we can't see it, you know. We can't look down into the deep. We can look at the moon, but we can't look into the deep very easily. But equally, yeah, it's just so much bigger. And that's why we also know so little, it is that vast size, it's so.. There's so much still to look at because we just haven't yet, and we haven't had the technologies up until just recently to be able to do that. So no wonder we were still kind of looking down there and going oh my god, we never knew this was here. Why it's just genuinely, I think just..Yeah, it's where biology and where, you know, learning about life on Earth...It's just the forefront. It's just this golden age of learning about this planet of ours and how life exists in all these strange forms. And you have to look to the deep to see those things.

Marty Martin 12:10

Do you think that there are parts of the deep Helen, like..Are there deeper parts in the Mariana Trench? Could there be even deeper regions than we found before?

Helen Scales 12:18

No, I don't think so.

Marty Martin 12:19

How well have we mapped it?

Helen Scales 12:20

Yeah, I think we know that. I think we've got the kind of bare essentials on the deepest bits, and the general overall shape. And when we've got sort of, what we have got, in terms of the total of a full map of the deep seabed, at least, is mostly mutt ones that are...They're not sensed directly, but it's based on basically kind of sea level that you have, like geographical features like sea mounts, and so on, which are so massive that they pull water towards themselves and the sea, sea water sort of bulges up a bit above them. And you can kind of figure out from those surface, really good satellite imagery of the sea surface, you can sort of figure out what's going on down below. And I'm pretty sure that we know where all the trenches are. Because they really are a lot deeper, we're talking about the kind of, yeah, that sort of four kilometer average depth. And then in a few places, at the edge of tectonic plates, you've got these just casms going down, almost three times as deep as the average depth. And people have, you know, and we've had the five deep expedition last couple of years with Victor Vescovo, this millionaire, billionaire who decided to go to the five deepest points in the world. I think they figured out quite carefully where those five places where in each of the oceans, so yeah. I think we know. Okay, so speaking of those technologies, so how are we getting a view of the deep ocean? What are what are the key things that people are using now. So I see this as really reflecting quite closely as well on how we're exploring space, like what we're doing on a small scale is sending human beings. And, and there is a value to that. And an interesting kind of aspect is this kind of demand human occupied, I should say, human occupied submersibles. And there's a handful of those. It's a handful of like vehicles, like cars, I guess, like the size of a small car, but in a severe sending humans down to go look, see what's down in the deep ocean. And there's a few of those, but everything else is remote. We're sending increasingly, sending down remotely operated vehicles, so basically a deep diving robot. They were, they were developed for the oil and gas industry, and then scientists were like: "Oh, those will be useful. Let's have them." The remotely operated ones are generally controlled down great big cables. You send them into the ocean, then they are, again, sort of the size of a car, small car. They have amazing cameras, they have manipulator arms, and it's all controlled by a skilled pilot at the surface who's flying this thing through the deep. You're watching on in real time. Sometimes these are getting broadcast over the internet, which if you want to waste a lot, no not waste if you want to have a wonderful time for hours on end, do watch some of these expeditions. Wasted is definitely not the word. If you want to wile away glorious hours, do go and watch some of these live footage. You get to see this kind of exploration in real time. It's amazing.

Art Woods 14:51

Awesome. So have these robots been to the very bottom? Like 11 kilometers?

Helen Scales 14:55

So I think, so I was going to say that there's a second category of these types of technologies we have which are untethered ones. I think the very deepest depths, you have to send untethered machines because actually that umbilical is a bit of a hindrance. And there are, especially if you've got topography to navigate around, it is hard to do that when you've got that control. So, so that is why, actually, the human occupied submersible does become more useful because you can go down into those depths. So I think that is how we've done that. But then there are other ways too. There are landers, so you can just drop down cameras. That's one way that a lot of this incredible footage of really deep fish, for instance, is coming back. And that's basically in a sense, just dropping down a camera with some bait attached to it into the bottom of a trench. You leave it down there for 24 hours, 48 hours, it releases and pops back up. And then you've had like whatever footage has been recorded of what came past at that time. And then, you know, there's all sorts of other probes and sensors that are put in the ocean, either fixed to seabed or floating around. And they're gathering, I guess, more information about the physical nature of the ocean, that kind of thing. So we do have like a real network of different types of technologies that are looking and listening and sampling the ocean throughout its full depth in all sorts of different ways. And I guess that's why I think we do have this golden age now because we're looking in more detail and with more lies in different ways in the full the full length of depth of the ocean than we ever have before.

Art Woods 16:17

So if you had a chance to go down in the Elven or one of these submersibles, would you do it? Or have you done it?

Helen Scales 16:22

I have not yet had that invitation. And I would, yes. Even though I am a bit restriction claustrophobic. I'm not great in tight spaces. But I think I'd just get over that. I mean, I would, definitely, just so I could say I did and so on. I'm sure it would be an extraordinary experience to do that. I mean, yeah, I had to get over that even as a scuba diver. I mean, I don't know if you guys dive? Are you scuba divers?

Art Woods 16:46

Yeah, I've done quite a bit of dry suits which can be very claustrophobic.

Helen Scales 16:49

But yeah, and then just that sense of having that water above you. I remember when I was learning, just thinking wow, like 30 meters is like 60 feet, that's a lot of water, and kind of freaking out. But then once I was in there, forgetting about it entirely. So imagine once you're inside a valve and you don't think about the miles of water above your head and just...

