

Sockeye in their bright red spawning phase in B.C.'s Adams River, a tributary of the Fraser and Thompson rivers

RED ALERT

B.C.'s wild salmon population is dwindling. What is going wrong and why?

By Kerry Banks

THE RIVERS OF BRITISH COLUMBIA USED TO RUN RED with salmon each fall. The spawning fish were so plentiful that it looked like you could walk from one stream bank to the other on their backs. Those days of stupendous abundance are long gone. Today, one of Canada's most iconic species is in a fight for its very survival.

In B.C. and Yukon, 121 stocks of migratory salmon and trout (a group of fish that spawn in close proximity to one another within the same species) have gone extinct in the last century, mostly due to urbanization and dams that eliminate spawning routes. Another dozen stocks are at a high risk of extinction. In the U.S. states (Washington, Oregon, Idaho) more than 100 stocks are now extinct, with another 200 at a high risk of extinction.

Of the five species of Pacific salmon — chinook, sockeye, coho, pink and chum — the population of the first three are all shadows of their former selves. Since the late-1990s, severe fishing restrictions have virtually eliminated all fisheries targeting coho and have radically restricted the harvest of chinook to the point where catches for these two species accounts for less than five per cent of the wild salmon harvest.

ALEX MUSTARD/NPL/WINDEN

TO GET A SENSE OF THE DRAMATIC DIVE in numbers in B.C., one need only look at the Fraser River sockeye fishery, once regarded as one of the largest in the world. Some historians estimate that as many as 100 million sockeye poured upriver at the turn of the century during the dominant runs that occur every fourth year. Yet with the exception of 2010, when 28 million sockeye unexpectedly returned, the returns have been dismal for the last decade. In 2016, the Fraser sockeye run was a mere 856,000, the lowest since estimates began in 1893. In 2017 it was only slightly better, at 1.5 million.

In response, the Committee on the Status of Endangered Wildlife in Canada stated in 2017 that Fraser River sockeye should be listed under Canada's Species at Risk Act. According to the committee's report, eight sockeye populations are endangered, two are threatened and five are "of special concern."

Generally, salmon are doing better in the north than in the south. Even so,

the sockeye run in the Skeena River, 970 kilometres north of Vancouver and second only to the Fraser run in importance, has also recorded historic lows in recent years, resulting in a complete shutdown of recreational fishing in the watershed. The Skeena used to average from two million to five million sockeye annually. Today the run is between 500,000 and 600,000.

What is causing the decline? "Overfishing, disease, pathogens from fish farms, habitat loss, the warming of the oceans. It's death by a thousand cuts," says Aaron Hill, executive director of the Watershed Watch Salmon Society, a science-based charity that advocates for the conservation of B.C.'s wild salmon.

Signs of trouble were already evident 20 years ago, which is why in 2005 the federal government, after five years of public consultation, adopted the Wild Salmon Policy, which was widely praised for giving prominence to conservation in decision-making. However, many pivotal aspects of the policy have not been put

into action. "Legislation has been slow and woefully inadequate," says Hill. "There has been a lack of political will to make it a reality."

The creation of dams and the industrialization of fishing certainly diminished the once majestic salmon runs, but gauging the factors involved today is problematic. Salmon are difficult to study because they move through very different environments during their life cycle, from fresh water to salt water and back again to fresh water. And the years they spend in the ocean are still a mystery to scientists. "Anything that happens along the coast and anything that goes on in the open ocean is like a big black box that we can't see into," says Scott Hinch, a professor of aquatic ecology and fish conservation at the University of British Columbia.

Yet despite the uncertainty about what goes on in the open sea, a few key themes are emerging that may help explain what is happening to Pacific salmon.

RISING TEMPERATURES

When asked to pinpoint the number one threat to salmon today, most experts offer the same reply. "Climate change is the most serious threat. It's obvious," says Hinch. "Temperatures have gone up by two degrees in the Fraser River. The oceans are warming, and there is greater acidification. Some salmon populations can't tolerate higher temperatures."

