Western Science

WESTERN SCIENCE SPEAKS PODCAST
SEASON 4, EPISODE 4

EPISODE TITLE

The Rise of Fish Farming in Canada

PODCAST SUMMARY

Dr. Bryan Neff from the Department of Biology joins the podcast to discuss the rise of sustainable fish farming in Canada, why we're hesitant to eat genetically modified food, and his research in restoring salmon to Canadian lakes.

INTERVIEW

Unknown Speaker 0:00
You're listening to the Western science speaks podcast. Presented by Henry Standage.

Henry Standage 0:29
Hey, welcome to season four of the Western Science Speaks podcast. We're kicking this season off with an interview with Brian Neff from the Department of Biology here at Western. Brian is one of the smartest fishery researchers we have here in Canada with work scoping from understanding evolution from a gene perspective, all the way to aquaculture sustainability. A lot of people don't know this, but fishing in Canada is going through something of a cultural referendum. On one side, the fish hunters have been doing this for generations. It's built into the fabric of their families. And on the other side, you have fish farming; the more analytically driven, slightly less personable method aimed at creating higher efficiency in aquaculture. Brian and I discussed that at the beginning of the episode, and then moved on to a whole bunch of other cool stuff about his research. Here it is.

Let's start with a topic that has become increasingly contentious in recent years: fish farming, replacing fishing as the primary form of aquaculture. Can you take us through the differences in this process?

Bryan Neff 1:42
Sure. So traditionally, most of the fish that we eat or ate came from what's called the capture fisheries. So we went out there and effectively hunted for the fish. They were wild fish, and we would use different techniques. It could be using long lines with hooks, really large nets, or even dragging really large chains across the bottom and collecting all the fish that we stir up. So that's a form of fish for fish. Edit that right, that's a form of fishing and it used to encompass almost 100% of the fish that we ate. And most of that came from the ocean. So it's marine fisheries as opposed to inland freshwater fisheries and the oceans about maybe 25 years ago, were fully tapped, so we were catching every possible fish that could be caught to eat. And it yielded about 100 million tonnes of fish, most of which we would consume. Some of it would be used for other other products, dog food, or even feeding other fish. Well as we saw aquaculture emerge, aquaculture as fish farming is exactly that, it's farming. It's like farming a cow or a pig. Most farming involves inland waters so you dig a hole, fill it with water and put some fish in it and grow them, and then you harvest them so you collect them and and put them on market. Some fish farming involves net pens that float in the ocean. And that's the farming were probably most familiar with in Canada it's the biggest form of farming in Canada but not globally. So globally, the

common form of farming is you know, dig a hole, fill it with water and put some fish in it. No net pens. But the net pen fisheries is fairly controversial particularly in Canada because it often comes up against the traditional fishing for fish and people who fish traditionally generally don't want to farm for fish. They're two very different professions. And sometimes the agriculture of fish farming has been implicated, albeit the evidence is not conclusive, in affecting or being detrimental to fishing. And so the two different types of Fish production sometimes come at odds.

Henry Standage 4:05
And when would you say the pivotal moment where you start to see this transition from fishing being the dominant form, and then the rise of fish farming coming in?

Bryan Neff 4:17
Yeah, it was probably in the 1980s. And really, the change was in the collapse of the world fisheries. You know, the Oceans Bounty, we had fully tapped it, we had over tapped it, so it was no longer sustainable. And we saw some of these very lucrative fish stocks collapse and it made you know, global news. The one in Canada that were probably most familiar with would be the collapse of the Atlantic cod on the east coast and around 1990 this was you know, a huge bounty for Canada and for international fishers to tap and then eventually all the cod one day were just gone. And there weren't any more to catch. And so as a result of the collapse, you know, so we were at globally about 100 million tonnes per year being pulled from the ocean that was, you know, most likely unsustainable, we saw a lot of catches just declined. So fishers would go out there that put out their nets, but they wouldn't come back with any fish. Those fish were needed in terms of feeding a hungry world. And so we saw aquaculture start to emerge. So more and more farms were developed to replace those fish that we could no longer take from the ocean. Most of that originated in in Asia, in particular, China, China's the single biggest farmer of fish in the world, they produce about half of all the fish that come out of farming. And that's important for food security globally, in part because they're feeding their own very large population and therefore not in competition for exports of other people's fish, but also because they're also an exporter of fish. So they provide that farmed fish to other nations that needed to to put in their stores for people to eat.

