Episode 4 - Coastal Tussac and Seabirds

Rachel - Hey guys, just a note from the future. There is an audio issue with my microphone, but it does get better within the first two and a half minutes. So thanks for sticking by through that rough first part, and I hope you enjoy the episode.

Nicole - Hello from your favorite Grasslands PR team. This week, we're back with another reason why these overlooked, underappreciated ecosystems are objectively the best biome. I'm Nicole.

Rachel - And I'm Rachel. And today, I was trying very hard not to do another episode on birds. I had an entire other topic planned, but it ended up being about birds again. And I was catching up on some episodes of Paleocast. We'll put that link to that podcast in the description, but stay here for now. And I listened to their interview with paleoecologist Dr. Jacquelyn Gill on ice age paleoecology, and I nearly lost my mind. So I'm so excited today to talk to you about some grasslands in the Falkland Islands.

Nicole - Ooh, that's very specific. Where's the Falkland Islands?

Rachel - You know what, how about this? I will tell you about that, but do we have any news or announcements or reviews to talk about first?

Nicole - We actually do have one new review, Johnny the Q, kind of a while ago, I'm so sorry. I forgot that Apple podcasts exist, even though we tell everyone to register. But anyways, he says, love the GPNC podcasts, which is kind of some of our old stuff that we used to do. Happy to see you ladies continuing here. Thank you so much.

Rachel - This episode today has, I think, just about everything that I find interesting. It has birds, it's ecology, it's paleo sciences, and yeah, just amazing stuff. I'm so happy. The work that I want to specifically talk about today is actually by Dr. Dulcinea Groff, who was a PhD candidate at the time, in Jacquelyn's laboratory. They saw a problem in the coastal grasslands of the Falkland Islands, which they realized they could use paleoecology to untangle. This is a modern grasslands problem that's being solved by paleo ecology from the Pleistocene.

Nicole- I'm so glad that my episode on African megafauna could inspire you to go back in time.

Rachel - That's actually what happened though. I was like, oh, paleo ecology in the Ice Age, huh? We're going to listen to this episode. Then my jaw dropped when they were talking about coastal grassland ecology and I was like, what? Before I jump into all of the ecology and the situation and stuff, I do want to mention that I'm going to have links in the description in whatever podcast app you're listening to. You can see it right now for the Twitter bios of these scientists, the paper I'm referencing, and the PalaeoCast episode so that you can go check

those out after you're done here. The interview that Dr. Jacquelyn Gill with the team from PalaeoCast was much more broadly about the work she does in general. If you want to hear more about that, go check out the interview with her. It was really cool.

Rachel - So here's my plan. First, I'm going to kind of describe what paleoecology is and how the heck they do this. And then I'll kind of describe what the heck the Falkland Islands are and what the grassland ecology is like in those coastal ecosystems. And then we'll jump into the research that dives into the problems of that ecosystem and what they uncovered.

Nicole - Okay, sounds like a plan. You scared me at first when you felt the need to lay out the plan. I was like, Oh, no, how complicated this is going to get. I can get behind this plan.

Rachel - Yeah, yeah, yeah. I just wanted to let everybody know what they're in for. And if you're waiting on the edge of your seat to hear about the Falkland Islands, don't worry, it's coming. Okay, here's the deal with paleoecology. What fascinates me about this is that it's a super interdisciplinary type of work because you're studying the ecology of the paleontological past, which is super difficult and complicated because you can't study the actual systems and how they interact because they don't exist anymore. They're all in the past. Yeah, so this is really sort of a forensic ecology. And a lot of the tools they used to uncover what was happening back then is like using super... they have to make a lot of inferences based on indirect data to decide what was happening.

Nicole - I think that's true for a lot of ancient, whether it's human civilizations or animals or plants or whatever, it's kind of... We have a lot of data to support this. We think this is what happened. But without a time machine, we'll never really know.

Rachel - So yeah, absolutely. And especially when it comes to cause and effect, like you can surely find a lot of things that relate to each other in the paleontological past. But maybe you can't say which one caused the other in a lot of cases. So it can be kind of hard to parse out what exactly was happening.

Nicole - Yeah.

