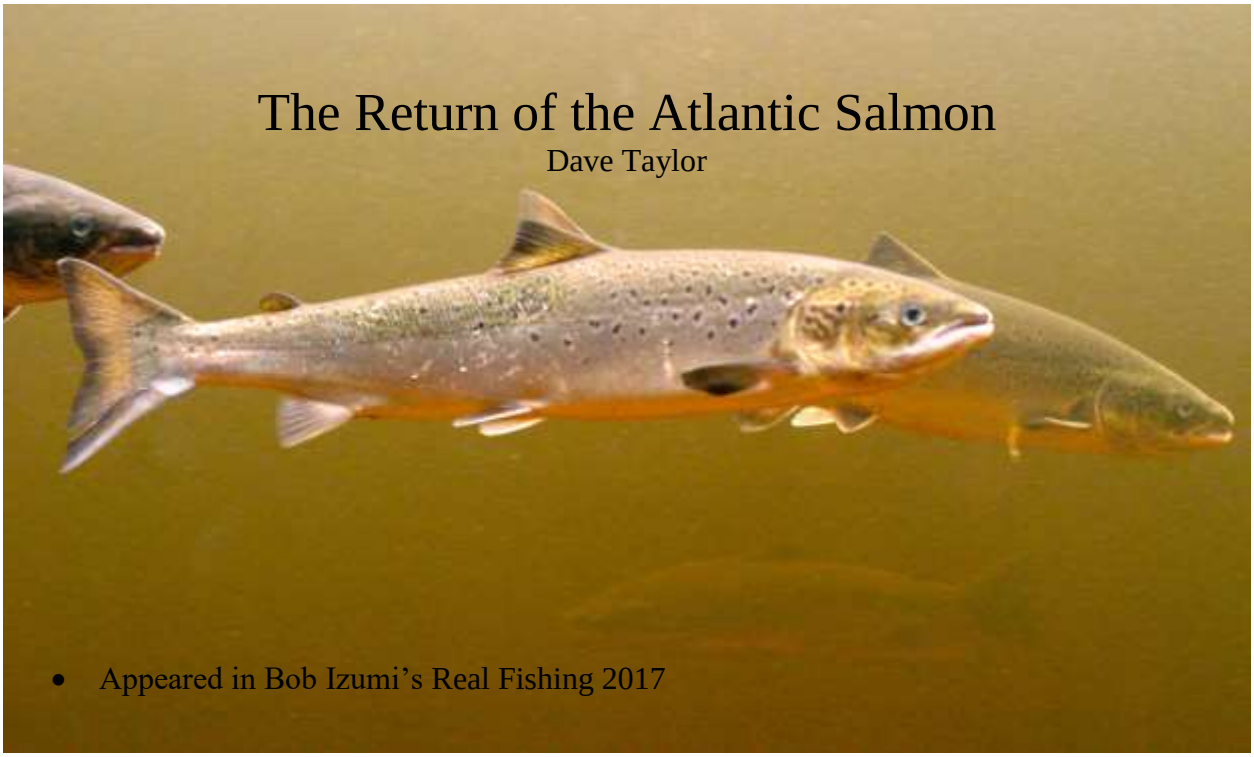

In the fall of 2016 I was hiking along a section of the Credit River in Mississauga when I came across the body of a spotted, silver fish. I knew at once that it was an Atlantic salmon (*Salmo salar*). It was a young male that had died making a run up the river to spawn. Young males that do this are known as "precocious" males because they are really not ready to spawn.

I reported the fish to Credit Valley Conservation biologist Bob Morris and he was excited with the news. Atlantic salmon have been stocked in the Credit River for quite some time now but they are still a rare sight. Anglers are far more likely to encounter Chinook (*Oncorhynchus tshawytscha*) and Coho salmon (*Oncorhynchus kisutch).*

This encounter started me on a quest to find out what was happening with the province's Atlantic salmon re-introduction. But let's begin at the beginning…

According to research done by Royal Ontario Museum archeologist Peter Storck humans first walked on Ontario land at least 13,000 years ago. They were hunters and gatherers and the evidence they left behind indicated that big game (especially caribou) was on their menu. So too were various species of fish.