Art Woods 17:04

Freak out for the first hour and then get over it.

Helen Scales 17:06

Yeah, exactly. It's a long day as well. Twelve hours at least. Would you go?

Marty Martin 17:10

I would never make it. I wouldn't, I wouldn't last two minutes. I couldn't do it. No, no, that's just terrifying.

Art Woods 17:16

I would, I would definitely go to the bottom of the ocean way before I would consider going into space.

Marty Martin 17:21

Oh, really? See, I would do the space. Yeah, I would do space. I don't.. It something about water. I've always had a phobia of extremely deep water. So you know, lack of oxygen, all of the other wonderful wonders of space. That's no problem. But deep water, I can't handle it.

Art Woods 17:32

Okay, well we won't have to compete for that ticket.

Marty Martin 17:34

No. No, no. Terrestrial bird biologists are not getting in Alvin anytime soon. So. Let's, let's switch gears a little bit, and talk about what lives down there. Because I think the the conviction, if people do think about the deep sea, and I know this is my impression for the longest time, because we think a lot of it is this giant, expansive sort of wasteland of nothingness. Right? Disuade us of that. What kinds of things are down there? What what are the estimates of diversity at depth?

Helen Scales 18:03

So I guess it's really hard at this point to, to put a kind of species number on it. Simply because, basically, whenever anyone goes to look, they're finding more. So that curve, that species area curve, or, you know, specimen discovery, whatever curve you want to look at, is definitely still just skyrocketing up. There's no sign of that tailing off at all. So, you know, even if I, and could go look, and I didn't, I was going to actually. There is a great catalog of like the current deep sea species that have been identified. And I'm sure that number is already way up from what I put into the book. But that's just really a tiny indication of what's down there, I think. And I like to think about actually, more about the different types of habitats and biomes that we get down in the deep ocean because again, you do think about just being this big, kind of monotonous net, you know, abyssal plain, whatever, there's not much there kind of thing. But there's a huge variety in the places that organisms live and the ecosystems they create and also from place to place. So just take for instance, seamounts, you know, we have, we know, because of these gravitational satellite-based mapping, that there are, you know, a good 100,000 giant mountains in the deep ocean, like miles high, but they're so deep, they don't go anywhere near the surface. And many of these create habitat for incredibly rich ecosystems built around corals and sponges that live for hundreds of them thousands of years. A whole bunch of other species come and live around these ecosystems: fish, starfish, octopuses, whales come in new to the tops of seamounts. There's a whole bunch of stuff just happening because you've got this physical structure of the sea mount. And we think there's a lot going on, for instance, just with upwelling. You've got lots of deep, slow currents coming through the deep ocean, colliding with the sea mounts and rushing up to the surface, bringing nutrients, basically kicking the ecosystem into life. And that's why you get these incredible hotspots of diversity. And then if you look from seamount to seamount around the planet, you see different organisms in different places. So it's not just a case that the deep ocean is this uniform space where species live everywhere. Because, I mean, admittedly, the conditions are much more uniform than they are on up at the surface. We don't have the sort of hot tropics and the cold poles necessarily. It's all quite cold everywhere and dark. And yet you do get this variation place to place. Same with hydrothermal vents and other really important incredible habitat in the deep ocean. And you get this huge sort of biogeography going on, around those vents, sites. So it depends where you go, and how you look and what kind of ecosystem you look at. It will totally dictate the kind of species that you'll encounter. And I'm just talking about the seabed. We've also got the whole water column to consider too. And again, you've got these regional variation.

Art Woods 20:40

Yeah. I was just about to ask about that. Yeah. What about the rest of it?

Helen Scales 20:43

Yeah. I mean, a lot of times I think the the open pelagic water ecologists do feel a bit hard done by because, you know, it's the bit that the, you have to get through to get to the seabed. Like, for instance, I was speaking the other day to the team who had been working off of Australia a couple of years ago. And they, they brought that video that got like, it kind of went viral a bit for a while, like it was 2020. On YouTube of that giant siphonophore that was in a spiral. I don't know, if you saw that one. It's just incredible. And I reckon it was the longest one anyone had ever seen. And they were like, you know, we were seabed biologists, we were just coming back up when someone was like: "Hey, what's that? What's that thing hanging in the water?" You know, so I guess, I guess that's also part of why deep sea biology is.. it is exploration in a way that you just can't get anywhere else. Because there's nowhere else you can just wander around and bump into stuff that no one has seen before. That just doesn't really happen anywhere else. It's, it's that level of discovery still is going on. So. So I guess the short story is like, wherever you look, wherever you put your robots, wherever you send people, you will, you will encounter stuff that, you know, the general response often is: "Oh, my God, what the heck is that? We have no idea what that is. What is that? We've never seen that before."

Art Woods 21:58

So you mentioned the species discovery curves still being, you know, almost vertical. So it means we're discovering new species at a very high rate, but has anybody tried to extrapolate from the data we do have to estimate how many species are in the ocean and in the abyss?

Helen Scales 22:12

I mean, the classic case goes back to Fred Grassle, and I think that was in the 80s. You know, several decades ago, at least, there were studies that were doing these kinds of extrapolations. And they were based on deep sea samples of muddy, sedimented environments and looking at small creatures like Maya fauna, and looking at those kind of species accumulation curves. And I believe like the the outcome of those sorts of studies were very approximate, kind of, let's just think about this and where could it end us up? But we're looking, I think it was, that kind of the ten million mark, I believe, something like that.

