**Audio Transcript**

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DAN WANSCHURA, CO-HOST: From Interlochen Public Radio, this is [Un]Natural selection. I’m Dan Wanschura.

MORGAN SPRINGER, CO-HOST: And I’m Morgan Springer. This special season of Points North is all about humans tinkering with the natural world.

WANSCHURA: Right, stories of mending our environment and meddling with it. But today’s story isn’t about what we've done. It’s about what we’re capable of.

SPRINGER: In 2010, the Food and Drug Administration was reviewing a controversial fish. While they were deciding if it was safe to eat, Lisa Murkowski was sounding the alarm. She’s a U.S. senator from Alaska.

LISA MURKOWSKI:

I would ask, again, you look very critically at this: the threat, I believe, to humans for consumption of this bizarre fish.

SPRINGER: Murkowski’s talking about genetically engineered salmon or as she calls it:

MURKOWSKI: We refer to this G.E. salmon as “frankenfish”.

WANSCHURA: The frankenfish’s real name is AquaAdvantage Salmon, and it was developed by the biotech company AquaBounty using transgenic technology.

MARK WALTON: So transgenic technology is technology in which you introduce a gene generally described as a foreign gene.

WANSCHURA: That’s Mark Walton, chief technology officer for AquaBounty.

WALTON: You use a micro injection, a really, really thin needle under a microscope and inject it into that embryo.

WANSCHURA: In the case of the so-called frankenfish, they used genes from a different salmon species and a fish called ocean pout. They inserted them into the embryo of an Atlantic salmon. And those genes are associated with growth hormones. That’s why AquaAdvantage salmon reach market size twice as fast as wild Atlantic salmon.

SPRINGER: I want to say that again: two times faster. Double time! Anyway, in 2015 the FDA did approve it. And it was the first genetically engineered animal available for human consumption in the U.S.

WANSCHURA: And in Canada.

CANADIAN BROADCASTING CORPORATION: Salmon, the ocean’s natural superfood, is about to come in a very unnatural variety … Health Canada has approved what critics are calling a frankenfish …

WANSCHURA: Now, all this frankenfish talk was going on during and just after the FDA’s review. But six years later, Walton says that initial skepticism has mostly worn off.

MARK WALTON: AquaBounty got caught up in politics. The people who we’re selling to right now, they’re not hearing from consumers about genetically engineered fish. What they’re hearing is we’ve got a product that tastes good.

PATRICK SHEA, BYLINE: For the record, I haven’t tasted it so I can’t verify that.

WANSCHURA: That’s reporter Patrick Shea.

SPRINGER: Are you sure someone didn’t slip frankenfish into your food?

SHEA: No, nobody slipped it into my food.

SPRINGER: That you’re aware of.

SHEA: Not to my knowledge. And I’m not saying I wouldn't, I just haven’t.

I don’t want this to sound like an AquaBounty commercial, but it does seem like Mark Walton is right. All the hullabaloo around this fish has sort of died down.

WANSCHURA: Huh. I wonder why that is. Did people just get over it?

SHEA: That might be part of it. It takes time for people to accept change. But whether you like it or not, genetic engineering is advancing fast.

AquaBounty actually first made this breakthrough with salmon in the late 80s. It was groundbreaking at the time, but new technology has made genetic engineering easier, cheaper—more feasible. And that’s led some to wonder how it might be used for conservation. And it led me to wonder what it could mean for a different fish: lake trout.

SPRINGER: Okay here we go, people. Episode seven of seven: Frankenfish.

SHEA: There’s this spot in Northern Michigan where the Jordan River winds its way through these steep ravines. It’s a beautiful place, kind of tucked away in the hills on a dead-end road.

ROGER GORDON: It’s pretty quiet out here. The North Country Trail—I don’t know if you’re a hiker at all—it’s right across the river there.

SHEA: I’m at the Jordan River National Fish Hatchery with Roger Gordon, the hatchery manager. We’re talking trout. We’re in this sort of warehouse that has long, skinny pools along the ground. Roger calls them “raceways.”