Rachel - This particular lab, so Dr. Jacquelyn Gill's lab and their, the whole team focuses on the Pleistocene specifically. And I hadn't really thought about this before until I was listening to her interview where she was describing it. And she says that the Pleistocene is functionally modern, which, looking at it, I totally get what she means because a lot of modern animals, like, you know, cowbirds, make their first appearance in the Pleistocene. So functionally, if you were back in the Pleistocene, like if you were a Pleistocene bird watcher, it would feel like you were in the same time period, kind of, you know what I mean? Like maybe the beavers are way bigger, but it feels like home.

Nicole - Yeah, that's such a fun way to look at it.

Rachel - Yeah, and it's also way closer to our modern time than I think a lot of people realize. Like we had full-sized woolly mammoths on the planet when the pyramids were constructed. So this is like the biggest missed high five in history that a lot of these like amazing animals that you think of when you think of megafauna, hey, tie into our last episode, like they were here at the same time as us, you know, like, I guess if you think about it, we kind of are the Pleistocene, like we are an extension of the Pleistocene, and human groups and cultures that have names that we know and whose members we can have conversations with today were here in North America when the glaciers retreated. Yeah, functionally the Pleistocene really is the same as us and because of that, this is what's really interesting to me, we can learn a lot about how our modern ecosystems are changing now from how they were changing in the Pleistocene.

Nicole - That is really interesting. You have to learn about the past to avoid repeating it, that kind of thing.

Rachel - Yeah, but no, really, this has a lot of implications for climate change and it seems like her laboratory has a lot of interest in learning about climate change and that's going to come in to play in this particular study. Also, I want to point out that her team in general is interested mainly in how plants and animals interact and there's a lot of poop involved in their research somehow. She doesn't seem to understand how that keeps happening either, but apparently poop is super useful for studying the past, so that's awesome.

Nicole - Poop is useful for studying anything. Poop is fascinating.

Rachel - That's why you always have to poke poop with a stick. We just went on a hike recently out by Hutchinson and found some really fun poop and gave it a nice poke and learned that it was very fresh.

Nicole - Yes, yes. And not fake or a seed pod.

Rachel - Oh man, okay. So that's paleoecology. So what's going on with the Falkland Islands? And this is going to make me sound like a total idiot, but I kind of thought the Falkland Islands were in the Northern Hemisphere because maybe I'm an idiot.

Nicole - I thought they were too, so at least we're idiots together.

Rachel - Cool. And I guess like there's some human history that makes some sense. Like, okay, it is a cold weather sort of island. So, you know, we typically think of those cold weather islands as being up, you know, around Greenland and Iceland and the Faroe Islands and stuff. But it's actually an archipelago in the South Atlantic Ocean, west of Argentina. Ecologically, it has a lot in common with the ecology of Patagonia in mainland South America.

Nicole - Interesting. Sometimes I forget that, you know, like the equator is warm and then it gets less warm on both sides of the equator. It's not just the north that's cold.

Rachel - Yeah. But I mean, okay, so if you visit the Falkland Islands and or look at pictures of it, it seems and feels very tropical because of the types of plants that are there. But then there's penguins running around because, yeah, it's really close to Antarctica.

Nicole - But there are plenty of penguins that live in very moderate, even warm climates. Just saying. Penguins do not equal cold.

Rachel - You're right. You're right. Okay, but this is maybe why I thought that it had something to do with more North Atlantic stuff. Because it turns out the Falkland Islands, which are also known as Islas Malvinas in Spanish, at one point were ruled jointly by Spain and the UK, but it's been under British rule since 1833. So it's part of the UK.

Nicole - I looked them up because you mentioned them, and I saw that it was owned by the UK, and I was like, ah, okay, Northern Hemisphere. I vaguely know where they are. But, you know, whoops.

Rachel - But yeah, so I'm going to forgive myself for making those assumptions. But now that we've established that they are more ecologically related to South American ecosystems, like Patagonia, this is where they ecologically become pretty interesting. So like, okay, ecology, the dominant herbivore on the Falklands is a goose. Like, that's the kind of environment this is. But today there are a lot of introduced species like reindeer, rabbits, foxes, rats, that kind of stuff that you kind of associate with these cold climate island habitats. But they did actually have one single native mammal, and it's called the Warrah,, which was a sort of fox-like canid. Yeah, Darwin actually has writings about it, and he described it as a large wolf-like fox. And he predicted that it would end up like the dodo because it was being hunted for its fur. And yeah, it was hunted to extinction in 1873, which really sucks. Because it was like so recently extinct. Did, uh, make it extinct? Hunted to extinction? Whatever. We were able to test its DNA. And so, yeah, kind of like the warrah, or not the warrah , the quagga, where, you know, we were able to test its DNA and discover, oh, it was a subspecies of the plain zebra. We actually know now that this animal was a relative of the maned wolf. Yeah, which, as you know, maybe our listeners don't know, is a super unique canid.