Higher water temperatures impair the survival rate of young salmon on their way to the sea and again when they return to spawn. "We call it the master factor," says Hinch. Even just a couple of degrees can prove lethal. During the fall sockeye run of 2016, the temperature in the Fraser River was 20.6 C, 2.5 degrees higher than normal at that time of year.

Research has shown that the swimming performance of migrating salmon weakens when water temperature hits 18 degrees C. Warmer temperatures increase a fish's metabolism, causing it to burn essential fuel at a faster rate, and warmer water also contains less oxygen. On their return from the sea, the salmon are not eating and are already exhausted as they fight through the rapids. In warm water, many simply won't have the energy to reach the spawning grounds.

The situation was recently exacerbated by a warm area of water in the Northwest Pacific dubbed "the Blob" which appeared in 2013 and remained for three years. Warm ocean temperatures deplete plankton food supplies and result in many juvenile salmon being devoured by invading predators, such as mackerel and sharks coming up from farther south.

Hinch expects salmon will start to shift northward in reaction to rising temperatures. "Just within the last decade, we have seen chinook and chum salmon appear in the Mackenzie River in the Arctic for the first time," he says.

HATCHING NEW PROBLEMS

In a bid to compensate for the impact of overharvesting and habitat loss, fisheries on the Pacific rim began to propagate salmon in hatcheries to bolster declining wild stocks, a strategy that one officer with the Department of Fisheries and Oceans

The upriver salmon migration is one of nature's most exciting dramas, but it is also a long, strenuous, desperate race against time with every obstacle taking its toll. For every 1,000 eggs a salmon lays, only one salmon will survive and return to its spawning grounds.

The excreta from some large salmon fish farms are estimated to equal the sewage produced by a city of 10,000 people.

Chum salmon (*Oncorhynchus keta*) eggs and alevins

A century ago, the Fraser River sockeye fishery was one of the largest in the world, with 100 million fish heading upstream each year. In 2016, the annual run was 856,000



Left, sockeye swarm the Adams River. Right, on the Skeena River at the beginning of the 20th century



VIA MOMATUUR 66; JOHN EASTCOTT/MINDEN PICTURES; PHIL SAVOIE/NPL/MINDEN PICTURES; SOTK2011/ALAMY STOCK PHOTO

HIROYA MINAKUCHI/MINDEN PICTURES



Purse-seine fishing for salmon, Clayoquot Sound, Vancouver Island, British Columbia

Salmon are now getting smaller, a side effect of a long-term lack of regulation by the government on net size and a deliberate targeting of the biggest specimens by fishermen. The result is the skewing of genetics in favour of smaller fish.

four- to seven-year cycles — means they have faster generation times and deal more readily with environmental changes. They hatch in the spring, move to the ocean as fry the same year, overwinter there, eat like gluttons and return home to spawn the next fall. In contrast, chinook, sockeye and coho spend more time in rivers where they are vulnerable to a host of dangers, including dams, industrial pollution, a sketchier food supply and higher water temperatures. Another unwanted consequence of the hatchery hordes is the straying of these “ocean ranched” salmon into wild salmon streams where they breed with wild stock. Says Peterman: “It degrades the fitness of the wild population. Wild salmon have a great deal of genetic diversity that enables them to respond to a variety of situations. Hatchery salmon have an impoverished genetic diversity. The survival rate of hatchery raised salmon is half that of wild salmon.” As well, the offspring of these fish may not have the “homing guidance system” of wild salmon. If interbreeding happens often enough, the genetic makeup of the wild stock may be altered, threatening its viability.

LOSING COUNT

Fisheries and Oceans Canada (DFO), the department responsible for salmon management, can't be blamed for global warming, but according to a 2017 study in the *Canadian Journal of Fisheries and Aquatic Sciences*, the department does get a failing grade for its monitoring efforts. The study notes that the number of streams being monitored by DFO on B.C.'s north and central coasts dropped dramatically from 1,533 streams in the mid-1980s to an all-time low of 476 streams in 2014 — a 70 per cent reduction. “As a result, we're now only able to assess half of wild salmon populations,” says one of the study's authors, SFU fisheries biologist Michael Price.