GORDON: All the raceways with white buckets have fish in them right now.

SHEA: We can see young fish—just a couple inches long—darting around in the water.

GORDON: I’ll have to try to sneak up on them and we’ll net some.

SHEA: He walks slowly towards the pool, and in a flash he scoops a netful of juvenile lake trout.

SHEA: Wow, first try!

GORDON: Yeah, look at that. Done it a couple times.

SHEA: He pulls one out to show me as it flops around in his palm.

GORDON: There’s about 40,000 in each one of these raceways.

SHEA: Last year, this hatchery alone raised 2.2 million lake trout. It's just one part of a massive stocking operation by the U.S. Fish and Wildlife Service.

GORDON: The federal government spends tens of millions of dollars every year in direct lake trout restoration … and Lake Michigan, of the upper three lakes, relies on stocking the most.

SHEA: Roger says without stocking, there probably wouldn’t be any lake trout in Lake Michigan. For more than 50 years, the lake’s top native predator has been on life support.

CHUCK MADENJIAN: By 1960, they were gone. You can essentially say there were zero lake trout in Lake Michigan.

SHEA: That’s Chuck Madenjian, a fisheries biologist with the U.S. Geological Survey. He says first, lake trout were overfished. Then, they really collapsed under the pressure of invasive species. Those invasive species caught a ride to the Great Lakes in shipping vessels. Humans got the lake trout into all this trouble, and now we’re spending a lot of time and money trying to fix it.

MADENJIAN: Stocking has been critical to try to bring them back.

SHEA: But even after all these years of stocking, there aren’t many signs of lake trout reproducing on their own, in the wild. Chuck knows this first-hand. He does surveys twice a year to study populations in Lake Michigan.

He’s noticed that a certain strain of lake trout is doing a lot better in the wild. Strain, meaning same species, different original location and slightly different genetics. This one’s called the Seneca strain. And they started stocking it in Lake Michigan in the 80s.

MADENJIAN: Seneca Lake is a lake in upstate New York that has a native Lake Trout population in it. That strain, somehow, has the quality of being able to better evade lamprey attacks, for whatever reason.

SHEA: After a breakthrough last summer, we’re a lot closer to knowing that reason.

That’s because a PhD student at Michigan State University assembled the first-ever reference genome for Lake Trout. That’s like a map of a species’ genetic make up. And it can help scientists find out which specific genes are responsible for specific characteristics.

The student who assembled the genome was Seth Smith. And to be clear, he didn’t do it with genetic engineering in mind. He just wanted a deeper understanding of this species. Seth spins a pretty good metaphor for how hard it is to map a genome.

SETH SMITH: You know within every cell in an organism, you have a copy of a genome. And you can think of each copy of that genome as a full set of encyclopedias. And then assembling a genome is kind of like shredding all those copies of the encyclopedia and trying to piece back together one of the single copies from all of this nonsense you get.

SHEA: Mapping a whole genome used to be pretty much impossible for most geneticists. If not physically, then financially. But that has totally changed. In just the past ten years, the price of sequencing a whole genome went from tens of millions of dollars to just a few hundred dollars.

Seth’s research could tell us why the Seneca strain does so much better than others. In fact, he might’ve figured it out already. Or at the very least, he’s provided some great clues. He looked at trout that were part Seneca, part something else. And tried to find which Seneca genes might be favorable.

SMITH: So basically what we did is looked for regions of the genome that had an excess of chromosome blocks from the Seneca strain.

And what was really interesting is the genes within these regions were enriched for genes associated with the regulation of vascular wound healing and swimming behavior. So kind of our hypothesis is that maybe the Seneca strain is doing better because they have an increased ability to either avoid or survive lamprey predation.

SHEA: If you listened to the last episode of this series, you already know that a sea lamprey is basically a blood-sucking monster fish. It’s one of those invasives that hitched a ride on shipping vessels into the Great Lakes.

SPRINGER: Ok this is starting to make a lot of sense, because sea lampreys cause wounds, right?

