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BONNIE WILLISON: I'm Bonnie.

SYDNEY WIDELL: And I'm Sydney.

BONNIE WILLISON: And this is *Introduced,* a podcast from Wisconsin Sea Grant.

SYDNEY WIDELL: And today on our show, we're going to bring you some stories about snails. My snail fascination really got started a few months ago, after this conversation we had with Kelsey Taylor. Kelsey is the aquatic invasive species coordinator with the Fond du Lac Band of Lake Superior Chippewa, and she had a lot of really interesting perspectives about how to live with and manage introduced snails on and around the Fond du Lac reservation.

We'll have way more from Kelsey in just a second. But after that conversation, I just started noticing snails all around me, like on pavement when I would walk out of my apartment, or in the gardens. Yeah, and I just realized that they'd been there this whole time, and I was just very snail blind, I guess you could say.

BONNIE WILLISON: So am I going to become snail aware by the end of this?

SYDNEY WIDELL: Hopefully. That is my goal.

Also snail, the word, what is going on with that? It's so vague. There are so many different types of snails out there.

First of all, there are terrestrial snails and there are aquatic snails. And within that category of aquatic snails, there are over 5,000 known species of freshwater snails alone. So we're talking about a huge number of species that are living in very different places and doing very different things. So before we hear from Kelsey and the other people who shared their snail stories with us, I wanted to talk to someone who could help me begin to overcome my snail blindness.

Hi.

KATHRYN PEREZ: Hello, can you hear me?

SYDNEY WIDELL: Yeah, thank you so much.

So I called a freshwater snail expert.

KATHRYN PEREZ: My name is Kathryn Perez.

SYDNEY WIDELL: She's been based out of the University of Texas Rio Grande Valley since 2014 where she studies snails that live in desert springs and underground aquifers. But before that--

KATHRYN PEREZ: I lived in La Crosse, Wisconsin for six years. I did a lot of terrestrial snail work when I was in Wisconsin, so I was more on the bluffs overlooking the Mississippi and on hills in the Viroqua area.

SYDNEY WIDELL: If you are into snails, you might recognize Kathryn's name, because she is the co-author of *The Key to Wisconsin Freshwater Snails,* which is a beautiful document that has some really great illustrations and information about different snails you might run across in Wisconsin. We link that in the show notes.

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KATHRYN PEREZ: People just have a very vague impression of a snail, you know? They might see them crawling around their yard sometimes, but don't make special note of them. But when you catch their interest with something unique that that snail does, or they realize, wow, there's all these tiny snails, or these snails that have all these unique features that they'd never noticed, then they become more interested in the world around them and place more value on the functioning and conservation of those areas.

SYDNEY WIDELL: I asked Kathryn, as someone who spends a lot of time looking at different types of snails, what her process is for discerning between different species.

KATHRYN PEREZ: First thing I do is I measure it. What is the total length? What is the width? How big is the opening, compared to the overall shell size, the color of it? The texture of the shell, is it really shiny? Is it clear, or dark brown, or you can't see through it at all? And then you'd get into more details about the overall shape. Is it kind of one that's shaped like this, that's tall? Or is it one that's really round? Yeah, so those are the basic features you start with.

So if you're walking around in a stream in Wisconsin, probably you will see Physa. And so Physa is a little-- maybe a small shell, smaller than your fingernail, likely. And actually, if you hold their shell up so you can see the entrance to the shell, they have an opening to the left-hand side. They're one of the only ones that will open to the left, rather than to the right. And so you can recognize those pretty easily. And those are ones that you'll sometimes see floating around on the surface attached to some vegetation. Sometimes, you'll see them floating around or hanging out at the edges of the stream.

Since most snails are kind of brown and match the mud or substrate of a water body, unless you're looking for them, they just kind of blend in. So you would have to go out there with a dip net or pull up some vegetation and shake it out over a tray in order to see most of the snails.

In Wisconsin, I really like the Valvata, Valvata winnebagoensis and the other Valvatids. They're really mostly found in cold, well-oxygenated lakes. So you don't really get them down in South Texas. They're something that's pretty unique to cold lakes.

SYDNEY WIDELL: Maybe the biggest thing that stuck out to me about my conversation with Kathryn was just how diverse snails are. Some snails are more than an inch long, but then there are other snails that you could fit 20 of them on the face of a single dime-- so really, really small. And then there's some that you would need a hand lens or even a microscope if you actually wanted to see it.

I read that some snails can withstand all sorts of degradation and pollution. And you know, they're pretty general and can do OK wherever. But then there are some snails that need very, very specific habitat conditions and only live in very specific places. So it's really hard to generalize the role that snails play in ecosystems.

KATHRYN PEREZ: Most of them are eating plant material and eating algae, and so you can think of them as grazers, the equivalent of something that grazes in a terrestrial food web. So they are taking plant material-- so that plant has captured the energy from the sun, and the snails are eating that plant and algae material and then being eaten in turn. And so they're moving that energy from plants to higher levels in a food web. So they get eaten by fish, and lots of birds, and beetles, and other larger animals.

SYDNEY WIDELL: And there's still a ton to learn about snails.