Art Woods 22:44

Sounds about right.

Helen Scales 22:44

Just based on, you know, box coring, piece of sediment, get the next one, see how many new ones they were, and so on, and so on. And I believe it got to around the 10 million mark that one, at that point. I don't know if anyone else has done any more, kind of more recent updates on those sorts of projections, or if that's even particularly popular at the moment in biology, to do those sorts of mind experiments of how many could there be, especially for the deep sea. I don't, I don't, haven't come across that. I didn't come across that so much while I was writing the book, but it's it's possible that people are still kind of thinking along those lines. But it is a lot, I think. And I think the kind of interesting thing to think about as well in the deep ocean is that it's another one of these myths that perhaps is proving not true, but kind of difficult to shake, which is that there is sort of less, there are less boundaries in the deep ocean, therefore there is less speciation, perhaps. You've got this, especially in the open water, this huge body of interconnected waters, how can species divide that up between themselves? But they definitely do? You know, we're finding, I think there's a lot more studies happening on species that maybe morphologically looked kind of similar and was considered to be the same sort of. One group, I think of the these incredible anthropods that live in the deep. These crustaceans and deep ocean waters called hyperiids. And it turns out, there's, there are more species than at first glance that there are even though they do have this very interconnected space. So it's very different ways of dividing up ecological space, I think compared to on land because it's often times about things that we maybe aren't really thinking about on land, like light levels to trying to see in the twilight zone, and there are different specialities and weird kind of eyes that are evolved to exist in that space together. So, So I think evolution is doing different things with species in the deep ocean, too, which is also another fascinating thing about that space. Yeah.

Marty Martin 24:29

I think that was one of my favorite parts of your book, it's the section about the innovations that we see in the deep and I mean, I think the intuition is that eyes are going to be different. So sorry, but I'm not so excited to talk about that because of the many other cool things you listed, and unless you want to do a four or five hour podcast, we probably shouldn't hit them all. It seemed to me that one of your favorites may have been the Yeti crabs because they took such a prominent role in the book. Maybe I'm putting words in your mouth, but can you tell me about the Yeti crabs and the innovations that they had that gave them such a prominent place in the book?

Helen Scales 25:03

Oh, yeah, absolutely. No, you're quite right. I basically did just pick out a whole bunch of my favorite ones and shone a light on them, and Yetis were definitely one of those.

Art Woods 25:12

I mean, who wouldn't?

Helen Scales 25:12

Yeah, exactly. I mean, if you, like my thoughts were if you don't know about Yeti crabs, you need to. If you do know about them, you need to know some more about them, so here we go. I mean, first up, they just look so wonderful. I mean, I have a, Yeah, I have like a fridge magnet behind me. There's no good for a podcast. But you know, I just like that's how much I love Yeti crabs. I actually have pictures of them around me, inspiring me. They just have these beautiful long, hairy arms, hence the name. You know, the first ones were discovered near the Galapagos Islands down on hydrothermal vents. These crazy extreme places in the deep ocean where life really shouldn't exist at all because it's not only super deep and dark, and the pressure was incredibly high, but because we've got these essentially deep sea equivalents of of hotsprings on land. Only, like super extreme, with temperatures and hundreds of degrees and toxic chemicals, and very little oxygen and just all the kinds of things that life just hates. And yet, vents are covered in life, including wonderful creatures like Yeti crabs, with their fuzzy arms and adorable little pincers on the end. So they just, they look super cute. But actually, when you start understanding, or we start learning about how they survive and how they exist on vents, it gets even more interesting because I think.. I mean, it's no understatement to say that the discovery of life on vents really did blow biology apart. Because up until that point, it was thought that life really just needed, you know, the sun's energy to, pouring down, powering photosynthetic machinery and providing the organic matter and energy for for the whole of the food web. And yet, here we are, cut off from sunlight in the eternal darkness of the deep ocean on hydrothermal vents and their ecosystems doing things by themselves. And up until that point, people hadn't really figured out that chemosynthesis, this dark alternative to photosynthesis, could be an option for supporting whole ecosystems. And so basically, what's going on is, in those furry arms of these Yeti crabs, there are microbes that are underpinning these ecosystems. These are the critical kind of life support the energy producers. They're not harnessing energy from the sun because there isn't any down there. They aren't harnessing chemical energy that's from chemicals pouring out of these vents: so methane, hydrogen sulfide, things like that. And these Yeti crabs are farming these symbiotic bacteria in their arm hair, and then just kind of eating them. I mean, how cool is that? They just hang around, hanging out with their symbiotic partners figuring out how to eat food. And that's how, I mean all of pretty much all of life on vents is doing something like this. Some of the organisms have bacteria inside of them; they have the, you know, internal symbionts. Others are eating on, kind of feeding on matts of this stuff, but the Yeti crabs are one group that let it grow on them, basically. And since that first discovery, we now know there's a handful of different species. Another of my favorites, which is like the relative of the Yeti, is the Hoff crab.

Marty Martin 27:50

Yes, I love that one.

