Ask A Biologist Vol 108 (Guest: Stephanie Pfirman)

The Last Stand for Ice –

It's cold, it's hard, and you might not think of it as critical for life on Earth, but there is some ice that is more important than you might know. Dr. Biology sits down with scientist Stephanie Pfirman to talk about summer ice and how the amount we have in the Arctic is shrinking rapidly. This ice is important to more than the animals and native people who depend on it to survive. It turns out it has an impact on life far beyond its cold edges.

Transcript

Dr. Biology:

This is Ask A biologist, a program about the living world. And I'm Dr. Biology. Today, we're going to talk about ice, not the ice you put in your drinks or maybe skate on this ice is found in the northernmost parts of the Earth.

Dr. Biology:

You can consider this specialize. Why is it special or important? This ice covers much of the Arctic, including the North Pole, and is special because it lasts all year round, even in the summer months. At least we can find it today.

Dr. Biology:

But if global temperatures continue to rise, it might not be there much longer, and the plants and animals that need this ice to survive will likely disappear. Our guest today has been studying this ice this summer, ice for years.

Dr. Biology:

Stephanie Pfirman is a foundation professor in the School of Sustainability and a senior sustainability scientist in the Global Institute of Sustainability and Innovation at Arizona State University. She and a group of scientists recently published a report on summer ice and how long we might expect it to remain and the consequences of not having this ice remain year-round.

Dr. Biology:

In this case, it is where summer ice is likely to make its last stand. This might seem like an unusual podcast for living things, but you might be surprised about how important this type of ice is for life far beyond its cold edges.

Dr. Biology:

Thank you for joining me on, Ask A Biologist, Stephanie.

Stephanie:

Yeah, I'm so happy to be here.

Dr. Biology:

Let's start by getting our bearings and understanding of where this special ice is located. I think that's the first thing we should do.

Stephanie:

That's right. So about for the past 15 years, people have been modeling the Arctic ice and trying to understand where it's going to be, how it's going to change. You know what the implications of the changes are? And I started noticing in the models of the people who were doing this that there was this one area north of Canada in Greenland that consistently had ice. And this is important because, you know, you think about the ice being lost and if the ice is going to be sometimes north of Norway, sometimes north of Greenland, sometimes north of Russia in the future, as the ice declines, then there's no way that a habitat can really be established. Right? If it's all over the place and patchy and shifting 1000 kilometers one year to the next. But that's not the case. There's this one patch north of Greenland and the Canadian Arctic Archipelago, where the ice is predicted to stay. And right now, it's the place that has the thickest ice. And so, you would ask, well, why is that what's special about this one location.

Dr. Biology:

Right, and this is what we talked about the last stand for ice.

Stephanie:

Exactly. That's what people are talking about. You know, the last stand for polar bears, the last ice area. It's been called by the World Wildlife Fund. So, the reason for that is something that we become more accustomed to recently is the polar vortex.

Stephanie:

Right. So, you have these cold winds from Siberia that are blowing across the Arctic, bringing us those cold snaps and snow days. And that's also pushing the ice ahead of it. So, it's almost like kind of a snowplow pushing the ice ahead of these northern winds and they push the ice up against the continental shelf and the coast of Canada and Greenland. It piles up there and it gets thicker, and it takes longer to melt just like that snow pile that's been pushed up by snowplows.

Dr. Biology:

Now we know where we are, so we're talking about the ice in the Arctic. Let's talk a little bit about the ebbs and flows of ice, right? Because there are some ice was going to say it's there year round, but there's other ice, it isn't.

Stephanie:

That's right.

Dr. Biology:

OK, so let's talk a little bit about in general in the last ten years, how has that changed? Because that year-round ice is not the same.

Stephanie:

It's not the same. It's dramatically changed. So, when I first started working in the Arctic in 1980, we had about 8 million square kilometers of ice that would be remaining by September after all, the melting had occurred. And now we're down to 4 million square kilometers. So, it's dropped by half just since that time. So, it's really dramatically different right now.

Stephanie:

And to go to your question about how the ebbs and flows so ice forms in the wintertime. So, around now October-ish September in some places, you start forming the sea ice and basically, it's just a thin skin of ice, just like you might see on a pond or a river that forms on the surface of the ocean. And then it gets thicker over time. As the winter progresses, it gets thicker and thicker, and that reaches something like a meter and a half or so by the end of that first year of freezing.