Nicole - Fox on stilts.

Rachel - Yeah, the fox on stilts with a weird mane that kind of smells like skunk or weed, depending on who you talk to. And it's a super unique animal that lives in the Cejado, savannas of South America. So yeah, that's their only mammal. Everything else is pretty much seabirds. And here's the modern problem that they're having. So after about a century of overgrazing by sheep on the Falklands, the widespread tussock grasslands on the coasts of the island have been just decimated, like absolutely decimated. We're talking maybe about an 80% reduction in the coverage of these grasslands. But, you know, some of the primary economies on the Falklands apart from things like ecotourism, is actually sheep grazing. And, you know, I think the export of their high-quality wool is a huge part of their economy and their trade relationships. So,

like, grazing sheep is super important to the people on the Falklands, and the grasslands are just decimated, and that's really affecting the people there.

Nicole - Dang, yeah. I know... Let me cut this. But I know that the Arapahua island goat breed of goat also was introduced to an island, was completely decimating the island, and Arapahua island is off the coast of New Zealand, and the New Zealand government was like, yo, we gotta get rid of these goats. Like, they gotta go. They're destroying everything. And so, you know, I think maybe two or three dozen of them were taken off of the island and kind of preserved as their own unique breed of goat, and the rest were just decimated because, you know, it was either the goats or this island, and, you know, they made that choice. So, yeah, it's a really, really rare breed of goat. So, fascinating. It's definitely a story that has repeated probably several times in our history, unfortunately.

Rachel - Yeah, absolutely. And in this case, it's kind of a tricky situation because, you know, they can't just get rid of the sheep. Like, it's one of the main things holding up their economy, you know? So, it's a really complex situation, both for the ecology and the survival of this industry. I want to kind of go more into the Tussock ecology on this island. And this will be like the final piece to understanding what's happening in the modern system so that we can take a look at like, okay, how the heck is paleoecology going to help them figure this out, right?

Okay, so first of all, this is going to get really confusing because there's two different terms here that sound exactly the same that have different meanings. And that's the word Tussock.

Nicole - Yeah, oh God.

Rachel - Yeah, and by the way, this is the hashtag that I told you about, Tussock Tuesday.

Nicole - Oh, fantastic. Australia has Tussock grasslands too. They're really fascinating, they're so cool.

Rachel - No, they're really common. And so Tussock, and that's spelled with an O-C-K at the end, Tussock grasses are a type, like a group of bunch grasses, and they're grasses that grow in really big clumps or bunches that you can contrast with grasses that form nice big lawns, like sod grasses. Yeah, so those Tussock grasses grow absolutely everywhere. In fact, this I found amazing, Nicole. I just like to quickly find a definition of Tussock O-C-K grasses, went to the Wikipedia page, and the two specific ecosystems that they highlight with photographs to show you examples of Tussock grasslands are the Falkland Islands and Konza Prairie.

Nicole 0 Oh my gosh, I was just going to ask if some of our prairie plants would be considered Tussocks, and if they grow in bunches, but I've definitely never heard them, like, called a Tussock grassland or Tussock grasses, just bunch grasses.

Rachel - Yeah, exactly. I feel like bunch grasses is also the term I've heard used here in Kansas, but we absolutely have bunch Tussock prairie, and they literally have a picture of the Konza biological station as one of the two examples of a Tussock grassland.

Nicole - That's so fun.

Rachel - I know. And I know I've worked in grasslands up in the Arctic, not the Antarctic, so the Arctic, like Alaska, that area, that are called Tussock grasslands, and I think those are usually more dominated by these Tussock bunch-forming grasses because I know those ecosystems that I've personally walked through are something that I've described as being kind of like walking through a grassland, but it's beach balls, and the grass is grass growing on top of beach balls, and so it's basically like you're rolling your ankle every other step if you're not being very careful because these bunch grasses are just so dominant. Some examples of bunch grasses that you and I would recognize are things like blue grama or prairie dropseed, which I know I've definitely sat down with our friend Cassie and braided the hair of a drop seed before on a hike with you. So in the case of the Falkland Islands, their tussock system is a little different because it's kind of dominated by a single species for the most part. This single species, Poa flabellata, is called tussac grass, and that's spelled with an A-C at the end, not an O-C-K. It forms tussocks O-C-K like other tussock O-C-K grasses. But from now on, when I say tussac, tussac grassland, tussock grass, what I mean is this specific grass species and the grasslands that are formed by this specific grass species, not the group.