Helen Scales 27:51

The so named after David Hasselhoff. I mean, how great is that? He's a guys with a hairy chest. And so I know the scientists who found them and they were on the ship down in Antarctica, finding these crabs and they came up with these beautiful hairy chests, again, covered in microbes. And they were like, who should what should we call them after Sean Connery? How about David Hasselhoff? And if you haven't seen Baywatch, I realized this is getting to be kind of a dated reference. Go check it out. TV series, he played a lifeguard, didn't wear a shirt. Go watch it. I guess that the Yeti cup for me just sums up like how to survive, but in a kind of cool different way on these amazing ecosystems.

Art Woods 28:29

Yeah. So another vent associated animal that you described that really blew my mind are these snails that have iron in their shells. And the iron turns out to be doing something really interesting and unexpected. So maybe, maybe tell us about the iron snails.

Helen Scales 28:45

Absolutely. Another favorite too. So the scaly foot snail is their, is their kind of official scientific name. And they do they have scaly feet, which is unusual. I'm sure you all know mollusks. Gastropods generally don't have too much going on on their feet apart from just squishy muscle. But these guys have this kind of armored plate going on. Again, with iron incorporated into it. I should say, you know, that an iron based compound isn't, hasn't been found in any exoskeleton in any animals we know of apart from this one species, and it comes back again to this extreme environment of vents. And these chemosynthetic bacteria which are providing the food. These snails have internal symbiosis. So they have a pouch in their throat where they house dense colonies of these microbes. And the problem, well, the problem that's solved by this skeleton of theirs is the fact that as a side product of chemosynthesis, they produce elemental sulfur, these bacteria produce sulfur, which is toxic to snails. I don't know if you take a look at a packet of firms snail killer, or slug pellets for the garden, sulfur is often a key ingredient in that so it's really bad for snails. So what they do, it turns out, is in fact the structure of the scales on their feet, they're full of tiny little pipes like little tail pipes on exhaust pipes on a car: nanoscopic little tubes. And the sulfur is drawn along those those tubes to the external side of the scales. And they're the sulfur reacts with metals in the water that are coming out of the vent with iron, they produce these iron sulfide compounds, and that's how it gets incorporated into the external side of the shell. So it's saving them from this threat that comes from within. I mean, when people first saw these snails, they thought that those scales were presumably protecting them from attack from the outside, they looked like like a suit of armor. But it turns out, it's sort of the other way around, they've evolved a way to survive this very strange diet of sulfur producing bacteria inside of them. And that's how they get by. So it's, again, this brilliant adaptation to a really extreme environment.

Marty Martin 30:40

To sort of stick on the theme of snail but to not stick on the theme of snail really, tell us about the snail fish. This is an amazing organism. They're found that up to 26,000, sorry, feet of depth. How did they do that? That's remarkable.

Helen Scales 30:57

Yeah, the snail fish. So these are, these are trench dwellers. Say that three times over after a glass of wine. Trench dwellers. They live in trenches.

Art Woods 31:06

I can't see it after zero glasses of wine.

Helen Scales 31:12

They are really one of the deepest that we know, amongst, really the contenders for the very deepest vertebrates on the planet. And they seem to be pushing this right up to the limit. They have various physical adaptations to being at this incredible pressure. When we're talking about the pressures that are equivalent to, you know, an African elephant standing on every square inch of your body, you know, every square inch of your body, not just one of them, but multiple elephants. And so these fish, they look, they don't look like the kind of iconic deep sea fish with black skin and huge mouth with teeth and scary looking things. They are pudgy and pale. And maybe some of them are slightly pink and purple, with tiny little eyes that probably don't work because there's nothing to see down there, really. But they have this kind of crinkly lips, which are sort of dimpled, and we think that they're full of sensory. They're basically able to detect ripples and changes in pressure in the water, and that's probably how they find their prey. And very kind of gelatinous body which is a good tissue to have in the deep ocean when you when there's not much food around. A gelatinous body is not particularly energy intensive to produce and to maintain. So like many things we see in the deep, you get this kind of movement towards the evolution in many different groups are very soft, squishy, Jelly-based creatures. Even though you think that jelly looks so delicate, and kind of fragile, but actually, it makes a lot of sense when you're at high pressure. And there's there's not much food around. But then there's all these adaptations that go down to the level of the cell for these creatures. Because it's such high pressure that you know, we're talking about proteins getting bent out of shape, and enzymes not working and cell membranes cracking apart because the lipids just become brittle. So you know, they have very high lipid content in their their cell membranes, to the point where I believe if you do catch one of these things, and people do often with landers, they'll send down kind of traps and occasionally catch these things, bring them up, they sort of just then melt between your fingers, once you release the pressure. These animals can only exist at high pressure. They can't be brought up. They're adapted to that condition. Those conditions, they take them away, and they just they just kind of, blahhh. They just slip away between your fingers. So you know, there are all of these adaptations right down to this sort of level of molecules that allow them to occupy these extreme depths. And we think that yeah, they might just be kind of right up against it. So one of the things that that fish do is they put more of this compound called TMA, trimethylamine oxide, in their tissues to counterbalance, not just pressure, but also the the osmotic problems of being live in a very salty place. And there's possibly a point where they really can't put any more in their tissues because then it really becomes, you know, they will become more concentrated than the seawater, and then they will...

Art Woods 33:41

..Sort of toxic to them.