KATHRYN PEREZ: Freshwater invertebrates are definitely understudied. Snails, and freshwater mussels, and lots of the insects beyond the big couple that are water quality indicators, all of them could use more study.

SYDNEY WIDELL: And it's not study like, oh, what role does this snail play in the stream? It's like, what types of snails are even in the stream? We are still learning about new species of snail. Kathryn's lab has identified three species of snail that have never been named or described before.

KATHRYN PEREZ: Just published the description of a new freshwater snail species from one of the best sampled places in the country, from Comal Springs in central Texas. A colleague at Fish and Wildlife Service was putting drift nets, so little sampling nets, over springs where you catch everything that drifts out of a spring. And he was actually looking for salamanders at the time because there's a lot of endangered salamanders in central Texas.

And so through processing his samples, he found these little snails that seemed weird to him, and so he sent them to us. And we sequenced their DNA, and looked at their morphology, and compared them to other known cave snails, and they were distinct in the DNA, and the shape, and the sculpture. And so me and my undergrad at the time, Dominique Alvear, described that new cave snail species.

She'd been calling it spiky for the whole time we'd worked on it, because they have big spikes all over the shell. And so we worked out, what works with spiky that we can make Latin? And then we ended up with spica, Phreatodrobia spica.

It's just so cool-looking. That one is really weird. Maybe I'm really captured by neat-looking snails that have extra stripes, and sculpture, and spikes sticking off of them. So I like decorated shells. So it was just really exciting. You don't expect to see something that's clearly new, not like anything else that's been described, from one of the best documented places in the state.

And so that's part of why that one was so neat is because it's a place where people have been sampling for decades. It just only is found very, very rarely in samples there. And we just happened to connect with someone who was doing sampling there and found it.

SYDNEY WIDELL: What does it say to you that you could go to a place like that, that is so well studied, and still be finding new snails?

KATHRYN PEREZ: Obviously, it shows we have a lot to learn. A few years ago, someone described a new millipede species from Central Park in New York, right across from the American Museum. So even in the backyard of scientists there's still a lot to learn.

For example, the most common snail in yards in all of South Texas, like 97% of yards that we've surveyed, has this one little scrub snail, called Praticolella mexicana that I named. It's an introduced snail that is everywhere, but wasn't here 20 years ago at all. It moved north from its range in Mexico. And so they can be in everyone's backyard. Unless you have the training to recognize that it's something new, you won't know.

SYDNEY WIDELL: But even as scientists like Kathryn are finding snails that no one has ever seen before, there are entire species of snail that are disappearing before our eyes and maybe before we know that they exist at all.

[MUSIC PLAYING]

KATHRYN PEREZ: They're as imperiled, or more, than freshwater mussels. So in the like imperilment rankings, freshwater mussels and freshwater snails are the very highest. So they're the most threatened and have had the most extinctions.

SYDNEY WIDELL: There are 23 species of endangered snails and mussels in Wisconsin. Some of these species have been here since before the last glaciation. According to a 2019 report, freshwater snails that live in flowing water, like streams and rivers, are the most imperiled.

Habitat loss is a major driver of snail extinction. Introduced species contribute to habitat loss, including some species of snail. But like all stories about invasive species, it isn't necessarily the snail itself that's causing problems or resulting in habitat loss. It's the actions that result in the snail becoming introduced in the first place and then spreading. So today, we're going to meet some of the snails that have wound up in unexpected places, as well as some of the humans who are learning how to be better neighbors with new snails. Bonnie, do you want to go first?

BONNIE WILLISON: Oh, yes. OK. Our first snail story today comes off of the lakes of the Fond Du Lac Band of Lake Superior Chippewa, an Ojibwe group. The Fond Du Lac reservation is 20 miles west of Duluth, Minnesota. It's part of the Lake Superior watershed, via the St. Louis River and its tributaries. Kelsey Taylor has been the aquatic invasive species coordinator there since 2017, and she has spent many summer days waist-deep in a lake plucking Chinese mystery snail off of the lake bed.

KELSEY TAYLOR: A lot of times, Chinese mystery snails, luckily, are in waist-high to chest-high water or less. But they're in that really mucky stuff a lot of times. So we have our crew go out, and me included, and we are all in waders. And we try to either bend down and pick them up, or we have a net that we scoop them up with. And just this past year out of one lake that's about 500 acres, we collected over 500 pounds of Chinese mystery snail.

BONNIE WILLISON: For context, picture a Ford F-250 truck and the bed of that truck in your mind. Fill it up until it is overflowing with snails. That's roughly what 500 pounds of snail looks like.

KELSEY TAYLOR: Honestly, we were not expecting to pull that much out. [LAUGHS] I was a little bit shocked. And it was a little bit different than what I had anticipated.

BONNIE WILLISON: As aquatic invasive species coordinator, the mystery snail is one of her biggest concerns.

SYDNEY WIDELL: What is so mysterious about this snail?

BONNIE WILLISON: Just wait.

BONNIE WILLISON: There is not a lot known about Chinese mystery snail. It's a mystery, right?