Nicole - Good to know.

Rachel - So tussock A-C is the type of grassland on this ecosystem that forms on the coast. This tussock grass can grow meters tall. It's huge. It can reach heights of over four meters tall. What's four times three? 12 feet tall. So they're huge. And it makes these really extensive peat deposits beneath them. So there's these really tall sort of pedestals that are fibrous that they grow on. And that kind of adds to these intense heights that they form. And these grasses provide a lot of shelter for burrowing and nesting seabirds and also pinnipeds like seals in this region, which is kind of related to the same Southern Hemisphere systems that New Zealand is a part of. They've got really, really strong winds. Hang on, I gotta scroll down and find the name of the winds. It's an abbreviation and I have to find out what it actually stands for. Oh, the Southern Hemisphere Westerly Wind Belt.

Nicole - Oh, that sounds so fancy.

Rachel - I know, but it's kind of the same system that like Tanzania, New Zealand and some southern parts of South America are a part of, so it's kind of a high wind system. And that's why having these nice big tufts of tussac grasses is really nice for the birds and animals nesting on the island there. And because it forms these kinds of deep roots and deep peat beds, it provides enough kind of shelter that the seabirds that make burrowing nests have places to burrow and make nests and stuff. So it's really important for not only that, but grazing fodder and again, the formation of peat. And because these grasslands are pretty much only tussacs, it's really

important for all of the things we've talked about so far, like the livelihoods of the Falklanders, just preserving this one specific species. So that makes it a little different from some other grassland ecosystems where there's a lot of different community ecology going on with the plants themselves. In this case, it's really just like this one species and the animals that are affecting it.

Nicole - Okay.

Rachel - So that makes it a little simpler to study.

Nicole - Yeah. And sorry, I just Googled tussac grass. Like I was spelling out tussac AC and then it autofilled to tussic OCK.

Rachel - Yeah.

Nicole - And it auto filled again to tussock moth. And I just had like a brain blast because if you look at a tussock moth, they are, you know, a caterpillar, but they have little tufts of hair like a tussac grass. I'm freaking out.

Nicole - Sorry. It's very random, but that's how I got there.

Rachel - Yeah, no, it's not random at all because it's crazy how prevalent this stuff is, even though, I don't know, us prairie ecologists and biologists have never really heard about tussacs as much. Like I wasn't in the impression for a long time that tussics were just an arctic ecosystem. So, but they're not, they're not at all. They grow all over like everywhere.

Nicole - Yeah, yeah, yeah.

Rachel - Like pretty much every continent but Antartica. Yeah. And apparently caterpillar bodies.

Nicole - Yes.

Rachel -Oh, shoot. Okay, so here's the final, final piece of the puzzle with this ecology because remember I said that it facilitates the formation of peat. Paleo-ecologists love peat because these deep deposits of peat capture a lot of really long-term data. We're talking like samples of pollen and invertebrates and poop and spores and all kinds of stuff. So basically these kinds of ecosystems where there's a lot of deep peat habitats are really perfect for their style of forensic ecology. And just like one more little fun fact about these peat ecosystems on the tussacs is that peat decomposes, which means it's really warm, which means when all of these seals pop up onto the islands, they just like flop onto the tussac peat piles and just like lay there and bask on the warmth, and it makes me smile.

Nicole - That's great. I love that. Okay, so why I was googling the tussock AC grasses was because I wanted to get a better idea of their shape. And, you know, it's not just like a bunch of

grass or like some other tussock OCK grasses. Like these guys are really dense. And like, I'm not seeing the really tall ones in the pictures that I'm seeing, but like, yeah, they're super dense. And there's a lot of seals just laying on them and it's really cute.

Rachel - And dude, absolutely.

Nicole - And like the way that they're the grass kind of like, you know, bends over and makes like this nice little like almost sweeping willow kind of form. I can see how it would be really amazing habitat for a lot of birds too.

Rachel - Yeah, absolutely. I'm not going to steal any of the personal photos that the primary researcher Dulcinea took. But if you do go visit the Palaeocast link that I'm going to put in the description, they actually shared a lot of Dulcinea's personal photographs of the Falklands. I'll highly recommend that people check that out if they want to see what this ecosystem looks like, where they were literally doing this research.