Helen Scales 33:42

Yeah, it becomes toxic. Exactly. And the kind of theoretical depth maximum, I think, is about 8,000 meters for fish. And that's roughly about where the snail fish go down to. This could be that they go deeper. We don't know. But it might be that they just get to that that bottom depth, and then that's it. They can't really go much further without a real kind of expensive overhaul of their biology. So they're incredible. They're incredible creatures.

Art Woods 34:01

Well, I think it might be a good time to switch gears a bit and talk about some of the threats that you identified to deep sea ecosystems. Let's do a great job of laying out, you know, the biology and then some of the sort of current anthropogenic threats to those deep sea ecosystems. And I don't think we have time to talk about all of them. But maybe let's just pick a few that really caught our eye. Maybe we'll start with exploitation of deep sea fish. And maybe we can just start with the orange roughy. And can you tell us the story of the orange roughy and the consequences of fishing on its populations?

Helen Scales 34:40

Yea, so. I mean, I don't know. Is orange roughy a species that you ever, either of you to have seen on sale or, I mean, have you ever eaten it? Because in the UK and in Europe, it doesn't seem to be that common.

Art Woods 34:52

I think I've eaten it.

Marty Martin 34:54

I've eaten it. It's quite common in Florida. Yeah. I think most of the time, you can go to the supermarkets around here and find it. It's not was common as today as it use to be.

Art Woods 35:01

But I'm never gonna eat it again.

Marty Martin 35:02

Yeah, well, I know I know better now. Yeah.

Helen Scales 35:03

I mean, I didn't, I don't mean to make you feel bad. It's just a, I kind of.. It's interesting to know, you know, who's who knows of it, right? Because I think it isn't a species that's necessarily marketed everywhere in Europe, but so Europeans are often fairly unaware that this is still being eaten. And it's a species, I mean, it was originally.. It lives down in the deep ocean. They congregate around deep sea mounts. And so the fisheries really opened up in the 80s when there was the technologies to locate these huge mountains using sonar. And the fishing vessels had that capacity to go and find these places and refind them. And also the kind of power to send down colossal nets to troll these things. We're talking about you kind of single shots bringing up 50 tons potentially of fish in one go. And you know, really just extraordinary levels of industrial fishing on that kind of scale. That's just, it's just nuts to think that that many fish are there and that can be kind of quickly scooped out of the ocean. So in orange, it's called the orange roughy. The family of fish have rough scales. That's where the where the common name comes from. They're very deeply pigmented, They're quite red when they're alive. But when they die, they kind of fade this orange color, so they are called orange roughy. They were renamed. They're actually, slimehead was the original sort of common name for them, but once people started catching them and and figuring out maybe people want to eat them.

Marty Martin 36:14

I love that. Slimehead will not sell.

Helen Scales 36:16

Yeah. No. So it got rebranded. You know, and actually, they found that for deep, not a lot of deep sea fish aren't necessarily the kind of thing people do want to eat. These ones are actually quite unoffensive. They're not too oily. They don't smell too bad. So they were kind of suitable for the market in that sense. So people were like, we're catching them, let's try and get people to eat them. But the thing was with it, that it was a case of like a fishery that was really carrying away with itself before anyone really comprehended what was going on, how much impact this was having, and and how could it be regulated. So both on the biology side of things and on the regulation, it was just kind of freewheeling off. It was beginning in Australia and New Zealand fisheries were going out, and they were fishing out one seamount until it basically stopped catching whole nets full of these things, and then they just move on to the next one. And it was more like mining than fishing. In that sense. It was just like mount to mount to mount. And as that was happening, people were, only then, just kind of going: "Oh, do we know anything about these fish? Really ,about how they live and where they live?" And initially, when fisheries started to exploit a new seamount, not only would fish come up, but huge corals would come up to in their nets. Like giant trees, you know, of living corals that are hundreds 1000s of years old were also coming up in these trawl nets. So it slowly dawned that not only was there a huge ecological habitat damage happening with these physical nets being dragged across the seabed on the sea mounts. But also the animals that were being caught, these orange roughy, were just the kind of species that is going to be very difficult to sustainably fish because they live for at least 100 years. Now, they're estimates up to sort of 200, 250 years a piece. That they take decades to mature and to begin reproducing. So no wonder, I mean, they aggregate on these mounts, sea mounts to spawn. That's how they come together, so they're really easy to fish. And yet, once they've gone, you know, the populations were very quickly being wiped out, and you had this kind of zero depletion happening. So it really was a lesson in like the fisheries, we're running ahead of understanding of what's down there. You know, and if you were gonna pick a species to to do this with, let's try and use the oceans sustainably if we want to feed people. Orange roughy really isn't the kind of species that it's going to work out for, you know. It is technically possible. You could figure out, and people are trying to figure out how to set a quota. That would mean you wouldn't be depleting the population, but it's going to be so low compared to other much faster growing species. It just doesn't seem like the kind of smart move to make, especially given the ecosystem impacts to these amazing old corals. You know?

Art Woods 38:40

So is there much less fishing for orange roughy now than there has been historically? Or is it still going full bore?

Helen Scales 38:46

I mean, yes. But sadly, a lot of it, the declines were just because they were running out, you know. People stopped fishing them because they weren't catching them anymore. There is more regulation now. So it's not entirely, you know, it's not that they have gonem and they're not actually going to go extinct. But what we're seeing is very slow recovery times, and a real absence of young roughy coming into these populations. Some of these seamounts that have been stripped bare decades ago, you know, there's still no young fish showing up. So it's a big question as to if they will, and when they're going to come back and, you know, repopulate these areas, if that's going to happen at all.