Henry Standage 5:59
So these fish that have been farmed are almost being reborn because they're having the chance to start a new family albeit very small. And so I think something people underrate is that a lot of it is preservation of the fish, rather than a GMO genetically modifying it.

Bryan Neff 6:17
Yeah, that's very interesting. And, you know, you're right, that most of the fish that are farmed, are basically, you know, a wild fish at least originally, unlike the cow or the pig, which, you know, through many, many generations have been domesticated. So you don't really find a wild pig anymore, you know, might be the wild boar, but it's not the pig. It's not the cow out there in the wild, whereas in the case of fish farming, it's still young enough, you know that there hasn't been a whole lot of domestication that if we look at a fish like Atlantic salmon that's, you know, heavily farmed in Canada and say, Norway, it's still very similar to the wild Atlantic salmon. That said, it's a hugely controversial question. And when we look at conservation of wild fishes in Canada, the species at risk act, for example is one way that we monitor species that, you know, have been overfished and maybe threatened for extinction. They actually delineate what are called evolutionary significant units. And so Atlantic salmon is a species, but they'll distinguish different stocks. So an Atlantic salmon from Maine, may be considered different from an Atlantic salmon from Newfoundland. And so they're managed accordingly.

So they're considered different species and we want to preserve both of those stocks. So when you throw the Atlantic salmon that's now in a net pen, they're usually viewed as a domesticated species they're not a wild species, even though they haven't been domesticated, not like the cows, the pigs or the chickens have been.

Henry Standage 8:00
The first GMO fish for human consumption was approved in August 2017. Have scientists recently discovered how to make GMO fish safe to eat? Or was it an issue of overcoming the stigma attached to it?

Bryan Neff 8:13
Yeah, that's an interesting story. And it goes back about 30 years. So the first fish that we can consume, you know, as a GMO, was an Atlantic salmon and it goes back to your point is it still an Atlantic salmon. The researchers, much of it was done in Newfoundland, so here in Canada, and then it was commercialised eventually by Aqua bounty, which is a company that has an office in Prince Edward Island. There was such a new technology, you know, this idea that we could create a fish we could manipulate the genome and change it and put genes into that fish that we wanted, desirable genes, that it was treated as a drug, not a food and so to get a drug approved, and they focused in the US because if they could tap the US market then Canada would follow suit but also because the US markets far bigger

Henry Standage 9:04
Was it approved by the FDA?

Bryan Neff 9:05
Yes.

Henry Standage 9:06
Interesting.

Bryan Neff 9:07
So you know it to get a drug approved is a far bigger challenge than to get a food item approved. So the FDA requirements are very, very rigorous. And so they were held to a very, very high standard. And it took basically 20 years to meet all of those regulations, just like it would if you're developing a brand new drug - it can take 20 years from the discovery of the new drug to the point where we're actually using it for human health. So, you know, fast forward 30 years, it was finally approved and, you know, then enter the stigma and GMOs generally are not well received by society. So we see a lot of backlash for GMOs to a point where companies that produce a GMO usually try to hide that it's a GMO, it's usually not a seller. You know, put on your package: This is a genetically modified organism. It's generally not what you look for when you're in the grocery store. But yet, I would argue that it's a necessity moving forward. We've had GMOs for decades, most of them are plants. Most of the vegetables we eat are genetically modified. Usually it's just around, you know, having resistance to a particular pesticides so that they can grow them effectively and not have insects eat all the crops. But in the case of the fish, this Atlantic salmon that was approved, they manipulated genome by introducing genes from other fish. And so that makes it a GMO, albeit it one could argue, you know, if you naturally breed two different species and create a hybrid, no one would probably argue that's a GMO. What the researchers did is they just took out a gene from a Chinook salmon, a promoter from an eel white fish, and put it into the Atlantic salmon. So we have two genes from other fish in the Atlantic salmon. It's still a fish.