Stephanie:

What happens in the Arctic, which is really interesting, is the ice doesn't stay where it freezes. The winds are really strong, the winds and the ocean currents, but about 90% of where the ice goes is determined by the winds.

Stephanie:

So, the winds blow the ice ahead of it, and that direction in the Arctic tends to be from Siberia, from the coastal areas there across the North Pole and then towards Canada and Greenland. Part of the ice actually circulates in this big gyre, you know, kind of like a whirlpool, and it goes along the coast of Alaska and then the coast of Russia and then back around towards Greenland as well. And so, the movement of ice is really pretty complex. But it's the main thing is it's constantly in motion.

Dr. Biology:

OK, so we have this ice that starts from Russia comes across the North Pole. The wind reacts like a snowplow.

Stephanie:

Right.

Dr. Biology:

Pushes it up against the continent here.

Stephanie:

Right.

Dr. Biology:

What is the role of this ice? Let's start with the ecosystem.

Dr. Biology:

We're talking well. A lot of people get really interested in polar bears and seals. And there are no penguins there. Yeah, we have to go very south for that.

Stephanie:

We have to. That's right.

Dr. Biology:

But those polar bears and seals, those are certainly dependent upon this. But there are other creatures that too. Let's talk a little bit about the ecosystem and why it's so important.

Stephanie:

So, the Inuit talk about the sea ice as kind of being a garden where you have to think of this sort of in reverse. So, you have this platform of the sea ice. It let sunlight through and attached to that, our ice algae. And so that's the base of the garden. And then feeding on the ice algae are the ice copepods and then feeding on the ice copepods are some krill, but also some Arctic cod. And then feeding on the cod are the ring seals, for example, and feeding on those are the polar bears. And so you have this whole food chain that's established because you have the sea ice as a platform.

Dr. Biology:

You talked about how thick it was. Does it matter how thick it is?

Stephanie:

It matters how thick it is because that lets light through, right? So, you need enough light for the ice algae to grow. But there are some algae that actually gets established and grows these really long sort of almost kelp like forests underneath the ice.

Stephanie:

And what's really interesting is that the ice, as it's drifting across the Arctic, brings this whole ecosystem with them. And so, it brings in this entire habitat and the associated, you know, species from distant into coastal regions. This brings in this whole source of biomass and this whole source of food that many of the northern people have survived on.

Dr. Biology:

The indigenous people around there. It would be really impacted by this.

Stephanie:

Yes.

Dr. Biology:

It's one thing. But this ice has a really important role. I know there's quite a list, but let's pick maybe you know ... well you can give me a list and let's just pick a few of them to go into of how this particular ice impacts globally, not just that region.

Stephanie:

Right. So, I'll start first with a habitat aspect because it's Ask A Biologist. And so, one of the things is that you have to think not just about the organisms that are associated with the ice itself, but also with the ice edge. So, when the winds blow along the ice edge, it causes upwelling, and it causes nutrients to come up that will support an algal bloom and in some places, the algae. I was actually up there in May when this was happening, and it was like pea soup. I mean, there was so much algae that that was in the surface of the water and little bits of ice floating in it, and it was just amazing to see.

Dr. Biology:

So, when you talk about an upwelling, you're talking about pulling water from deep, pulling it on up.

Stephanie:

And it's got nutrients. You get nutrients and you get light and then that's the perfect, you know, fertilizer and the conditions for algae to bloom. So you get this algae bloom and then you have the zooplankton that are going to be feeding on that and they can't eat it fast enough. And so a lot of this biomass falls to the sea floor. And the seas around the edges of the Arctic are relatively shallow, like 30 meters, 50 meters, maybe 100 meters, something like that. And that food then is accessible to all of these benthic organisms that can feed off the bottom of the ocean and get the food.

Stephanie:

So, one of the problems and one of the things that we've been researching is where will the ice edge be in the future? Because if the ice edge is over the deep ocean, which is over a mile deep, then those organisms, those benthic organisms, the walrus, for example, are not going to be able to dive down to the bottom of the ocean to get it right. And so, they're going to lose that whole source of food. And so, I think that's one of these issues related to the distribution of the ice that it matters where it is and when. And so that's why we're researching, you know, and detail, you know, the seasonality of the ice, the location of the ice edge, the type of ice and all those issues.