SHEA: Yeah, because they’ve got a bunch of sharp teeth. I had a friend in college who called lampreys “ouch noodles,” which I love.

WANSCHURA: That’s awesome.

SPRINGER: So if they can heal from those wounds, that’s a plus, right?

SHEA: Yeah, and swimming skills—maybe those could help them avoid lampreys in the first place.

So, if those specific genes are the reason for the Seneca strain’s success, I want to know how that information might be used in hatcheries.

Because their goal is to get lake trout to a place where they don’t need our help anymore. Here’s Roger Gordon again.

GORDON: Our goal is to put ourselves out of business. We want to establish self-sustaining populations of fish. And then once that's done, we back off and we do something else. We have a lot of problems. We have a whole list of animals that we can work on. Well once this animal is done—it's restored—we'll move on to the next one.

SHEA: People like Roger have spent entire careers stocking lake trout. In Lake Superior, the population is fully recovered, and Lake Huron is well on its way. But Lake Michigan’s another story. Its population still hasn’t recovered. So what if there’s another way? A faster way? What if there’s a bold, new, controversial way to get lake trout back on their feet—or, fins?

What if we didn’t need to spend so much time and energy on stocking? What if genetic engineering could be used for conservation? What if that’s our ace in the hole for saving species from problems we started?

What if we could take genes from the Seneca strain, and insert them into other strains, to maintain genetic diversity and increase survival? What if—

WANSCHURA: Alright, Patrick. I’m gonna reel you in a little bit. That’s a lot of what ifs.

SHEA: I know, I know. I’m just trying to emphasize that this really is a “what if” story. I don’t want it to sound like scientists are about to let some frankentrout out into the wild. But should they?

WANSCHURA: Hmm. Maybe?

SPRINGER: I hear you, and I gotta just jump in and say my gut reaction is no. I think part of it is because of all the stories we’ve been hearing. We think we’ll just do this little thing, we’ll fix it and it’ll be great. And then it’s actually not great. I just don’t know how we do something that feels so massive, and don’t just continue that pattern of unintended consequences.

WANSCHURA: I mean if humans caused the problem, is there a burden on humans to try to be the solution? If they have the technology, you know?

SHEA: I think you guys are really capturing the split well. There’s this ethical line between what we could do and what we should do.

That’s really evident here, with conservation genomics. It’s a hope in the midst of mass extinction for some people. But for others, it’s a dangerous game. Playing god. Messing with the very fabric of the universe. And for me, it’s just very hard to wrap my head around.

One thing we have to acknowledge is that some form of genetic manipulation has been going on for a long time. Marty Kardos is a research geneticist with the National Marine Fisheries Service.

MARTY KARDOS: In reality, we’ve been tinkering with nature profoundly for thousands of years. I mean we took teosinte and turned it into—I mean look what we’ve done with a lot of crop species.

SPRINGER: What the heck is teosinte?

SHEA: I had to look it up, too. It’s a type of wild grass that eventually became corn, through selective breeding. Teosinte has a two inch ear with only about ten kernels. An ear of modern corn is usually about a foot long, and has around 500 kernels.

WANSCHURA: And always gets stuck in your teeth.

SHEA: Exactly. And think about all the selective breeding we’ve done in animals, too.

WANSCHURA: Yeah, livestock. Like chickens, cows…

SPRINGER: Oh my gosh, dogs.

WANSCHURA: That’s a good one.

SHEA: Dogs is a huge one. What is a wiener dog? How did a wiener come to be? And I’ve heard pugs have breathing problems because we’ve bred their faces so short.

SPRINGER: They do. I’ve seen it.

WANSCHURA: Oh yeah. They snore; they snort.

SHEA: Some form of genetic manipulation has been going on for a long time, that’s the point.

But what we’re talking about today is different. Apparently, since we live in the future, it’s now possible to extract a gene from one plant or animal and insert it into another. Like AquaBounty did with salmon.

So, say there’s a desirable trait you want a species to have—like, I don’t know, random example: wound healing or swimming abilities.