Nicole - Awesome.

Rachel - Yeah, so the paleoecologist team looked at this system and they said, hey, we can probably look at the paleontological past of the islands to figure out why these ecosystems established in the first place and maybe get a feel for how we can better preserve these grasslands. Because, you know, there's obviously efforts going on in the Falklands to establish or reestablish tussock grasslands. And the team of researchers went down there to visit and saw the tussock plantings, but they're having a really, really hard time actually getting any new plantings to establish. And that's part of the problem. And this is where it gets really fun. So Dr. Jacquelyn Gill was describing, talking to a local farmer who actually wasn't living on the coast where they kind of thought that these ecosystems could only thrive and grow. And, you know, this is why it's so important to talk to a lot of different people who are living there, especially if they're people who have had, like, a long history of being in these places. Because the farmer was kind of like - I don't understand the problem. Like, I grow tussock all the time. My chickens use it as a windbreak. Like, it's totally easy. What's the problem?

Rachel - Like, but for the researchers, this was a huge lightbulb moment. Because here's the thing. Because the tussocks are used primarily for access to sheep grazing, maybe those chickens are actually a huge key, right? Maybe giving only the sheep access keeps out the seabirds. And what if the grasses need bird poop to be able to survive? Which made me laugh, because that seems like a very typical paleoecology perspective of the poop has the key.

Nicole - Yes. yes.

Rachel - But also really looking at those plant-animal relationships as being important. And so, yeah, this lightbulb moment set them off to try and look for some of these clues in the peat. Okay.So awesome. I love it so much. So here's what they did. They took a lot of peat samples looking for some of those indirect indicators that they could look for, such as chemicals in the

guano, which, okay, bird poop is obviously super liquidy. You can't really find, like, copper lights of bird poop, but they can find chemical traces from the guano, like especially heavy metals and stuff, because these seabirds are feeding on ocean life. And so, you know, they can look for traces of nitrogen, reconstruct the nitrogen levels in these ecosystems, the heavy metal levels, and they can look at pollen records to show when these grasses were being established. They also wanted to look for charcoal traces, because one of the other land management questions going on has to do with fire. Is burning a natural part of these ecosystems? Is it a tool they should be using to manage the grasslands and can it be used by sheep farmers to establish better forage? That's kind of a debate that's going on with the ecologists down there right now.

Nicole - I love fire.

Rachel - I know, and I didn't even think that fire would be a part of this thing. I was hooked by the seabirds and the grasslands and the poop. I didn't even need the fire, but that's a part of this too, which is so freaking cool. So basically, by compiling all of this data, they were actually able to reconstruct a 14,000-year record of the ecology of the island based on all of these indicators.

Nicole - Dang.

Rachel - I know. And it's really cool because they actually were able to develop a really, really freakishly clear picture of exactly what happened. And basically, they have no trace of seabirds at all being on the island until about 5,000 years ago. And remember when I said that in paleoecology, the cause-effect relationships can be really hard to establish?

Nicole - Yeah.

Rachel - Well, here they actually have a really distinct order of events from the reconstruction, which makes it pretty clear what exactly happened. Because within a century of the seabirds showing up, that's when the tussock grasslands established.

Nicole - Oohh.

Rachel - Yeah, they see the peat productivity start to go way up. An increase in grass pollens, which for the record is hard to parse out individual species from the pollens. But because the peat productivity goes up at the same time as the grass pollen goes up, that's a pretty clear indicator that it's this specific species, because the other species that were present before, did not form peat like these guys do.

Nicole - Sure, sure.

Rachel- Yeah. And as soon as this happens, like within that first century after seabirds showing up, that's also when the first records of fire show up. So it turns out that fires in these systems might in fact be natural, and it seems like it's fuel limited like most fires are, but it's a natural part of these tussock grasslands as soon as they establish. And that means, which makes a lot of

sense from an ecological perspective, but basically the seabirds arriving and bringing all of these rich nutrients from the oceans, drove the changes in the terrestrial plant community structure, the composition of it, the function, and it also changed the fire activity and all of the nutrient cycling on the island. So this is a really cool sort of top-down ecosystem change, where, you know, I think sometimes ecologists have a perspective of like, well, the animals rely on the plants that are there, and that's their habitat, and that's what they need to survive. But in this case, it's the animals that are completely changing and pioneering brand new types of ecosystems, right?