Dr. Biology:

Right. So, location, location, location and depth, depth, depth.

Stephanie:

Yeah. And timing, timing, timing.

Dr. Biology:

Got it right. Got it. So benthic organisms, let's talk a little bit about those real quick.

Stephanie:

Yeah. So benthic organisms are organisms that feed off of the food on the seafloor or they're attached to the seafloor themselves.

Dr. Biology:

And those are like.

Stephanie:

Yeah, so walrus eat clams and clams need, you know, a supply of detritus, the plankton that's falling down to feed off of. Right? They're filter feeders. And so, the walrus eat the clams, and they eat something like 2000 clams in a day.

Stephanie:

So, they need a lot of clams, right?

Dr. Biology:

Wow.

Stephanie:

Exactly right.

Dr. Biology:

Wow.

Stephanie:

Right.

Dr. Biology:

For every walrus. Wow.

Stephanie:

Yeah. And they actually they siphon the meat out of the clams, so they're not actually getting all those clams that would give them quite a stomachache I would imagine. Walruses are actually really interesting. We talk about them as kind of the couch potatoes of the Arctic because they use the sea ice to kind of drift. They haul out on it, and they drift to a new patch of clams and then they roll off the ice and feed off some more clams, then climb back up and drift to another place. And so, they actually use the ice, you know, as many of the Arctic organisms do for kind of a platform for locomotion and transit as well as for habitat.

Dr. Biology:

I can just see that, you know, there's a cartoon in that somewhere

Stephanie:

There is. Yeah, right?

Dr. Biology:

OK, so that's part of their story or the whole thing.

Stephanie:

I think that's most of the habitat, you know, the ecological side of it. And then there's all of these other global aspects.

Dr. Biology:

Right? And you're correct when you're talking about that ecosystem and it is Ask A Biologist, we want to talk about that. But the things we're going to be talking about is global impact. And if for no other reason, if you want to be a selfish human, this is one of the reasons why or multiple reasons why we have to watch out for and make sure we protect his eyes. So, let's go into some of these.

Stephanie:

So, one of the things is that the ice is white, which means that it's bright, so it reflects sunlight. And what's interesting is that if you even get sort of this inch or so of sea ice or maybe five inches or so, it'll be bright white and it will be one of the whitest things on the entire planet. You know, a thin skin of flat ice potentially covered with snow is going to be incredibly reflective, and that's covering one of the darkest things on the planet, which is the ocean. So, you change the albedo, that's the reflectivity, the amount of sunlight that's being reflected from hardly anything being reflected to almost everything being reflected just by putting this thin skin of ice on the ocean. So, it's really important. And having the Arctic be white and bright, especially the central part of the Arctic, which is an ocean, reflects a lot of sunlight, so it keeps the northern hemisphere are cool. So, with the changes in the ice, they're not just affecting what happens in the Arctic, but also our entire weather system. In the northern hemisphere and global temperature as well.

Dr. Biology:

So, when we start warming things up, what else happens?

Stephanie:

So, another thing that will happen is that the glaciers will be melting, right? So, a lot of people think, well, it's ice and it's in the ocean. So, when it melts, isn't sea level going to rise? So, the ice we're talking about will not do that. So, think of a glass of water and you put ice in it and then the ice cubes melt, and your glass doesn't overflow, right? Because it's replacing what it's displacing, right? So that's the way you can think of the sea ice.

Stephanie:

But the sea ice and the cold temperatures up there keep the glacier stabilized. The glaciers are on land, ice on land. They're formed by precipitation by snowfall. They accumulate year after year for thousands, sometimes millions of years. So, you've got this thick ice cover on Greenland in particular if you have a warm ocean around it. It is going to cause that glacier to melt faster and to have a different weather pattern, and the glacier could become destabilized. That would take the ice that's on land and bring it into the ocean, and that would raise sea level. So that's another reason why we're worried about the loss of Arctic ice.

Dr. Biology:

Right? So, that's where we get sea levels rising.

Stephanie:

Exactly.

Dr. Biology:

Not the icebergs.

Stephanie:

Not the sea ice itself. For first year ice, you can think about much of the Arctic ice as being kind of the thickness of a room is high. So maybe like six feet to nine feet or something like that is what much of the ice in the Arctic is now.