KELSEY TAYLOR: So here's what we do know about the snail. They're about two inches, which is way bigger than any native snail, actually. And if you look at the shell, it's got six to seven whorls, which is the number of times the shell spirals around. It's got what's called an aperculum, which is a trap door that lets it live out of water for a few days. So it can close up.

They can pass parasites onto waterfowl. But a lot does remain unknown, including what the snail could do to wild rice, which is hugely important to the tribe as a food source, and as an economic resource, and as a culturally important being. Kelsey explains.

BONNIE WILLISON: I'm going to jump back in history a little bit. I'm not going to tell the story too much, because it's not my story to tell, but I do think it's important. So the migration of the Ojibwe people along the Great Lakes, they started towards the East Coast, and then moved along to a place where it was prophesized that food grew on water. So that's wild rice. So they were promised that as they were doing their migrations.

So along the way, there was six stopping places. And in the St. Louis River by Duluth is where Fond du Lac-- and on Wisconsin point is actually where Fond du Lac originally settled. And there was lots of wild rice on that bay. There was lots of wild rice in the St. Louis River. So they came to that place where the food was prophesized to grow on water, and that's where they settled.

So what about wild rice and these Chinese mystery snails?

KELSEY TAYLOR: One of the biggest concerns that I have is, because nobody's ever really tested the effects that they have on wild rice, and because it could be a sustainable food for them, that they could have really detrimental effects if they were to ever make it to our wild rice lakes. And that's just not something that we're willing to risk and wait to see if that happens. Because once they would get in there, it's really, really difficult to get them out.

BONNIE WILLISON: Yeah. So let's back up a little bit. Before white colonization, the Fond Du Lac Band's territory was really big. It encompassed the shores of Lake Superior, northern Minnesota, the UP of Michigan, and northern Wisconsin. The current Fond Du Lac reservation is 100,000 acres, and the tribe owns roughly half of that.

In a series of treaties with the US government, the Ojibwe people ceded millions of acres. And it's all that land that I just talked about. It's basically what we now call the shores of Lake Superior, northern Wisconsin, the UP. And importantly, these treaties preserve Ojibwe and Fond Du Lac rights to hunt fish and gather on all of these lands.

KELSEY TAYLOR: My program is trying to be involved in all of the decision-making processes that would potentially affect usufructuary rights which, of course, is invasive species, because that can impede the rights to hunt fish and gather, if they're negatively affecting those resources in those areas.

BONNIE WILLISON: Introduced species, like the Chinese mystery snail, can interfere with the Band's right to hunt fish and gather on the land of their reservation and beyond.

KELSEY TAYLOR: Fond du Lac, I would say, we are a lot of wetland that we are trying to protect. So there's a lot of areas here that are really wet. We also do have a lot of prairies that go on along Fond du Lac as well. And then we do have a lot of active hardwood forests.

BONNIE WILLISON: So right now, the Chinese mystery snail is contained to a few lakes, and the Band is trying to physically remove it. In general, Kelsey says that she avoids using herbicides and pesticides to manage aquatic invasive species. Things like this wouldn't really work on this snail anyway, since it has that trap door that protects it. While some people think about aquatic invasive species management as eradicating invasive species, the Fond du Lac tribe views it differently.

KELSEY TAYLOR: So a lot of times if you look at mission statements of state agencies or federal agencies, everybody is looking for eradication of invasive species. And I don't think that we are opposed to that goal by any means, but we're rather trying to find a balance.

So our mission statement is more about trying to find a balance so that things can cohabitate, while still effectively managing them. You know, we don't want things to spread. We recognize that invasive species are issues. However, we don't ever just want to get rid of something for no reason. But a lot of times, invasive species are causing harm in some way.

So I think maybe the ways that we go about getting to those goals, maybe, is a little bit different. But I think everybody in the end has kind of the same goals in mind. Whereas maybe some agencies are more focused on just that eradication word and that eradication goal, whereas, we're more focused on kind of the balance.

BONNIE WILLISON: So that goes back to Kelsey's trips into the lake to remove these snails.

SYDNEY WIDELL: So the 500 pounds they took out, did that have any impacts on the lake?

BONNIE WILLISON: Kelsey doesn't know how effective the removals have been yet. She thinks it's kind of too early to tell. And there's a lot more to learn about the ways that this snail behaves in these lakes. Kelsey also tries to use as much of the species they remove as they can.

This goes for the mystery snail and also for other species. For example, Kelsey mentioned that purple loosestrife, which is an invasive wetland plant, has some medicinal properties. You can actually use mystery snail for compost and gardening, for example.

So did they do that with the 500 pounds from the lake?

KELSEY TAYLOR: We gave them all to our garden program. And at first, they seemed really happy to get the snails. [LAUGHS] But then, I think, when they realized that it was about 500 pounds, they were like, oh, my gosh! [LAUGHS] What do we do with all this?

BONNIE WILLISON: Like, we don't have enough garden space.

[LAUGHTER]

KELSEY TAYLOR: So we're actually starting our own invasive species compost pile this year, just because there is so much material.

BONNIE WILLISON: That's such a good idea, covering your gardens with snails. And it turns out you can eat this snail too. According to the Department of Natural Resources in Minnesota, this snail was originally introduced as a food source.