WANSCHURA: Right.

SPRINGER: Totally random example.

SHEA: Pulled it out of a hat. It’s really not that crazy to imagine taking genes from the Seneca strain of lake trout and inserting them into other strains. Now, are any geneticists actually looking into that? The short answer is no.

Kim Scribner is a professor at Michigan State. Seth, who mapped the trout genome, studied under him.

KIM SCRIBNER: In conservation, I think that people have been somewhat reluctant to embrace gene editing because of the fear that once these edited genes are in the natural environment, it’s like the genie’s out of the bottle. And you really don’t know what the potential effects of that are going to be.

SHEA: Marty Kardos agrees. He wrote an opinion paper a few years back called “the peril of gene-targeted conservation.” Marty says our technology might be outpacing our understanding.

KARDOS: There’s no recipe for exactly how to go about doing this. And the natural world is immensely complex. It’s difficult to predict how ecosystems will respond to something we do.

SHEA: And he says even if we do get really good at this stuff, we won’t be genomick-ing our way out of this anytime soon.

KARDOS: Genomics is sort of an exciting new thing, but it can’t change the fundamental reasons for lots of populations not doing well. And those reasons are environmental factors. Climate change, overexploitation, loss of habitat.

SHEA: Clearly, experts are pretty hesitant about using genetic engineering for conservation. But we don’t have a crystal ball. We don’t know what threats to lake trout lie ahead. And we also don’t know what geneticists might do with the reference genome. That’s public information now.

So then the question is: will someone decide to use it for genetic engineering?

It might sound far-fetched, but right now, there’s even research going into bringing back extinct species.

WANSCHURA: Are you serious? No way.

SHEA: Yeah, this is real, well-funded research. Geneticists at Harvard are trying to resurrect the woolly mammoth by combining its preserved DNA with modern elephant genes. And in Australia, geneticists want to resurrect the Tasmanian tiger, which settlers hunted to extinction. They just raised an extra 3.6 million dollars for that project.

SPRINGER: Wow, that just seems so wild. Kind of crazy to think about. It just makes me think about what Mart Kardos said. We can’t predict—like what’s the resurrected Tasmanian tiger going to do on the planet? What’s the woolly mammoth elephant going to do?

SHEA: The frankenmammoth. It does seem crazy, honestly. But some people want to bring back species just for the intrinsic value of having them around. And they feel it’s the right thing to do, especially if we caused their extinction.

So there is some serious movement right now in conservation genetics. Or genomics. Or genetic engineering. Or whatever.

Personally, I find these advancing technologies amazing and interesting and honestly, promising. And again, I can’t help but wonder– shouldn’t we do everything we’re capable of to right our wrongs? I asked Roger Gordon, at the fish hatchery, that question.

GORDON: That’s a very open-ended question. Fisheries biologists, for the most part, are a very conservative lot. Especially ones as old as I am who have seen some of the problems we’ve had in the past where as human beings we thought we could improve upon mother nature. And most of those things turn out bad.

WANSCHURA: That’s kind of the essence of this whole series, in a way.

SPRINGER: Yeah it reminds me of the weevil. Of us thinking we’ve got this magical solution, and then womp-womp, it totally doesn’t work.

WANSCHURA: That’s episode one for you newbies, by the way.

SHEA: I thought the same thing. About the weevil. And what’s really interesting is a lot of the people I talked with throughout this series kept bringing up the same exact phrase, and it comes from the field of medicine. We heard about it in episode one, and Marty Kardos mentioned it, too.

KARDOS: Medicine and conservation are very similar in ways. Medicine is sort of the conservation of human life. And there’s this idea of the hippocratic oath in medicine.

SHEA: That “hippocratic oath,” put simply, is “first, do no harm.” Marty says just like physicians, conservationists should balance the risks and benefits of any intervention. The last thing a good doctor wants to do is hurt a patient when they’re trying to help, right?

And if you apply that medical principle to the environment, that means valuing our ecosystems as highly as our own bodies. And that's a pretty high bar.