Dr. Biology:

Was it thicker at one time?

Stephanie:

Yeah. So, and actually, I should amend that a little bit because it's getting thinner all the time. And so, it's decreased in thickness quite a bit. But talking about the multi-year ice that I've been studying, of course, it goes down to like very thin with the when the ice is first formed. It used to be that a lot of the ice was much thicker than that because it had been accumulating for longer periods of time. And now we've had so many years with really low ice cover that the ice is moving faster and it's not nearly as thick as it used to be.

Dr. Biology:

We also have some change in some patterns, and in particular, one of them I know is the jet stream,

Stephanie:

Right.

Dr. Biology:

Let's talk a little bit about the jet stream.

Stephanie:

Yeah.

Dr. Biology:

Because it has such an important role for weather.

Stephanie:

So, the position of the jet stream is basically determined by how cold the Arctic is relative to how warm the mid-latitudes are. So, people often use the analogy sort of a of a skater. So, when a skater puts their arms out, they're not nearly as stable as when they pull their arms and when they do a spin. So, the same is true in the Arctic. When you have the wind patterns in the whole climate, circulation is driven by the temperature difference between the Arctic and the mid-latitudes. So, when that temperature difference is really big, then it's kind of like the skater spinning really tightly.

Stephanie:

You have a driving force that is really strong, and it makes the jet stream and the sort of the whole polar vortex smaller and tighter, right? When the difference between the high Arctic and the mid-latitudes is less, the whole pattern becomes destabilized and you get these large loops, you get these, you know, meanders kind of, as you would see in a river. And that brings both cold temperatures down when people say the polar vortex is here right, that brings us cold temperatures down. It also brings warm temperatures up. And so that destabilization and that slowing down of the jet stream is basically governed by the temperature difference between the high Arctic and the mid-latitudes.

Dr. Biology:

It's one of the reasons why we've shied away from focusing too much on the term global warming.

Stephanie:

Right.

Dr. Biology:

We actually call it wacky weather.

Stephanie:

Yeah. OK.

Dr. Biology:

And the reason why is people misunderstand that the cold they're having this cold weather is coming in is actually due to we're actually warming the planet. Which doesn't make sense until you start looking at these big loops you've talked about.

Stephanie:

That's right. Yeah.

Dr. Biology:

So. How long do we have? To. Deal with this because. To say this is in the news all the time it is. And I'm afraid that we become almost. You know, desensitized. Let’s talk a little bit about a timeline here. What are we looking at for going from what was once 8 million square kilometers to 500,000? What are we talking about?

Stephanie:

So, we've already gone from 8 million square kilometers down to around 4 million square kilometers. We are projecting that sometime in the next couple of decades will be down to the 500,000 square kilometers. And so, you know, it's going really pretty fast.

Stephanie:

Then there'll be this long tail because, you know, we'll keep forming ice in the wintertime. This is something for people to think of. I think when they think of a almost ice free Arctic, they think of it being ocean year round, but it won't be. We'll still be forming ice in the winter. The winds will still be blowing it across. And so, we're expecting that there will still be ice within this area, about 500,000 square kilometers for decades after that. Then what happens, right?

Stephanie:

That's the big question. So, we actually held some workshops on this, and we've been talking about how quickly can we move, what else can we do? And one of the really neat things is that there's increasing attention to - people have seen it, I think. More solar panels, more wind farms, you know, we're increasingly moving in the direction of alternative energy. So that's going to help a lot. We'll still be emitting a lot of greenhouse gases, but not as much as we've been admitting.

Stephanie:

So that will help. But in order to actually bring back ice right, we would need to cool the Arctic, and that would mean that we would need to cool basically the planet. So how could we do that? And on what timescale? And this is something that we're talking about, and one of the key people in this is actually Klaus Lackner here at ASU.

Dr. Biology:

You know, I'm glad you brought him up because I was going to talk about it. He was on the show.

Stephanie:

OK.

Dr. Biology:

So, if you're listening to this one, go check out hacking nature. Yeah. Let's talk about Klaus. Yeah.

Stephanie:

So, Klaus is and other people are working on this too. But Klaus has this really interesting idea, and it's more than idea right now. He's shown that this can work where what you do is you capture carbon dioxide from the atmosphere.