KELSEY TAYLOR: Some people are really into eating snails, and some people aren't. [LAUGHS] But we at least try to give the option to have it out there.

BONNIE WILLISON: Have you tried eating snails? What do they taste like?

KELSEY TAYLOR: Oh yeah, I have. They're kind of gummy. [LAUGHS]

BONNIE WILLISON: Yeah?

KELSEY TAYLOR: So I'm not a chef, so I usually put my snails in a salsa, because a lot of the other flavors kind of soak up into the snail. So that it's not quite as like, oh, gummy snail. [LAUGHS] And I think it's OK. Our chairman loved it the last time that I had it. I think he ate almost the whole bowl, so that was great. [LAUGHS] It's just a little bit of extra protein in your salsa, you know?

BONNIE WILLISON: Kelsey and the Fond Du Lac Band are always looking for ways to use these snails in a productive way, while managing the population size, keeping them in check, and looking for balance.

KELSEY TAYLOR: One of the things that we kind of live by is that you're always thinking seven generations ahead. Whatever you're doing today, as somebody seven generations from now, you want them to benefit from it. So that's kind of like what really drives us.

We're not just looking to our children, we're looking at those seven generations to make sure whatever we're doing is good for the long term, and is going to have a positive impact, and that also these resources are going to be available to those seven generations ahead.

BONNIE WILLISON: If you want Kelsey's snail salsa recipe, as well as more info about how to identify mystery snails, you can find that linked on our show notes.

[MUSIC PLAYING]

SYDNEY WIDELL: Next, the New Zealand mud snail is spreading across South Central Wisconsin, but it's really hard to tell exactly how far they've gone and which streams they're present in. Aquatic invasive species coordinators and fishing guides team up, and one woman's mission to track the tiny snail, but first, this message.

BONNIE WILLISON: Wisconsin Sea Grant and the Center for Great Lakes Literacy are proud to bring you the Aquatic Invaders Attack Pack, a grab-and-go teaching tool to educate students and the public about aquatic invasive species. Sydney, what's your favorite thing in the Attack Pack?

SYDNEY WIDELL: I love all of the specimens. There's a preserved sea lamprey inside each pack, which I think is amazing. And the packs also include little resin blocks with a lot of different specimens. Like they have rusty crayfish, and round goby, and a lot more. And it was my first time seeing some of these species in real life, which is kind of cool. How about you?

BONNIE WILLISON: I love the cut-outs of bighead and silver carp. And they're life size, so I can imagine a kid standing next to one and getting a sense of how big that these fish can get. Each pack includes these items and more, along with a guide with curricula and activities. If you're a Wisconsin resident, you can borrow an Attack Pack and have it delivered to your local library, free of charge. Visit the educational resources tab at seagrant.wisc.edu for more information.

SYDNEY WIDELL: Ellen and Nick Voss don't see very much of each other during the summer. Ellen is the aquatic invasive species program director with the River Alliance of Wisconsin, and Nick is a fly fishing guide with the Driftless Angler. They live in the southwestern part of the state by the Kickapoo River, or in Wisconsin's Driftless area.

And sidebar-- if you've never been in that part of the state, it looks very different from the rest of Wisconsin. And that's because the glaciers were never there. I want you to picture big, beautiful hills and cool, windy trout streams, like everywhere. OK. Anyway, for them, a typical summer day would begin around 4:30 in the morning, and it would go something like this.

[MUSIC PLAYING]

So first, Nick gets up.

NICK VOSS: [INAUDIBLE] drink coffee.

SYDNEY WIDELL: And he makes a game plan.

There is a lot to think about too. Is it going to be sunny out? Windy? When did it rain last? And what bugs are hatching right now?

ELLEN VOSS: You have to be really cognizant of water temperatures in fish. So he's getting up at like, 4:00, 4:30 sometimes. So he'll start trips at 7:00, especially in the heat of the summer. Then, I just try to go back to bed [LAUGHS] and pretend that it's-- you know, his day is definitely bumped up a lot earlier than when I would prefer to be awake. [LAUGHS]

NICK VOSS: That's my morning.

[LAUGHTER]

And then I get in the car, and drive off, and check a few streams on my way into town, and then wader up at the gas station, put gas in, and--

SYDNEY WIDELL: Nick will meet quickly with some of the other guides.

NICK VOSS: Don't want to step on each other's toes.

SYDNEY WIDELL: And he'll be headed out to go fishing with his clients by 7 o'clock in the morning, at the latest. Nick will fish until the sun gets high, and then he'll take the afternoon off. When it cools down enough, he's back out on the water till nightfall.

NICK VOSS: The summertime days, for us, get a little wonky.

ELLEN VOSS: For sure.

NICK VOSS: Because sometimes I don't get home until 10 o'clock.

ELLEN VOSS: And then it starts again at 4:00 the next morning. So yeah, there's some crankiness, I think.

[LAUGHTER]

NICK VOSS: Yes, there is.

ELLEN VOSS: On both sides.

SYDNEY WIDELL: While Nick is wading through streams with his clients, chasing trout, Ellen would normally be headed up to La Crosse where she works to prevent the spread of aquatic invasive species and to raise awareness around the protection of the streams she, Nick, and so many others love and rely on.