It is unlikely that those fish were salmon back then. Glaciers still covered much of Canada in those last years of the Ice Age. Their rapid melting created huge lakes that covered most of the land that would one day become Ontario. At various times that massive amount of water, enough to raise the oceans hundreds of meters, sometimes flowed out through the Mississippi basin, or later the Hudson River and finally around 9000 years ago out the St Lawrence.

It is most likely that the salmon reached Lake Ontario via the latter route but the exact timing is not known. Atlantic salmon are native to the North Atlantic. They are an androgynous species. They start their life in freshwater streams in northeastern North America and northern portions of Eurasia. As the glaciers melted back new habitats opened up for these fish as older spawning

streams to the south became too warm to support this cold-water loving salmon. Its current range was established when the ice finally melted away.

However upon reaching Lake Ontario they could go no further because of Niagara Falls. It was long assumed that they were migratory and that they would spawn in the rivers which feed into the lake and then return to the Atlantic. And this was likely the case. (Unlike Pacific salmon which die after spawning Atlantic salmon may make several spawning runs.)

But something changed in their behaviour. Lake Ontario became their new home. A recent study done by Eric J. Guiry, *et al.* analyzed the DNA of several museum specimens of Atlantic salmon from Lake Ontario and the St. Lawrence and discovered that the fish living in Lake Ontario were not migratory even 500 years ago. They had given up their need for salt water and were enjoying Lake Ontario as a sort of surrogate sea.

Atlantis salmon along with Lake trout (*Salvelinus namaycush*) were the top predators in the lake. Their main prey species consisted of smaller fish, among them a deep water fish known as a bloater (*Coregonus hoyi*)' called that because when they are brought to the service from the deep they bloat.

During their spawning runs the salmon would in turn be food for humans and other predators. And for thousands of years this was their ecosystem. But that would change.

The catalyst would be the arrival of Europeans. At first the salmon would benefit as European diseases wiped out huge numbers if indigenous peoples. So great was the impact of this die off it can be seen in the record of forest cover change in Ontario. From circa 900 AD an increasingly agricultural component of aboriginal culture had reduced the forest cover of Southern Ontario from just less than 90% to just under 80% by the late 1600's. Then in the next hundred or so years there is a sharp rise in forest cover with it increasing to over 90% as the native peoples died off.

The huge reduction in the population of one of their main predators (aboriginal people) meant more salmon and better spawning streams. But then came the American Revolution in 1776 followed by the expulsion of the Loyalists a few years later. Great Britain welcomed them to the new colony of Upper Canada (Ontario). These new immigrants were farmers and immediately began clearing the forest. By the year 1900 the forest cover had dropped to less than 10% and the Lake Ontario salmon population was gone. Extirpated!

As late as 1846 there were still reports of Atlantic salmon in Lake Ontario streams being so thick that you could walk across the river on their backs "dry-shod". The explanation for the loss of this wealth is still being sought. We do know that by clearing the land for agriculture the farmers altered the environment. It became drier and the erosion from their fields silted up the gravel beds the salmon needed to spawn. The stream waters became warmer because the trees that shaded and therefore cooled them were gone. Dams built to provide power for grist mills also blocked off streams and cause spawning beds downstream from the dam to silt up.

A small fish, the alewife (*Alosa pseudoharengus*) was the final straw. The most popular theory is that these fish migrated up the Hudson River into the Erie Canal and then via connecting channels into the Lake. Others disagree arguing that the fish was present in the lake for much longer but changing conditions favoured its population explosion. No matter. The fact is that this species dealt the final blow to Ontario's Atlantic salmon. By 1896 the salmon were gone.

The introduction of Pacific salmon into the Great Lakes in the 1950's has been well documented and features into this story in two ways.

First, it showed that salmon could still survive in the lakes and this no doubt was a factor later on in selecting Atlantic salmon for a try.

Second, any attempt to reintroduce Atlantic salmon had to be undertaken with the knowledge that the ecosystem has changed due to the introduction of new top fish predators. This may seem obvious to you and I but in the 1950's and 60's our understanding of ecology was in its early stages. However since the plan was for Pacific salmon to be stocked annually the degraded spawning habitats and polluted waterways were not a factor. Atlantic salmon would not have done well under the conditions back then.

Since then our environmental consciousness has improved with the result that the spawning streams and rivers are far more suitable (in many cases) then they were even a few decades ago.

It would be inconceivable today for any government in North America to consider introducing large non-native animals into an existing ecosystem. The Pacific salmon experiment would not be allowed to happen today but for the last 15 to 20 years conditions were much improved. It was time to bring back a native fish.