Henry Standage 11:04
Yeah, I think it's incredibly important to note how important it is how something enters the public consciousness. And so the fact that it entered as this drug and freaks people out I don't want to eat some drug fish. It's like some scaled down Jurassic Park-esque thing. And I think changing that perception is incredibly hard. I think this is why you still see it as a super controversial issue.

Bryan Neff 11:30
Yes, and the case that the Atlantic salmon too, the gene they took from the Chinook Salmon was a growth hormone gene and so it does speak to what you're getting at - it was a hormone and that basically just causes the fish to grow faster and that's a good thing for aquaculture. You know, you want to harvest it as quickly as possible so we can eat it. Interestingly, the growth hormone levels in the Atlantic salmon are no higher than the Chinook salmon and the Chinook are these big salmon, you know. I love to eat, lots of people love to eat their Pacific salmon. They're, they're part of the capture fisheries in Canada. But the growth hormone levels although not higher than the Chinook salmon are higher than the Atlantic salmon and that's why those salmon are smaller. And so it was treated as a drug in that sense that they didn't compare them to Chinook Salmon they compared the growth hormone levels to other Atlantic salmon that live in the wild.

Henry Standage 12:25
There are other ways to genetically modify fish other than for consumption like human food. Such as fish technologies that allow zebra fish to express jelly fish and sea coral proteins, giving the fish bright red fluorescent colours when viewed in light. And nobody has a problem when it's for entertainment purposes. It's when consumption comes into play that you see issues arise. To follow up, are fish the only animal to have their DNA changed for consumption. You mentioned cows and pigs earlier in our talk but as it solely fish that can be modified for consumption.

Bryan Neff 13:03
Yeah, that comes up an issue of perspective. So, when we use these really advanced techniques like these really, really micro needles to introduce a gene into an egg that manipulates the genome of the fish as they did in the Atlantic salmon, or sometimes they use viruses, you know, to introduce the new DNA or RNA into an organism to manipulate its genome. It's very, you know, that gets labelled immediately as a GMO, you know, we're using these highly advanced technologies to manipulate the genome. But humans have been manipulating the genome of animals for centuries, you know, thousands and thousands of years. This could be anything from our pets. You know, if we think of cats and dogs, they've been widely bred for particular trades, like the dog is a single species, but think of all the different types of dogs, very different. Their genes and their genomes have been manipulated. Much of the food we eat, you know, grow the crops were manipulated by breeders, they would pick crops that had certain traits, you know, maybe it was more corn or more tasty corn. And they would then breed those individuals to produce their crops in the next generation. And so that's a form of selection, even natural selection, where we're manipulating the genomes based on the phenotype. So the traits that particular organism has, just picking the ones with the best traits to breed, and consequently, we change the genome of the population. And that's a form of genetic modification, but it's not labelled GMO and nor should it be.

Henry Standage 14:51
Right. And on the surface, this entire issue feels like an issue of class stratification where you've had Blue Collar families, where fishing has been something they do for generations. And then you have fish

farmers and maybe it comes across as this elitist way to fish. Am I looking too far into it? Or do you think that's a real concern with some people?

Bryan Neff 15:17
Yeah, that's an interesting perspective and probably a Canadian and North American perspective because most farming in the world is done in Asia and in particular in China and it is not an advanced industry by any means. It's done by locals, by peasants, by people who live in towns that have you know, very little electricity or clean running water. That farming is literally you know, dig a hole and fill it with water, you find a pond, and you remove all the stuff that's in it, and then you put fish in it and the most commonly farmed fish is carp. And so they fill a pond or even a rice paddy with carp and they don't feed them, they just tend them. So they make sure they don't leave or go anywhere. And when they're big enough they harvest them. The perception in, in North America might be that, you know, aquaculture is an advanced industry and so much as, in the ones that we hear most about are these ocean net pans where we're fishing, you know, these highly expensive crops, so to speak, salmon, the Atlantic salmon or the Pacific salmon, and those are our cash crops like that's an expensive fish. And so it might have that, you know, that idea notion that fish farming is you know, a super advanced industry and it's putting, you know, some advanced industry against the traditional fishing ways of life. I would argue though, that fishing in North America is a hugely advanced industry. You know, some of the lucrative salmon fisheries, the tuna fisheries you know, these are massive boats that they go out to fish with. And they have, they have helicopters on them and the helicopter pilot flies around looking for the fish and radios back to the fleet: Here's the fish. Then they come out, the big trawlers come out and they, you know, unwind thousands or hundreds of kilometres of net to catch the fish. Some of the big boats that are offshore fishing boats have the full processing of the fish right on board the boat so the fish comes in the back, they process it, out the front comes your canned tuna or your frozen fish. So it's also, it can be a very advanced industry as well.