ELLEN VOSS: I organize watershed groups, and try to get people to go out in the field and look for these things, and try to prevent their spread in our area.

SYDNEY WIDELL: Do you ever find yourself in the same places?

ELLEN VOSS: Yeah, we definitely could. And there's a lot of potential for overlap.

NICK VOSS: But the long story is, there's probably going to be a time period where I'm on the stream, and all of a sudden I see a Honda Civic with a rack pull up. And I'm going to be like, oh, crap, guys. Grab your brushes. Quick. Quick. Brush them off. [LAUGHS] And so yes, there will probably be some overlap here.

SYDNEY WIDELL: I think the brush he's talking about is for getting invasive species off of your boots and gear. But there's one invasive species that Ellen and Nick are particularly concerned about. It's small. It's brown. It is a snail-- the New Zealand mud snail, to be specific. Its home range is in New Zealand, as the name implies.

BONNIE WILLISON: People are really worried about this snail, because in out-competes and displaces native snails and mussels. And if you'll remember from our conversation with Kathryn earlier, a lot of those species, those native species, are severely imperiled. A lot of those native snails and mussels are also really important food resources for fish, like trout, which drive so much of the economy in the Driftless.

SYDNEY WIDELL: Another interesting thing to note is that these New Zealand mud snails are super tolerant of a very wide range of environmental conditions, and they thrive in really nutrient rich water. So in places where there's a lot of farming and a lot of agricultural runoff into streams, like a lot of really nutrient rich runoff, that's really setting up prime conditions for these snails. If they are introduced, they can be really successful in places like that.

Another thing that's concerning is that they are not edible. Trout will eat them, and they will pass through trout and come out completely unharmed, like live snail. And with any invasive species, there is so much we don't yet know. The first time I saw the New Zealand mud snail was in Ellen's kitchen.

ELLEN VOSS: They're identifiable by some pretty key features. So I've got a little vial of them sitting here.

SYDNEY WIDELL: Oh, my gosh.

[LAUGHTER]

ELLEN VOSS: And the first thing you'll probably notice about them is how small they are. And snails, in general, can be right-handed or left-handed.

[LAUGHTER]

Meaning, so if you hold them with the opening facing outward and the cone pointing up, the opening for these guys is on the-- well, they're actually girls-- the opening is on the right.

SYDNEY WIDELL: How do you know?

ELLEN VOSS: Oh, they're all girls, [LAUGHS] because all of-- this is interesting-- all of the snails, all the introduced populations in North America, are females. And they're all clones of each other.

BONNIE WILLISON: Every snail here?

SYDNEY WIDELL: Every snail is the same snail.

BONNIE WILLISON: What?

SYDNEY WIDELL: Ah, yeah. It's so weird because, how the heck does that work? What? That doesn't make any sense to me at all. [LAUGHS] How can they be clones? Like, what is this? Yeah, so how it's been explained to me-- and I'm no biologist here-- a female snail is born from an egg, yeah? OK. OK, wrap your mind around that.

She emerges. And she is born with eggs inside her, but these eggs do not require fertilization. She is basically ready to start having more snail children, snail daughters. The scientific word for this kind of reproduction is parthenogenesis. But it's interesting because, back in their home range, these snails can do this, but they also reproduce sexually. So they can do both, which is quite powerful, I think. Basically, this is a recipe for infinite snails.

ELLEN VOSS: It literally only takes one snail to start a new population. So if even just one of these ends up in a new area, it can have 230 offspring per year. So I mean, if you do the math, that gets out of control pretty quickly.

SYDNEY WIDELL: The theory is that these snails are the daughters, the great, great, great, great, great granddaughters of snails that were introduced in Wyoming and other places out west and really took off during the early 2000s. And we can tell, because the snails here are genetically identical to them.

ELLEN VOSS: Because of their really small size, they're really good hitchhikers. You could be carrying these things on you and not even really know it. So diligence is really key in making sure, if you're ever leaving a stream, definitely making sure that they're not attached to you.

I went fishing yesterday. And when I was putting my waders on, I was just looking at-- it's sort of overwhelming at all of the possible places where these things could be living, and you wouldn't even know it. And so yeah, it's definitely waders, definitely wading boots, kayaks. Recreational equipment is probably how these things are moving around.

And also, like I said, they can survive out of water for a really long period of time. You know, you go fishing, and even a month or almost a month later, you might still have living snails attached to your equipment.

SYDNEY WIDELL: And fishing is something that brings people to the Driftless from all over the place. I mean, Nick said he has clients who come from as far away as Japan. And when we're talking about the Driftless, we're talking about this expanse of land that covers southwestern Wisconsin, some of Iowa, a corner of Minnesota.

NICK VOSS: We'll count a little tiny bit of Illinois, but I don't know if I want to count that.

SYDNEY WIDELL: It's lots of hills, lots of streams, and some seriously good fishing.

ELLEN VOSS: When I first started fishing here, I was used to fishing in Idaho is where I learned how to trout fish in really wide streams where you have a lot more forgiveness with your fly line. But out here, it's definitely a lot more challenging-- narrow, windy, clear, cold, lots of fish. It's an amazing resource that we have here.