Nicole - Yeah. It's so cool. So technically, the tussock grassland is not like, native or natural to that ecosystem at all.

Rachel - No, but it is an important part of the modern ecosystem of the Falklands, and it's an important part of what has been developed since then because it gets a little more complex too, right? And this is such a cool thing about looking back at paleoecology because change is a really natural part of history, obviously, especially when you're working on stuff like ice ages. And, you know, there's just a lot of changes that are always happening. But in order to understand how things are changing now, we have to understand how they've changed in the past and how they've gotten to the places where they are. And that informs our conservation work and what we should be conserving and how we go about conserving those things that we've decided should be conserved. So yeah, it's a complex conversation around that. But here's some more pieces to this system that we know about. The islands naturally are a really low productivity ecosystem. So not a lot ecologically can really happen without the nutrients from those seabirds. And we really don't know which bird species were creating those signals. Historically, there seems to be a lot of shifting in the populations of those seabirds based on the changes in poop chemistry and the arrival of seals and things like that might be a part of it too. So, you know, once the seabirds established, that is when we really saw a flourishing of this ecological diversity on the islands.

Rachel - And today, our world looks a lot different than it did 14,000 years ago or 5,000 years ago. And that's important because maybe when those seabirds originally established on the islands, like we have no idea where they came from originally, but as our climate changes in new ways, we don't know where these birds will go or if they will be able to stay on those islands and their ability to recolonize other areas has changed. And so that's an important part of this modern piece too.

Niole - So we don't know where the birds came from, but do we know if the kinds of birds that first established are the same kinds of birds that are there currently?

Rachel - Oh, that's such a good question. Actually, that is part of what they want to do going forward. Let me scroll down to that section of my notes because I wasn't totally sure if I wanted to get into this, but since you asked, that's actually the next step of what they'd like to do with this research. They want to see if they can identify specific seabird species that created some of these changes. Their lab has actually been doing a lot of work with ancient DNA lately, but the

problem with using ancient DNA in this system is that peat is super acidic. Not only does it break down things like DNA, it even breaks down bones, so it's very hard to even find bone and feather residue in these systems. So yeah, they basically cannot do that. So here's what they've been kind of proposing, and this is for the future. There's no work that's actually been done or analyzed that I know of, but they could do a couple of things.

Number one, they could do DNA analyses of the populations of birds on there right now, and they can look for traces in the birds' DNA to kind of indicate how long these populations have been there and at what point they divided up from maybe past populations of seabirds and get an understanding of when these modern populations arrived and established. So that's something that they can do. There's fingerprints they can look for. I'm not a geneticist, so I can't tell you what that looks like, and I don't think our listeners, I feel like their ears would and eyes and brains would glaze over if I even tried. But know that we can do this.

Nicole - Okay, okay, that's fair.

Rachel - Okay, so the other thing that they can do, which I also love, has to do with their poop. Basically, they can try to characterize the chemistry of the guano of these modern birds. So they'd like to go back and get guano samples and compare the heavy metal abundances to that guano and then compare the heavy metal abundance shifts in the record that they already have reconstructed. So yeah, forensic ecology. So they can probably do this. They just haven't done the work yet. So we don't know it yet, but maybe we can find out. And that's pretty freaking cool.

Nicole - Yeah, that's wild. I don't know anything about how paleo scientists do the things that they do. I admitted this last episode. But it's wild.

Rachel - It is. And you can see why it's super interdisciplinary, right?

Nicole - Oh, yeah.

Rachel - There's actually a few other things that we can gather. So they had another primary question related to this past development. Even though they couldn't say which seabirds arrived at what point in time, they could ask why the seabirds arrived originally. They have a lot of hypotheses about what drove their arrival and what could have led to some of the changes on the island of the composition of these different species and the poop and, you know, all that good stuff. So the most reliable data that they can look at for this has to do with wind and temperature records. Here's a hypothesis that they had. We know with modern birds that an increase in wind strength increases their travel speeds for flying seabirds and it also increases the foraging success for flightless seabirds.

Nicole - Wait, wait. Why are they better at catching things when it's windy?

Rachel - I don't know, because they're penguins. Maybe...

Nicole - That doesn't answer my question.