Henry Standage 17:40
I think my generation and your generation, make the optimization of certain fields, and not just fishing, whether it be sports, or any sort of hobby in any field, how the next generation uses technology to get higher efficiency. That always frustrates people with tradition, I think. Anyway, let's switch it to your research. You look at some of the genes underlying certain adoptions. One of the major themes in your research is understanding the genes underlying adaptation. Can you discuss that?

Bryan Neff 18:20
Yes, sure. So I take an evolutionary approach to understanding adaptation. And what an adaptation is, in my field it's defined as basically the gene of the gene variants, what we call eels that allow an organism to persist well in its environment and to reproduce. So basically the live and then to reproduce, produce lots of kids. The gene, the genome and the genes underlying adaptation. There's been a long history of work looking at the genes that underlie adaptations, but really in the last 10 or 15 years with the advent of technologies that allow us to actually look at the DNA of organism. So for example, the sequencing that we can now do, it opened up a new understanding of adaptation. So we could really get at these different levels, the different base pairs that are in the genome, and how that affects, you know, one fish versus another fishes ability to survive in its environment, perhaps to guess at how it will survive in a future environment, and ultimately, to reproduce, which is important if you want a fish to persist. Some of the genes that we looked at in my lab pertain to thermal tolerance and is one example. This is something that's getting a lot of attention in terms of global warming, so we know that our waters are warming. And that's a question given that fish are ectotherms so they don't regulate their body temperatures like you ot I would, they're very prone to changes in temperature of the water. And so we

tried to get at the genetic basis of what we called thermal performance or thermal tolerance. So their ability to perform well in water of different temperatures. And so that's going to be important in understanding whether or not a fish will persist, say 50 years from now in a particular water body, and or what we might be able to do to allow it to persist, including maybe going back to that idea of GMOs, do we go in and actually start manipulating the genomes of these fish to ensure that they have future adaptations, you know, to this changing environment?

Henry Standage 20:30
And your group specifically works at restoring salmon. What are some of the difficulties you face regarding the evolutionary resilience of salmon?

Bryan Neff 20:39
Yeah, the salmon fisheries in Canada is a complex issue, one, because it's multifaceted so the traditional challenges so that the populations have been decimated, you know, the Pacific populations are now down to around 5% of their historic run sizes, run size is basically the number of fish that come back to reproduce and it's a nice easy way to track how many fish there are, so they go out to the ocean, they feed, they grow. And then when they reproduce, they come back to the freshwater streams. And we can count them pretty easily as they swim up these streams. So the historic run sizes are down around 5%. And basically, you know, they're gone or they're almost gone. So a lot of them are threatened or endangered. And so this is a serious concern. It's a multifaceted issue starting with for one, we just caught too many of them, you know, we ate too many of them. So we fished them unsustainably, not enough came back to reproduce to produce that next generation of fish for us to fish. Other issues though are around habitat destruction, and so in particularly with salmon because they come back and breed in these streams. We also live around these streams, we built big cities like Vancouver, and other cities, that we change the landscape and the ecology of those streams and that to can affect whether or not the fish are able to persist in them. For example, if we build a dam for hydro power, which we do a lot of in Canada and globally, the fish can't, you know, jump over a giant dam, and so they can't get back to where they want to reproduce. And how do you compensate for a shortcoming such as that? Yeah, so there's a big movement now to actually get rid of as many dams as we can, particularly for fish that live both in the streams but also want to go up to the ocean. That's not going to that's going to take a long time. There's a lot of dams but there's a movement to move away from damming rivers for whatever reason, whether it's just a whole back water or whether it's for hydro power. There's a lot of restoration work now going on around streams to try to rehabilitate the riparian zones which is the shores of the streams to make them more natural. But also there are more significant interventions where we might go in and take the last fish that would swim up a stream and we put them in what's called a live gene bank, so you can think of it as almost like a zoo, or an ark, where they're all brought in and they're kept in captivity. So they're kept in in, you know, big ponds or something. And they're bred in those ponds with the hopes of one day re-releasing them back into their natural environment, once we've had time to restore that natural environment to a state where they could survive.