SYDNEY WIDELL: In fact, inland trout fishing makes up roughly 10% of the state's fishing industry, which is just an estimate based on who buys a fishing license and also who buys a trout stamp. But in 2018, the fishing industry in Wisconsin, as a whole, was valued at $1.9 billion, according to a report from the American Sportfishing Association.

And it does seem like there's this constant tension that people like Nick and Ellen have to navigate between wanting to welcome anglers and people who are so enthusiastic about these beautiful streams, welcoming those people into your community, but then also being aware that people coming from outside of the watershed even could be bringing hitchhikers, like New Zealand mud snail, with them. And that could pose serious harm to the health of these streams.

NICK VOSS: The angling community and definitely the industry of fly fishing has long been concerned and dealt with invasive species, like whirling disease, or just things coming in and the presence of it. And as professionals, there is a very, very, very strong push from both the companies that supply waders, and fly rods, and stuff like that, all the way down to the guides and the fly shops, have been pretty strong in pushing for education and trying to clean your stuff up.

SYDNEY WIDELL: But despite how many people move in and out of the Driftless area streams and watersheds, as far as anyone knows, New Zealand mud snails haven't been detected there yet.

ELLEN VOSS: The take-home message just has to be like, the reason this stream that you're in right now looks the way it does is because it's working how it's supposed to. It's an intact ecosystem. And all of that can change really quickly, and it'll become a place where you don't want to recreate anymore.

But in terms of a stream, if this is the only way you've ever seen it, it's hard to know how bad it could get, potentially. So just driving home that point of, this looks the way it does because we don't have any of those species, and so we have to do everything that we can to make sure it stays that way.

[MUSIC PLAYING]

SYDNEY WIDELL: Nick and Ellen only have to look a few watersheds to the east to imagine what a snail introduction would look like in their own backyard.

BONNIE WILLISON: Black Earth Creek, which is about halfway between Madison and where Nick and Ellen live, is widely considered to be the epicenter of the snail introduction in Wisconsin.

Maureen Ferry, an aquatic invasive species coordinator with the Department of Natural Resources in Wisconsin, she remembers the first time she saw a New Zealand mud snail in Black Earth Creek. It was 2012.

MAUREEN FERRY: It was a cool fall day.

BONNIE WILLISON: New Zealand mud snail had been detected at the site a year before in a sediment sample. So Maureen and some other scientists went out to see what they could find. They showed up at Black Earth Creek in their waders and started sampling.

MAUREEN FERRY: We went there and collected them in kick nets. We collected sediments, and then plopped the sediments into our tray and just started looking in the tray. And to me, I'm like, well, all we're collecting here is mud. I'm like, I don't see any snails. And we keep swishing it with the water and looking at it.

It wasn't until like probably 15 minutes of having these sediments as we're trying to stare and sort through them that we realized, oh, my god, it's all snails. It was a really shocking moment, I think, for us, to see how disguised, how camouflaged they are when you take them up in the sediments. And you couldn't even see them. And we knew they were there, and we were looking for them.

BONNIE WILLISON: New Zealand mud snail has been in Black Earth Creek since at least 2012. That was the first year Maureen said they were observed, just in a routine stream sample. The DNR does stream samples at around 600 sites across the state every year, samples like the one Maureen was just describing. And they started to see that the New Zealand mud snail was showing up in more streams around the state.

Early on, the people who live and fish on Black Earth Creek were raising concerns about New Zealand mud snail. And that's how Bobbi Peckarsky got involved.

BOBBI PECKARSKY: I volunteered to go way back to the beginning of their bug sampling regime and analyze the data. No one had ever done that.

BONNIE WILLISON: Data that stream scientists, like Maureen, have been collecting for years, like the routine sample stuff, bug samples.

And so Bobbi was just going to help them crunch the data?

BOBBI PECKARSKY: You know, I'm retired. No one pays me. I just do all this stuff because I think it's important.

BONNIE WILLISON: Bobbi has lived on Black Earth Creek for over a decade. Before that, she taught freshwater ecology at Cornell, and she wrote a textbook on freshwater macroinvertebrates, a.k.a. snails. Ellen Voss called her the biggest driving force in the Black Earth watershed.

BOBBI PECKARSKY: When I retired, we moved back to the homeland, which is Wisconsin, and moved into the Black Earth Creek Watershed.

BONNIE WILLISON: She remembers when the snails first showed up.

BOBBI PECKARSKY: It happened in a routine bug sample that was taken in one location in Black Earth Creek, which was called South Valley Road. And it happens to be one of the favorite fishing spots. There's a whole bunch of trout bums on that stream. There's people who have been fishing that stream for 40, 50 years, and they just love Black Earth Creek.

BONNIE WILLISON: When Bobbi looked back through all of the records, she saw something that felt unusual. The reports had actually shown a new species of snail in the creek a year prior to the detection of the New Zealand mud snail.

BOBBI PECKARSKY: Never been collected before. Never been collected since. And if you look it up, it's not an aquatic snail. It's a terrestrial snail.

BONNIE WILLISON: Bobbi's theory is that the new snail wasn't terrestrial at all. She thinks the New Zealand mud snail has been in Wisconsin longer than anyone thought.