Stephanie:

We have to do this at the same time that we're reducing emissions. Otherwise, it just won't work. But if we have a very strong program of reducing emissions of carbon dioxide and we start withdrawing carbon dioxide out of the atmosphere and sequestering it, we think that we can result in actually bringing some ice back or at least bringing it to about the level that it is now. I think it'll be really hard to bring it back to the 8 million square kilometers that, you know, back of the 1980s. But that's a target that we're kind of heading for is to try to, you know, cool the planet enough.

Stephanie:

And not just, of course, for the Arctic for other reasons, too. But that would have a major impact on the Arctic if we were able to implement both the alternative energy and increases in efficiency, as well as the carbon capture.

Dr. Biology:

Right. And the carbon capture. In the simplest sense is Klaus has built the ultimate mechanical tree.

Stephanie:

Yeah.

Dr. Biology:

Right?

Stephanie:

Yeah.

Dr. Biology:

So, we've been talking about how people think about how the climate is changing, but it's kind of hard to get your head around it, right? What really is going to happen? And so, a while back, you created a card game. And the card game that I, you know, I find rather intriguing is called EcoChains. And that's been out for a couple of years now.

Stephanie:

Yeah.

Dr. Biology:

You know, a couple of years recently, you now made it an online version.

Stephanie:

That's right, we have a digital version.

Dr. Biology:

So, let's talk about EcoChains and how it can be used to get your head around all.

Stephanie:

This. Yeah. So EcoChains is a really exciting project, and we've worked on this with collaborators from residents and indigenous leaders in Alaska to game Professor Joey Lee at Teachers College and Columbia in New York City to Arctic ecological experts like Jackie Grebmeier. So, we've been able to pull together all of this different information and these resources. And we created this card game, and the main point of it was how do we make the invisible visible, right? So, I was describing that the ice supports almost like a garden, you know, hanging down below it.

Stephanie:

And you don't see that right? Even when you're up in the Arctic, it's hard to see. And so we thought that a card game that could show the interrelationships would be a good way to do it.

So EcoChains, you get some ice and you draw cards and you are basically building a food web based on the cards that you draw. So, you know, you start with the ice as the platform and then you build up through the ice algae, ice. So, plankton, you know, Arctic cod ring seals and then polar bears. But we also have the walrus and the clams as well.

Stephanie:

And we have hunters, the indigenous hunters of the Arctic, too, and we show how they're all interrelated. And one of the interesting things is th at we bring in ecological threats to this. So of course, we have the warming, which will, you know, melt your ice and you'll have to adjust your food web. But we also have invasive killer whales and we have ocean acidification that could attack the clams that the walrus are feeding on. And so as each of these events happen, you need to strategically manage your food web and to try to be a steward of your marginal sea.

Stephanie:

And it's been great. We've been playing with all sorts of different people from, you know, five-year-olds at museum events all the way up to grad students and then, of course, parents and elders as well. And it's been really exciting to see the reactions. When the ice is melted, people go, Oh no. And then when they can bring the ice back, they go, ha, you know, because they take the actions like the carbon capture and sequestration, and they're able to actually bring some ice back.

Dr. Biology:

Get those mechanical trees going.

Stephanie:

That's right. We've got we've got them pictures of them there. Yeah. I'm an early version of it, but he's his version now is much cooler. So, one of the neat things is that we've actually done research on this too. So, we had people either read an article or play the game to see what the differences were. And what we found is that immediately after playing the game or reading the article, people remembered the same number of animals, plants and animals, you know, species.

Stephanie:

But four weeks later, the ones who played the game remembered the ones that they had learned, whereas the ones who read the article reverted back to what they had known before they played it. We describe this as the learning being stickier than by playing the game versus reading the article.

Dr. Biology:

OK, so we have the game. Do you have other tools that people can use to learn about how this change in ice and everything? What's going to happen?

Stephanie:

Yeah. So, we have this cool new tool called CITU, the sea ice tracking utility, and it's really neat because we developed it for research and then we realized that it's great for education and for just curiosity as well. And what it is it's a tool that allows you to track the ice as it's been moving in the Arctic. It's interactive, it's available, it's free to the public and you can just tap on anywhere in the Arctic where there's ICE and you can see where that ice will go. And you can also see where that ice came from. And the really neat thing is that you can do this from 1980 up until now, but you can also look at projections for the future, so you can look at how that will change.