The first introductions did not go well. Back in 1983 New York State made an attempt at restocking this species. It failed and further attempts were abandoned in 1990 in favour of stocking more viable game fish. Ontario got into the game in 1987 but this effort too produced poor results.

The main reason these attempts did not succeed was the alewife. Alewife are now well established in the lake and they are one of the main prey species of all species of salmon. The problem especially for Atlantics with this food preference was something called EMS. Early Mortality Syndrome. Alewife produce an enzyme called Thiaminase which destroys Thiamine. When ingested by female fish it effects their ability to reproduce. Simply put, this Thiamine deficiency prevents the young fry from developing the ability to ingest food either in the yolk stage or as fry. They starve to death.

While not confined just to Atlantic salmon (other salmonids also suffer from it) EMS certainly appears to be the major cause of failure of these early attempts.

However the Ministry did not give up and in 1995 re-evaluated their program and drafted a Recovery Strategy. Soon up to 200,000 young fish were being stalked. In 2006 The Ontario

Ministry of Natural Resources and Forestry (MNRF), the Ontario Federation of Anglers and Hunters (OFAH) and Ontario Power Generation (OLG) joined with 40 other partners to try again to reintroduce the Atlantic salmon. This group manages the reintroduction.

Two separate but equally important teams are working to solve the problems facing the reintroduction of the salmon. On the one side of the equation there are scientists looking at all aspects of the fish's ecology. While they work very well together it must be noted that on the management side there is an element of politics involved. Chinook salmon, brown and rainbow trout (*Oncorhynchus mykiss)* are so popular with anglers that, even though they are non-native, it is almost inconceivable that anyone would suggest their removal.

I interviewed people from both sides.

Trevor E. Pitcher, PhD is the Interim Director, Research and Innovation (ORIS) and an Associate Professor Department of Biological Sciences & Great Lakes Institute for Environmental Research at the University of Windsor. His university and Western University are doing the scientific research that helps guide the management side of the program including suggestions for restocking and hatchery procedures. His work is supported by OFAH, OMFR and VEMCO (a fish tagging and telemetry company).

The first funding supported research into which current stock of Atlantic salmon would be best suited for the reintroduction.

The closest genetic match to the extirpated genotype of Atlantic salmon happens to be found in Chile. In order to start a salmon fishery in Chile some entrepreneur imported Lake Ontario Atlantic salmon to this country in the late 1800's. The fish thrived and are now commercially farmed. But is this the type that should be returned?

The researched made the choice not to use this population. The ecosystem of the lake has changed so much since they were the top predator if was felt that these fish would not do well in today's Lake Ontario. Instead the restoration project looked to three other river populations: Lahave River in Nova Scotia, Lac Saint-Jean in Quebec and Sebago Lake in Maine.

They went for these three strains to get the eggs for hatchery. Both of the latter two lakes are home to Atlantic salmon that have adapted to life entirely in freshwater like the Ontario salmon did. The Nova Scotia site offered a robust androgynous population to sample from.

The Atlantic salmon now stocked come from these three populations. The next phase Pitcher's team is working on ends in 2020. "The second grant", he said "looks at how within a population we can help them improve their chances of successful reproduction." and despite progress he knows there will still be a lot of work to do beyond 2020

I also spoke with Ryan Hill, a hatchery technician for Fleming College in Lindsay. The college has been involved off and on in the reintroduction of Atlantic salmon for some time now. At first they raised salmon fry to three different ages/sizes; spring fingerlings (five months old), fall fingerlings (about 8-9 months old) and spring yearlings (15 months). Today they stock and

release only the spring fry. “Their survival rates are far higher than either of the other two sizes” he told me. They do not hold any adults. The adults for spawning are at either the Hardwood Fish Culture Station or Normandale Fish Culture Station. These two stations supply the eggs and fry for other sites including many schools and private individuals who want to help bring back the salmon.

The college receives about 100,000 eggs in January which produce 70,000 spring fingerling for release that May. The Lindsay Campus uses this program as part of their biology courses. The Normandale Fish Culture Station located on Lake Erie produces around 450,000 spring fry per year.