Henry Standage 23:26
With respect to aquaculture and Canada's role at the forefront of that transition. What are some of the new practical technologies that your lab is helping implement?

Bryan Neff 23:36
Yeah, again, this is a quite a distinction between North America from you know, the rest of the world, particularly Asia where most farming is done. So if we go to Asia, their movement is actually away from the high tech agriculture and so they want to remove net pens, and instead focus on fish that you don't

have to feed. So you put them in a pond, and they feed on the natural foods that are produced by the water. So they tend to eat very low in the food chain. So they're herbivores, so to speak like a carp. In North America, our movement has predominantly been around net pen farming of these high cash fish like salmon. And they're the technology that the movement the technologies is really to ensure that these net pens and the fish themselves minimally impact the environment where the net pens floating, so they're typically in the ocean around the coast. And the idea is to make sure that they don't pollute the environment around the net pens too much. And that pollution is, you know, just all the poop that the fish release, because there could be millions of them held in these net pens, all the food that isn't eaten, so they throw in the food, they tried to make sure it gets all eaten, but eventually, some of it floats away or sinks out of the net pen and so that can be significant organic loading in the area, as well as potential disease, and that's a major concern. So those diseases can be treated sometimes with therapeutics in the in the net pens. But the concern is that they might transmit those diseases before they're treated to wild fish that are swimming, you know, by the net pens. So there's been a movement to try to create fish that don't need those therapeutics so that have these heightened immune systems. And that's something my lab works on. But also to try to reduce the impact or the creative barrier between the fish in the net pen and the fish that aren't in the net pen. And so new technologies include not using nets anymore net, you know, are obviously very porous, lots of water comes in and out, but instead using a close containment technology, and that's where you basically have what's like a giant floating Tupperware in the ocean, something made of a plastic where the water is controlled the water that comes in controlled, the water that goes out is controlled. The problem with that technology is that it requires that we pump water on like a net pen which just uses natural parents to water. pumping water requires electricity. Electricity is expensive. So it's more expensive than traditional net pen farming. And so the profit margin, you know, it's going to shrink and there isn't a high profit margin in fish farming. And so right now it's not economical to switch to these new technologies.

Henry Standage 26:32
Last question, Are you optimistic or pessimistic about Canada's aquaculture future?

Bryan Neff 26:38
Yeah, that's a that's a that's a tough one. I'm optimistic in the sense that globally, we must invest in fish farming, you know, human population is growing. No other food industry is growing like fish farming. It's the only way that we're going to feed a hungry world that needs animal protein. Canada is a leader. It has great environmental policies. So I think we can be a leader globally around fish farming. That said, there is a social element as well, that needs to be tackled. And there's no real timeline when you're dealing with, with issues that are controversial or seen as controversial in society. And so Fishers and fish farmers are generally different people, their different professions. And at the moment, there's still a lot of tension between fish farming and traditional fishing. And, you know, I don't know, it's going to be a long time I think before those challenges are reconciled.

Henry Standage 27:44
All right, that's it for this episode. I hope you enjoyed we'll be releasing 12 more episodes bi weekly until we get to 2020. If you did enjoy this and feel compelled to share it with your students, your prof, or whatever it be. We really appreciate it. And I'm really excited for you to hear from our team at Western this semester. I'm Henry Standage, signing out. Thanks for listening.