Stephanie:

So, our recent paper that we published, looking at the ice shed of the last ice area, we use this tool to do that. So, what we did was we basically picked locations within the last ice area, and we back tracked the ice across the Arctic to see where it would come from. So sometimes it comes from the coast of Siberia. Sometimes it comes from the central Arctic, you know, so we could see the locations and we also did that for the present. And then we also did it for the future. And that's the paper was about how those things will change.

Dr. Biology:

Stephanie:
, before my scientists get to leave, they have to answer three questions. So, the first one is when did you first know you wanted to be a scientist? Was there an aha moment?

Stephanie:

There was when I was in high school, I had. It was in New York, and we were required to take an Earth science class. And right after that, my family did a cross-country camping trip, and I could understand what I was seeing in the landscape. And I was just amazed that I could actually read the landscape having taken that class. And I kind of knew where I was and what had happened, and it was at that moment, I'm actually getting kind of a chill right now. It was at that moment that I realized that that's what I wanted to work on.

Dr. Biology:

OK, so now I'm going to be mean. This is the next question. I'm going to take it all away. You don't get to be a scientist. Most of my scientists are also faculty, and they love to teach. So I'm going to take that away from you. So here's your opportunity to be anything or anyone you want it to be or do anything you wanted to do. What would that be?

Stephanie:

This is going to sound really funny, but I think I'd be a. Like a business behavioral analyst or something. The reason why is that we can have the best ideas in the world, but if people don't act on them, then nothing's going to happen. And I've been working on climate education for, you know, since 1992 and on the changing Arctic since 1980. And I really want to see change. And my second profession would be trying to be in a position where I could really understand and actually help to affect that change.

Dr. Biology:

That's a really good point. What can other people do to make change, right? Because we didn't really talk about that. How, how should someone go about making change to help with the sea ice?

Stephanie:

So, the main thing is the scaling. So, you're interested, you're concerned. Get together with other people who have interests and concerns. You know, you can pull them together yourself.

Or if you're a member of a church, you can talk to people within your church, if at school or at your work. If you have a hobby, just get people together and say, OK, what can we do to effect change? Because that's what it takes is a lot of these little actions, as well as some of the bigger ones, right?

Stephanie:

The policies vote for sure. And we need more policies that will help tackle some of these issues, but also just, you know, by multiplying your interests and amplifying them. That's where we'll get to, where we need to be.

Dr. Biology:

That's one of the things that people often need to know is you can make a difference.

Stephanie:

Yes.

Dr. Biology:

The last question is, what advice would you have for a young scientist, what advice would you have for them?

Stephanie:

I think to try to. Find some angle of it where you feel that you're making meaning and you're contributing. It's one thing to have curiosity, and it's another thing to translate it into making a difference. And I think that that that's the one thing that I've worked in a lot of different areas, you know, in game development and, you know, working on the on the Arctic as well. And each one of those, what threaded through for me was, you know, how can I use this in some way to make the world a better place?

Dr. Biology:

Hmm. I like that. I grew up as an was a Boy Scout. And there is a motto there is - always leave a place better than you found it. So, if I can do that.

Stephanie:

I think that sustainability, that that's what that is right is to try to leave the world the way that we would like to have received it ourselves.

Dr. Biology:

Well, Stephanie Pfirman thank you for visiting.

Stephanie:

Well, thank you very much for having me. I really enjoyed it.

Dr. Biology:

You've been listening to Ask A Biologist, and my guest has been Stephanie Pfirman, a foundation professor in the School of Sustainability and senior sustainability scientist in the

Global Institute of Sustainability and Innovation at Arizona State University. If you want to play EcoChains, we'll list a link to the game in the description of this podcast and also in the transcript of the episode. The Ask A Biologist podcast is produced on the campus of Arizona State University and is recorded in the Grassroots Studio housed in the School of Life Sciences, which is an academic unit of The College of Liberal Arts and Sciences.

Dr. Biology:

And remember, even though our program is not broadcast live, you can still send us your questions about biology using our companion website. The address is askabiologisit.asu.edu, or you can Google the words, ask a biologist.

Dr. Biology:

As always, I'm Dr. Biology, and I hope you're staying safe and healthy.