Marty Martin 39:21

You mentioned a lantern fish as a possible alternative. Where do things stand with the lantern fish and why is that promising?

Helen Scales 39:27

So that would be potentially a whole new type of fishing which isn't happening yet. And this is mid water, fish in the twilight zone. So from that 200 meter mark down to about 1000 meters, this kind of dim twilight area of the deep ocean, you get these enormous huge abundance of small sardine sized little fish, little bioluminescent glowing fish. They go on these incredible migrations to the surface every night to feed, and then they come back down into the Twilight Zone. And they form this these dense populations. Originally they were discovered because Navy sonar were kind of focusing on the deep ocean trying to figure out if there were submarines and so on down there. And this, they thought they saw the seabed moving up and down during the day and coming up at night and going back down during the day. Turns out that was just fish though..Because they have swim bladders, so they were, the sonar beams were bouncing off of them. They're so dense, you know, they were impersonating the seabed. So there are huge, there's a huge biomass of these species. A bunch of different ones, you know, there's a couple of 100 species of lantern fish, there's also bristle mouth, that did a similar kind of thing. Myctophids is the kind of general name for, what for the family, I guess, you know. And they've been various estimates of the global abundance of these things. And they're, there's no doubt that they are super abundant, you know. We're talking a giga ton maybe twenty gigatons of fish in this twilight zone. And that in itself is incredibly exciting, but also, you know, they're clearly playing a critical role in the ecosystem as a bunch of other wildlife and species that feed on them. They're also doing an incredibly important job of pulling carbon down into the deep ocean because a feeding at the surface at night coming back down, and that's where they poop and where they die and where other things eat them. And that carbon from the surface is really getting down into deeper parts of the ocean where it's going to stay for much longer. So the carbon cycle and the carbon pump down into the deep, these guys are critical in that. But of course, there are also people who find out about this incredible abundance of animal life with this biomass and think: "Hey, can we exploit that? Can we do something with it?" You can't eat it directly. These things are very bony and oily. They're not really palatable. So okay, great. We turn them into fish oils and fish meals, and we feed other fish with them. And we create health pills and that kind of thing. And that's how we can make money out of it. And it's at that kind of stage right now. It's like, I think it's industry is thinking, is this the next big thing? You know, is this the next big way we're going to monetize the ocean. And I do see it as monetizing as opposed to it, I don't think we can, we can't expect land and fish to feed the world. I don't think. This is not a solution to world hunger, to food security. It's really a case of another industrial exploitation and other industrial idea of how to use the ocean. There aren't any, as far as I'm aware yet, any commercial scale, deep, open twilight zone trawls, trawl fisheries happening. But there are some experimental ones, and people are looking into this. You know, it reminds me of krill in Antarctica. You know, this idea of the huge abundance of Antarctic krill and boats going down there and getting the technologies to suck them out of the ocean. Is that a good idea? I don't think so. I think these are ecosystems that very much need to be left alone as much as possible. And yet, of course, there's always those thoughts about what more can be done to monetize and to commercialize the ocean. And the Twilight Zone is one place where that that could potentially happen.

Art Woods 42:29

Yeah. Well, you mentioned carbon. And maybe let's use that as a segway to talk about hydrocarbons and deep sea drilling for oil and gas, which I guess is, you know, hydrocarbons coming out of the earth. And then the flipside is this idea that people have been toying with quite a bit recently of carbon sequestration back into the deep ocean. So how big of a deal are those? And what are the impacts on the deep sea at the moment?

Helen Scales 42:55

So do you mean the natural processes by whereby carbon is getting into the deep or, like deliberately trying to put more down there to get it out of the atmosphere.

Art Woods 43:03

Deliberately trying to use it as a sink. Yeah. Yeah.

Helen Scales 43:06

Right. Yeah. Okay. Because obviously, there's, there is that, you know, with the lantern fish and a whole bunch of other ways that carbon isn't naturally getting into the deep. But in terms of that, kind of, yeah, sequestration and putting carbon down there, again, I think this is.. I think it stems back to the idea that there's like an overarching all of the considerations of how humans have looked at the deep ocean and thought about it and thought about using it which comes back to this massive size. You know, this billion cubic kilometers, this, you know, vast, vast space, as also kind of offered itself up to be this sort of resource simply through its enormous size, that in various ways people have thought, what can we do to use that? You know, and there are thoughts that we could use this huge space in the deep ocean for maybe putting carbon or doing other things to, that we can use that space. So one, I think, slightly wacky idea, which I don't think will ever happen, I'm not sure we'll ever get to the point of people thinking this is a good idea, and let's do it, but you never know, it's just to pump CO2 into deep sea trenches. Because there comes a point, I believe, where the pressure is so much that that CO2 liquefies. And you get this kind of slushy, I guess, like dry ice, you know, that we've all been to nightclubs, or whatever, you see, see dry ice evaporating.

Art Woods 44:22

Yeah, yeah. So you'd have kind of leaks of this kind of semi solid or liquid CO2 in the bottom of the trench?