BOBBI PECKARSKY: So I believe that this snail was introduced in 2011.

BONNIE WILLISON: Over the next months and years, Bobbi watched with increasing frustration as people moved in and out of the stream, and the snail showed up in more places across the state. She told me about some of the absurdly careless things she saw early on.

BOBBI PECKARSKY: I remember being at the Crossroads Coffee Shop in Cross Plains, and was in the parking lot, and we just happened to see a fishing guide that had a couple people that he had just taken out of the stream. And they were shaking their boots off, or whatever. And I said, you know-- I was-- I had to be my responsible self.

I said, you know, there's New Zealand mud snails in this stream? And he said, yeah. Yeah, I know. I said, yeah, I think we saw them. And I said, well, you know, you guys have got to be really careful about cleaning your gear and not going site to site. He said, well, we're just staying in Black Earth Creek. Well, that's just irresponsible.

BONNIE WILLISON: Or there was this other time when Bobbi and her friend were volunteering at Trout Days. It's this festival that Cross Plains puts on every year.

BOBBI PECKARSKY: Somebody had told us that they thought they saw snails upstream of Cross Plains, near the QuikTrip.

BONNIE WILLISON: So after Trout Days was over, Bobbi and her friend walked up the block and popped behind the gas station, and they picked their way down the creek bank.

BOBBI PECKARSKY: He went in the stream, and he found an old boot that was stuck in the-- you know, somebody had chucked it in the water. He picked that up, and it was covered with New Zealand mud snails. Oh, my god. So I was like, OK, these things are spreading. And we don't know where, and we don't know how fast, and we don't know what the extent of the invasion is anymore.

BONNIE WILLISON: Bobbi has made it her mission to figure that out, to track where in her watershed the snails have ended up. So Bobbi pulls her waders on and starts doing her own stream sampling from Cross Plains up to Mazomanie, which is about 10 miles away.

She's also collaborated with professors at UW Madison and taken undergrads out to do stream sampling with her. She'll visit sites and streams where the snails have been detected and also sites where the snails haven't been found yet. And she's ended up making the first reports of snails at sites where we previously didn't know snails had reached.

The other thing Bobbi has noticed is that the snails aren't continuous over a stream. Like, you have these hotspots, right? And you would expect there to be snails between those hotspots, because they move at a snail's pace. But that isn't what she's seeing. She's seeing these very distinct hotspots at these sites, but they're not connected. And she's interpreting that as, the snails aren't moving on their own. People are moving them.

[LAUGHTER]

Bobbi's been doing these really intensive stream surveys now for almost a decade, and I asked her to describe some of the biggest changes she's noticed. She thought for a second, and then described this really specific morning back in August of 2018. It was just after record breaking floods had sent Black Earth Creek way, way over its stream bank. And she ended up going for a walk in the park in downtown Cross Plains.

BOBBI PECKARSKY: I was just super curious about the stream. So we went over to Black Earth Creek after the water had gone down enough that it was safe. And so I was walking along, you know? There's a park right next to the creek. It's called Zander Park. It's a lawn, you know? There's just lawn and little trails and things.

So I'm walking along. And I'm looking down at the lawn, and that lawn was covered with snails. [LAUGHS] So the stream had gone up, up, up, 10 feet, flooded everything. And then when it went back down, the snails were everywhere all over the flood plain.

So I'm totally freaking out. I took photos. Oh, my god. Look at this. Told my husband, my dog. There's all this snails. They're on the lawn. So that was like, well, jeez, what's going to happen now?

BONNIE WILLISON: In hindsight, Bobbi thinks a lot of the spread that began at South Valley Road just outside Cross Plains. She thinks that spread was preventable.

BOBBI PECKARSKY: We needed to close South Valley Road. We needed to quarantine South Valley Road, to put up caution flagging and say, no one gets to go in here.

BONNIE WILLISON: The citizen science community has played an especially big role in helping monitor and detect snails, even populations of new snails.

ELLEN VOSS: We had a citizen coordinator that trained citizens. And they are who found one of our other populations from a couple of years ago in Badger Mill Creek. It was a citizen group that found them, which is cool for them, but not great that we found another population. But it was like citizens are able to find these tiny things that you can't even see.

BONNIE WILLISON: Meanwhile, Ellen and others in the Driftless are monitoring their streams for signs of this snail. And Nick continues to teach his clients the best practices for making sure that they are not moving this New Zealand mud snail or other invasive species from stream to stream and from watershed to watershed as they fish.

SYDNEY WIDELL: I think about it all the time. It's like one of those things that, once you know about it, you can't stop thinking about it. And it's so close. Black Earth Creek is so close to us here. If this does become a problem and these snails take off, it could have very direct impacts on all the people who rely on that for their livelihood.

BONNIE WILLISON: In New Zealand, the snail is controlled by a parasite. There's been discussion about what would happen if the parasite was also introduced in North America. But at this point, that is way more of a thought experiment. And people would have to do so much research to make sure that introducing a parasite here wouldn't have any unintended consequences. In other places, for instance, parts of Europe where this snail was introduced and was really, really successful, those snail populations have inexplicably and drastically crashed.