For all this effort to work several problems had to be addressed. Streams that were to be stocked had to be suitable for the fish to successfully spawn. Shade trees needed to be planted to keep the water cooler. Pollution sources needed to be eliminated if possible. A lot of this work was undertaken by volunteers some of whom were anglers.

I asked Hill if there was any genetic manipulation of these Atlantic salmon that would allow them to combat EMS. He gave a definite “no”. Any “mixing” of the three strains occurs on natural spawning runs not in a lab. By doing DNA testing the researchers are able to identify what population each tested fish is from.

The program is hoping that selection pressure will develop fish that can either tolerate Thiaminase or that select to feed on other forage fish such as bloaters. The Atlantic salmon restoration project will continue until at least 2021 in the hopes that one or both do occur. Certainly it is a different ecosystem now than it was back in the 1980’s. The lake is cleaner. Lamprey numbers are better controlled. Alewife numbers while they have fluctuated are still a factor.

To combat that threat New York State and the Ontario researches are looking at reintroducing “bloaters” back into the lake. The native population was all but extirpated in the 1800’s. If successful this would provide an alternative forage species for the salmon and therefore reduce the occurrence EMS as bloaters do not carry Thiaminase. Pitcher points out that bloaters were not an important prey species for Atlantic salmon however they are important to the lake’s healthy ecology. They help transfer of energy (food) from the deep water to the top of the lake.

The Atlantic salmon program carefully selected the rivers that the salmon fingerlings are released in. In the case of the Credit River the upper reaches provide the sort of habitat the fish need for spawning. Since Atlantic salmon typically spawn in the spring and summer (as opposed to the fall for the Pacific species) they are allowed access to these waters via fish ladders. When closed the same ladders prevent the Pacific salmon from reaching these desirable beds. Equally important however has been the large numbers of trees planted by Municipalities and Credit Valley Conservation along the river. These trees stabilize the bank, prevent erosion and shade the river.

The Credit was chosen as one of 3 waterways for restocking in the first phase. The others are Duffins Creek, Cobourg Creek. The Humber River, Bronte Creek also had some stocking as did the Ganaraska River. Other rivers and streams will be added in the coming years.

Pitcher has worked in Credit River for 20 years. "I happen to be, just by chance, the person who caught the first Atlantic salmon coming back as part of this program in 2006. That fish was from the Lahave population."

Since 2006 over 6 million young salmon fingerlings have been stocked.

Will it all be worth it? There is some indication that the various strains of Atlantic salmon are cross-breeding. There have also been fingerlings and smolts found in yearly samplings that were not marked so there does appear to be some natural spawning occurring.

Bob Morris said that the Atlantic salmon reintroduction in the Credit River is "proceeding". "We've seen some evidence of successful breeding especially in Roger's Creek." This creek is one of the tributaries of the Credit River. It is above the Norval Dam.

Morris explained that there are two dams on the Credit River. The Streetsville Dam is the first barrier fish encounter as they migrate up the Credit from Lake Ontario. It is managed so that it allows Atlantic salmon and Rainbow trout to pass. Pacific salmon (in theory at least) are barred from getting past this dam. The next barrier is the Norval Dam and only Atlantic salmon are allowed to move past this dam.

Beyond Norval lies the best spawning areas on the river. The water is cooler and the rocky bottom makes for a fine bed. However this is also where brown trout (*Salmo trutta)* from Europe have been stocked. Morris felt that the larger Atlantic salmon were able to out compete the smaller trout species for spawning beds. However Pitcher' research suggests that brown tout fingerlings are the bully boys in the river and out compete the salmon fingerlings. Adult brown trout feed on both types of fingerlings.

"We know that there is some natural spawning and we know that they are spawning eggs into the substrate but we do not have a clear picture of how successful this is" Pitcher said. "We need a functioning ecosystem." It is not so much the number of the fish stalked but the quality of the fish (age, size) and their environment. "This problem is not something we are going to solve by 2020. There is no silver bullet. It is also important to understand what fishers want (i.e. Chinook salmon as well as Atlantics). We get a lot of help from fishers. They return fish tags and report sightings. We need to engage these stake holders."

Phase III of the management project launched last spring and will release another 3.4 million fingerlings. I look forward to the day when seeing an Atlantic salmon on the Credit River (or any of the other rivers or streams) is not a rare event. As eons of time have shown their future is tied to our actions and keeping the salmon around for eons to come will be good for us all.

Atlantic Salmon Images
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