Rachel - I don't know, man. Maybe there's less competition from flying seabirds. I don't know. I have no idea. Cannot answer that question. But we know that it's true based on studying modern penguins, so that's all I can tell you. So maybe during these times, like 5000 years ago when they established, maybe it was more windy and that's why they came here. The other thing that they have more reliable data on is temperatures. That's all I have to say about that. Okay, so here's what they found from the Paleo record, right? They found wind records based on the long-distance travel of pollen from other ecosystems that were there at the time. And I want to point out that they think that the wind records might be a little unreliable on the actual Falklands because they hypothesized those really tall tussock clumps that developed may actually have been more effective at trapping pollen, which means, yeah, that the abundance of the pollen may be kind of misleading in those systems.

Nicole - Sure.

Rachel - Yeah, but from what they could gather based on data that they also got from New Zealand and the Southern South America and Tasmania and sub-Antarctic areas. So, you know, the Antarctic that's a little bit closer to not the South Pole. It seems like the seabirds actually likely did establish during a phase of stronger winds across the Falklands. But again, a little unreliable.

Nicolr - I mean, it seems if it's really windy, birds are like, oh, snap, they're just flying all over the place. I mean, sure, why not? It's really windy. Just open your wings, see where the wind takes you. I get it. I get it. It seems legit.

Rachel - Totally, totally legit. And it's also likely that the tussocks being able to make it to the Falklands and colonize the islands could have also had to do with, you know, higher wind temperatures. Good grief. Wind speed. Yeah, like more ponds blowing in. Hey, perfect timing. Now we can establish, because there's a bunch of seabird poop everywhere. Okay, but this is what's much more interesting to the researchers and to me is the temperature records. So they got this data through both marine records and terrestrial records. And it looks like those intensifying winds during that mid to late Holocene when the seabirds were establishing happened when there was cooling in that region.

Nicole - Interesting.

Racgel - Yeah, so when the sea surface temperatures fall and winds are higher, we also know generally there's more ocean productivity, which would have supported the idea that there's more resources available for the seabirds. So those two things in combination, the low temperatures and the high winds, meant that the oceans were just producing a lot more stuff for those birds to eat. And it also means that the Falkland Islands may have been important because they were a refuge during colder climates for these seabirds.

Nicole - Ok. Here's another question for you. Why are oceans more productive when it's cold? That seems counterproductive, that seems counterintuitive.

Rachel - Yeah, I have no idea. Don't know. All I know is that we know it. Maybe someday in the future, if we get some of these scientists on, to actually talk about their work, we can ask them those questions. Actually, yeah, you can just tweet Dr. Jacquelyn and Dr. Dulcinea Groff. I totally forgot. Oh, Gill. Gill is Dr. Jacquelyn's, Gill's last name. Okay, I was like, I think they both start with Gs, and now I'm getting confused. So yeah, you can totally tweet them and just ask them. Okay, so Nicole, this is, this is where it gets kind of scary. Because if these birds established on the islands, because they were a much colder climate refuge, what is going to happen to these islands as our habitats continue to warm in that region? And where are those birds going to go if they're primarily using the island or historically primarily used it as a cold weather refuge, cold climate refuge?

Niole - I don't want to think about it.

Rachel - I know, but they, but they need to think about it.

Nicole - They do.

Rachel - Because it turns out the grassland ecosystems that they're trying to conserve probably depend on the presence of seabirds. And that's why they're not able to survive right now because of invasive predators that are preying on these birds and because of pushing them out of grazing land and stuff. So this is an important thing for the Falklanders to be thinking about because they need to conserve these grasslands, literally for their economy to survive.

Nicole - Yeah.

Rachel - Okay. A couple of other things, and then that's kind of the end. I maybe have some wrap up thoughts about the implications of it or whatever, but we've kind of already touched on that. But like the last thing I want to go through is a couple of the other less substantiated inferences they made about this period of time. So here's some other things. They know that the sea levels changed during that entire period of time, but they do not think that it had a significant effect on the population. You can go read the discussion in the paper if you want more information on that, but it doesn't really matter because it doesn't seem to have affected them at all. Here's the other thing.

Rachel - They did have data suggesting, obviously, that the seabird community changed. The arrival of that extinct wara may have driven some of those community changes. And we don't actually know when the wara arrived on the islands, but we do know that it was present by at least 3,500 years before present. So it's possible that the animal arrived in a way that impacted or coincided with some of the community changes.

Nicole - Okay, and I was going to ask that earlier. Like how this, like a giant fox is an unusual single mammal species that naturally occurs on an island. Like how did it get there?