SYDNEY WIDELL: I would hope for this eventual population crash, for reasons that we can't explain, to happen. Which is to say that things do happen in nature that we don't have an answer for just yet. But at least in other examples, in places in Europe, this has happened before. So we don't know why, but you can hope that that can potentially happen, I guess.

BONNIE WILLISON: There are other more realistic short-term solutions that Maureen and Ellen feel much more confident in, and I want to tell you about some of those. The first one is using environmental DNA. That's basically like the material the snail is shedding as it moves around in the water, like its skin, or waste and stuff.

And that's floating around in the water. And you can take a water sample, and then really easily be able to say, oh, it looks like the snail was present in the stream, or the snail, we haven't detected at this time around. And in theory, you'd to be able to tell pretty quickly whether or not the snail's in the stream.

One thing Ellen has really pushed for is installing wader wash stations at some of these super popular fishing spots and also putting up signs and other information. So if you're fishing in a spot where there's a lot of New Zealand mud snail or any other introduced species, you'll have that information and maybe be more mindful about how you fish and how you clean your gear afterward.

SYDNEY WIDELL: Wisconsin Sea Grant and the extension have helped purchase and place some of those signs.

BONNIE WILLISON: What does a wader wash station look like? Is it like a sink?

SYDNEY WIDELL: Have you ever been hiking and seen those boot brush stations?

BONNIE WILLISON: Yeah, I've seen those a lot.

SYDNEY WIDELL: Yeah, that's kind of what it--

BONNIE WILLISON: OK.

SYDNEY WIDELL: Yeah, that's kind of what it looks like.

There's been growing interest in training dogs to sniff out New Zealand mud snail other invasive species in water samples, which I just think is the coolest thing in the world. We talked to someone actually who trains dogs to do that. And we're going to have much more about that in a future episode, so keep your ears open for that. But that's another solution that could be on the horizon.

BONNIE WILLISON: And lastly, Ellen thinks that bridging the gap between people in management and people in the fishing industry is a really important way to advance detection and monitoring for invasive species, including the mud snail.

And fishing guides, like Nick, could play a big role in that effort.

ELLEN VOSS: They have this unparalleled access to so many different places on any given day. So they're the best eyes on the ground, in terms of early detection for the IS. And I think-- I mean, you don't know what you don't know. So I think once people, like once they chat with you guys and show you the things you should be looking out for and their close relatives that are not invasive and just being able to make that distinction, I'm really excited to build those relationships. I don't know. I think we'd get a lot of data that we just haven't had before.

SYDNEY WIDELL: If you like to fly fish, Nick and Ellen say one of the most important things you can do to stop the spread of New Zealand mud snail is start using a brush to clean off your gear before you move from stream to stream. They recommend checking gravel guards on your waders, your shoelace, like the tread in between your boots. And thanks to some of the work people like Ellen and Maureen have done, there are brush stations now installed at many of the access points at creeks around the region.

Stopping the spread of introduced snails is an important first step in protecting our native ones. Sometimes though, the success of an introduced species is a sign that habitat is already changing. The New Zealand mud snail, for example, it thrives in nutrient-rich streams. A lot of times, those excess nutrients are entering the water straight off of the surface of the land.

Those streams were changing before the New Zealand mud snail showed up. Supporting the farmers who are working to be better land stewards, as well as policy that supports sustainable agriculture, are two ways to help keep extra nutrients out of streams. Kathryn, the snail expert we talked to at the beginning of the show today, told me the most important thing we can do to protect freshwater snails is simply to protect freshwater.

KATHRYN PEREZ: I would say, probably, teaching and helping people understand the value of clean water would do the most good for snail conservation. You have a whole genera of snails in the southeastern United States that went extinct with the damming and channelization of the Tennessee and the Coosa, the different rivers in Alabama and Tennessee. So lots of species have gone extinct, and lots are imperiled.

The other big area of imperilment is in the snails that are in springs in the west. As you're probably aware with climate change, and also increasing human usage, we use up water. We use it for our household use. And then it's heavily used for industrial use, like oil and gas extraction, for example, in West Texas and other places.

And so if you use up groundwater-- springs go dry and people's wells go dry. And if a spring goes dry, most spring snails are only found in a single spring or a few springs that are nearby. And so if that spring goes dry, then all the snails and other things that only lived in that one spot go extinct.

The most important thing for snail conservation is for people to value water and thinking about water as a shared resource that is a right for all people, and not something that should be wholly considered for its commercial value.

[MUSIC PLAYING]

SYDNEY WIDELL: *Introduced* is produced and hosted by Bonnie Willison and me, Sydney Widell. Please subscribe, rate, review, and share this podcast with a friend. You can find Wisconsin Sea Grant on Twitter @UWISCSeaGrant and on Facebook at University of Wisconsin Sea Grant and Water Resources Institute. We'd love to hear from you. Send in your questions and comments to Bonnie-- bonnie@aqua.wisc.edu.

If you're curious about identifying any of the species we talked about on the show today, we'll have a lot of information linked in our show notes. You can listen to our show on Apple Podcasts, Spotify, and Google Play Thanks, for tuning in. See you next time.