Helen Scales 44:28

Yeah, that's, I think that's the idea. Again, I think, so many questions as to whether that's a good idea ecologically or even in the long term, if it would be stable. I think technically, it could happen. You know, that if you did put CO2 down there, that would be what would happen. It would sort of form this, yeah, sort of slushy, carbon-rich substance. And ocean trenches are huge. You could do that. But yeah, it comes with so many questions that what the impacts would be. I mean, we're already obviously facing huge changes in the ocean because of acidification from the CO2 that's already getting in from the top. So the idea of pumping some right in at the bottom level seems like just opening up a whole bunch more problems that we don't fully understand at this point. I should say there were some really interesting deep sea ecosystems based around the natural kind of carbon rich ecosystems, not just the hydrothermal vents, but methane seeps have got some really cool creatures living in them. And again, like living off these chemicals coming out of the seabed, that's natural stuff. That's natural methane deposits that are kind of bubbling up. They are kind of cool and interesting, you know, those small Yeti crabs live on those too. But on the whole, I think we are, we understand that there are really critical natural reserves of carbon, stockpiles of it in the deep sea, that we really need to try and leave be and leave that where it is and not not disrupt that and make things even worse.

Marty Martin 45:40

So, Helen, one more conservation issue. It seems you read a lot of in the book about the deep sea being used as a source of materials. A lot of mining happening and probably the risk of much, much more happening in the future. So what's, what are the main targets right now? What are the pluses? What arethe minuses? What are the biggest concerns?

Helen Scales 45:59

Yeah so deep sea mining for metals, for minerals, is something that people have dreamt about for decades. I remember when I was in high school being taught about manganese nodules, black rocks that look like lumps of coal, shiny coal, that are scattered around these abyssal plains. And I remember back at that point, being told about these and thinking well, oh, well, yeah.. I think the idea at that point as well, a few decades ago, I shant say how many, but a few high school, the idea that really it was just mud and rocks. That there wasn't much else down there. You know, that we really was just this kind of boring, endless planes of squishy mud and these rocks scattered around that happened to be full of metals, not just manganese, but a whole bunch of other things, cobalt and rare earth metals and various other things. And maybe one day people are gonna figure out we should go get them. We've known about this for much longer. I mean, they were first sort of found by the Challenger expedition which is just about to celebrate its 150th anniversary. But when those guys set off on this crazy round the world two year voyage of oceanographic exploration and really sort of set that bar for understanding the ocean, they came back and, you know, they found these things, and it was seen as a curiosity. They were sort of put on display as being as curious and wonderful as moon rock. You know, these things that grow at the bottom of the ocean. And they do, they grow from the water, and they take millions of years to form. It's one of the slowest geological processes that's been measured. It begins perhaps with an ancient bit of shock tooth and then, very slowly in these very particular conditions, you know, dissolved metals in the water will start to precipitate out and they form like.. I can kind of view these layers, these concretions of metal rich substance. You know, and people have really been thinking about potentially mining them for decades. There's a couple of other places as well, where there are these rich metal rich deposits which are currently interesting potential mining companies, one of them being hydrothermal vents, these black smoke chimneys, also full of metals, and seamounts, we get there across metal rich rocks on the tops of seamounts forming a similar sort of process as these nodules, and are full of various different elements. And at this point, there is no commercial scale exploitation of these deep sea deposits, but we're very close to it becoming a reality. There was kind of this initial wave of interest in the 60s and 70s of people kind of thinking we could go do this and scoop up these rocks and had various ideas of how that would happen. But the technologies really weren't there. The costs were too high. Now, that's it is different. The you know, we have much more advanced tech to do this. And there's also potentially, well, there are arguments being made that there's more need to go and get these metals. The biggest one being that we need them for green transition. So so a lot of the talk is about, oh, well, you know, electric car batteries need cobalt, and various other things. We'll get them from the deep sea because the land-base sources are either running out or they're highly problematic. And then suddenly, there are problematic sources of things like cobalt. And so we're looking to the deep sea to say: "All right, okay, so we're gonna get these stuff from down in the deep."