Rachel - And it's not as big as the maned wolf, I should point out, but it's probably got something to do with increases in sea ice levels and stuff, making their migration a little bit easier because sea ice changed quite a bit during those periods of time. But I don't know.

Nicole - Why don't you know anything?

Rachel - It sure managed to get there though. It's like, how did arctic foxes get on Iceland? You know, probably similar stuff, like sea level, sea, sorry, sea ice changes and luck. So another thing they learned is that the poo chemistry composition changes that occurred seem to have happened when there was a shift to warmer and drier climates on the island, which also coincided with a shift in the winds and sea surface temperatures. And fortunately, whatever happened during that time period, it seems like the functional outcome was basically the same for the ecology of the grasslands. So whatever species replaced the species that had been on the island, whether it was like the seals or the seabirds, whatever the changes were, the outcome for the ecology was the same, which gives us some hope because it means that, you know, even if the community structure changes, maybe the ecology of the island won't drastically change.

Nicole - Ok.

Rachel - And finally, the ultimate thing that they discovered, or confirmed rather, was that ultimately the disruption of the ecosystems was just the widespread grazing. So we have absolutely confirmed that that is the cause of the reduced tussock coverage.

Nicole - It's nice to have a cause, but it's also like, well darn. We need that, so.

Rachel - It's a really interesting puzzle that was kind of put together, or at least the picture was put together by paleoecology. And ultimately, this kind of means that as the Falklanders are trying to conserve these grassland ecosystems they depend on, they can do a lot to reintroduce birds and those ocean nutrients to the grasses to preserve these ecosystems. But also the warming South Atlantic Ocean is putting a lot of questions out there for whether this is really a sustainable long-term sea breeding hotspot.

Nicole - Sure.

Rachel - And also, you know, as the sea surface temperatures rise, it's going to limit food resources because we know that that's what happens. The warmer oceans are less productive, and this could lead to less nutrients available for the grasslands that need those nutrients, obviously, to survive. And, you know, these seabirds forage huge distances, and we have no idea where they will end up going as ocean temperatures rise if this region becomes a place where they really can't sustain themselves. So there could be some really abrupt changes that

will occur in the future for the seabird communities that are there, or just a collapse of those ecosystems. And what's really scary is that, like, Dr. Dulcinea Groff points out that this collapse or abrupt overturn in the community could happen in a matter of decades. You know, that's the kind of time scale we're looking at for how these changes could occur. And what really makes this so much different than some of the other ecological questions out there is that it is affecting human lives. And I, you know, as an ecologist or a person who values ecology, I really like that in this case, the things that are bad for the ecosystem also happen to be bad for the humans because, you know, having those goals overlap means that whatever changes the humans want to make to benefit their livelihoods are ultimately changes that will benefit the ecology there. So that's really cool in terms of problem solving.

Nicole - Yeah, definitely.

Rachel - It's a really great opportunity for some good changes to occur. And we know that human conditions caused these changes. And we know that humans have the power to alter these conditions in a way that's favorable to the grasslands again.

And so that gives us some hope for restoring the grasslands. And climate change is what makes the long-term success scary for these islands and for a lot of other coastal grassland systems. That's the Falkland Islands situation. And it just fills me with all kinds of giddy joy, optimism, and a sense of impending doom like all climate change discussions do, but in a really productive way. And I think that's what made this entire ecosystem really catch my soul in a way that a lot of other conversations like this just can't.

Nicole - Sure, yeah. There's light at the end of the tunnel. There's a chance to make some really good changes. And we know that these things are possible through science and research.

Rachel - And we know that there's a huge willingness to make those changes. Everything, the stars have just aligned for these changes to really be put forward. So that's so exciting and also really enlightening and scary that we can really make some informed inferences about what will happen in the future based on knowing pretty exactly the order of events that happened in the past that led to the modern conditions. Science is so cool.

Nicole - It is. It is. Well, thank you, Rachel. That was awesome. What a cool ecosystem that probably not a lot of people know about. I know I certainly didn't.

Rachel - Yeah, same.

Nicole - And thank you everyone else for listening to The Best Biome. As always, if you enjoyed this episode, please share with a friend, consider leaving us a review. All that good stuff, it really does help. Give us a follow on Facebook and Twitter, send us a fan mail, leave us a voicemail. We'll even give you a shout out if you give us some love. And we will see you next week.

Rachel - Yayy.