But the thing is, and I talked about this in the book, and it's one strong reason why I decided to write the book because I felt like this was an issue that was coming up, and that really needed looking at in detail because there are a lot of assumptions into this question. Well, there are a lot of questions about whether we can and should be mining the deep seabed, and I wanted to look at it in more detail. And it's super complex. I wrote two long chapters about in that book. But I think the kind of high level stuff is, is well the assumption of would it be these particular metals that we need for the tech that's going to, you know, get us off of fossil fuels and reducing our carbon out but as in, globally. Then the tech is changing, you know, that we already have cars being made with cobalt-free batteries. So it's a very simplistic argument to say that we need that cobalt from the deep sea to make electric car batteries and therefore stop using gas and petrol. You know, we could easily move away to a different type of vehicle, we could look at different solutions. And I guess that I mean, the one thing I want to absolutely underline is things have changed a lot in my lifetime since those early high school days of them going: "Oh, it's modern rocks." We know so much more about these deep sea ecosystems and what lives down there. It is not an empty void. It's, I mean, it's easy to see that seamounts and the hydrothermal vents are full of life. We just have to go look at it and you can see that it's obviously the case. But even for the abyssal plains, which might at first not look quite so exciting, you know, they're not brimming with life in that sense, but there are still a huge amount of unique endemic species that live in these systems, in this rock and sediments around them. There's a lot of new species being found. And a lot of them rely on these rocks. So even if you could, even if you could very carefully take those rocks away, you're removing that basis of the habitat. And that's not coming back anytime soon. It's like cutting down trees and old growth forests, but times that, you know, times millions more. It's going to take that much longer. So the ecological impacts are a big question when looking at this possibility of mining the deep seabed. A really practical question for that Helen, you touched on it a little bit in the book, maybe it's good to bring it up here, who owns the depth? I mean, this is not, I have a hard time figuring out how this is going to happen, how it's going to be regulated because presumably so much of the deep, deep ocean, is their ownership. Is that clear? No. And it's, it's actually, the whole story of how we got to this point of potentially mining the deep seabed is wrapped up in this early dreams of doing it. And even how we think of the jurisdictions of the ocean now was kind of a consequence of people early on in the 60s going: "Hey, could we do this? Could we mind the deep sea?" In which case, who gets which bit, and it was very much the, it still is, very much the rich, industrialized nations who have the capacity to do this kind of thing anyway. And they were just kind of, you know, reaching further and further from land and saying: "This bit mine. This bit is mine." So you know, the United Nations got together, and they were like, okay, look, we need to figure this out. Who owns the sea, and who owns the seabed? And through, a good 10 years debating this, it took an awfully long time to come to any kind of agreement. And gradually, we have now got these kind of more fixed boundaries in the ocean, at least on maps showing, you know that that a nation has its territorial waters, and then it's got like a 200 nautical mile zone in which they have rights to exploit and do what they want, well, within reason. And then everything else beyond that is technically called the high seas, areas beyond national jurisdiction, A, B and J very exciting acronym. And there's lots of interesting things happening in terms of a new potential new treaty for that part of the world as well. And the seabed, I mean, the water and the seabed, weirdly, are kind of disconnected, which doesn't make much sense ecologically. But the seabed is called the area. Technically sounds like something out of a James Bond movie to me: The Area. And that is now, I mean, the thing I find absolutely fascinating about how this whole, these discussions happened was the area, the seabed is technically the common heritage of humanity. It does belong to all of us, and everyone in the future, who will, is going to exist. It's the same as asteroids and the moon, and trying to figure, that that they even happen, I think, is amazing that we have that in place. But it is now raising a huge issue of okay, well, then, who should benefit from mining that? And how if we were to do that, how are we going to share that out amongst all of us because if we're all co owners, we should all get a benefit. Plus, also, maybe we should have a say in it, too. And there is an organization set up by the UN to supposedly represent all of us when in matters of the big seabed of the seabed, the International Seabed Authority. And as of right now, there are questions, there are increasing questions about how that job is being done, in terms of balancing exploitation, industrialization, against, you know, the ethics of it, and the ecology of it and how we should do this. There's big reports now happening in the main media, and the New York Times did a huge report on this, over the summer, looking into some of the ethics of this. It gets kind of involved and a little bit nerdy, but I think it really does matter because we're talking about such huge areas of the planet, potentially, with huge, potentially huge impacts with kind of good intentions at the base of it. You know, the idea of sharing and looking after our planet, we desperately need to do that. And we have a framework, potentially, whereby we could do that in the deep ocean and on the seabed? The question is, is that going to actually happen, and are we're going to get that far with this. And the more, I just think we need to talk about it more. It is an issue for everyone that we should all know about. And yet, it does feel, it still feels a bit kind of sideline to me.

Art Woods 54:04

Well, thanks so much for the fantastic conversation, Helen. I feel like we've covered a lot of ground. I should say we've covered a lot of water. And we always like to end by giving our guests just the chance to say anything else that they would like to say that we haven't asked you about or you covered.

Helen Scales 54:23

And I always asked the same question, and then I realized that, you sit there going: "Oh, I have so much more."

Marty Martin 54:30

It's a long book. Yeah.

Helen Scales 54:31

Go read the book. I guess, I guess I would, and by saying, you know, often when I'm talking about the ocean to people about the great wonders and the great threats, you know. And I do have this on a daily basis of like, you know, an absolute blend of wonderment and excitement about what we're learning and just the wonders of the deep ocean, the living discoveries we're making, or any part of the ocean and how I balance that out against knowing how many problems the oceans face. Do you know do I feel hopeful about it, is often a question I get. And I will say: "it depends on the day you ask me." But, But yes, I do have hope. I'm not necessarily hugely optimistic necessarily. I don't know how it's gonna pan out in the ocean in the future, but I am hopeful because there are more people who are getting involved and being interested in the ocean. And I'm so often asked: "okay, what can I do?" So I tell you about how awful this all is: overfishing and pollution and deep sea mining and everything else. So what can we do? And there is so much we can do. And I think what I really want people to think about is how you can become an ocean person, wherever you live, whatever you do. And you don't have to do it all you know, we, we all have our own skills, and we all have the things that we love and that we're good at. So you know, if this is something that is concerning you, or you feel you want to know more, then you know think about what it is that you are good at. Who do you influence, who can you talk to? Go out and learn more yourself. Become that person who, like me, feels they have to tell other people about the wonderful stuff that's being discovered in the ocean and just make it more of a thing in everyone's lives. And that, I think really does have a power. That is where my hope comes from. This is my kind of final point is my hope comes from people. More ocean people in all different ways. A diverse, wonderful group of people who are looking out for the ocean and who are the voice of the ocean, then yeah, then I really do have hope.