The process of monitoring spawning streams provides vital information on trends over time. Without such data, fisheries may continue to catch diminished populations. “In the past, monitoring was done by individuals who had been doing this job year after year for decades,” explains Price. “They would walk the entire system counting fish. These people are retiring and are not being replaced.

Fishery officials used to make decisions in real time according to what these people told them. Now it's all based on what happened last year.”

A rollback in monitoring is not the only area in which the department has come under fire. Critics see a clear conflict of interest in DFO's mandate to regulate the salmon-farming industry while it also promotes the industry and its products as debate rages about the potentially harmful effects of fish farms on wild stocks.

ON THE FARMS

Many conservation groups and First Nations fear that pathogens and sea lice are spreading from B.C.'s open-penned fish farms and infecting wild stock, especially in the Broughton Archipelago on the northeastern tip of Vancouver Island where salmon pass through a bottleneck en route to the open sea. There is also concern about Atlantic salmon escaping and competing with native species. One such jailbreak occurred in 2017, when high tides and currents

FLIP NICKLIN/MINDEN PICTURES



Sockeye salmon in the Adams River

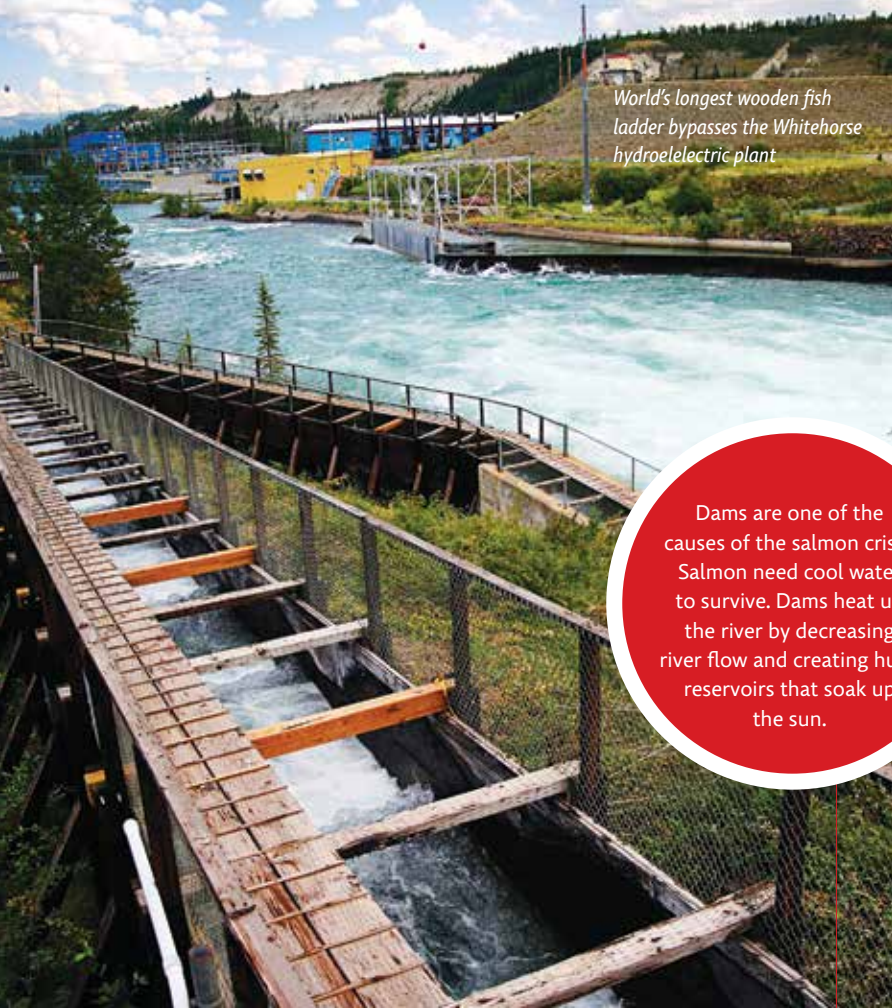
Chinook salmon are known to travel more than 16,000 kilometres in the Pacific Ocean before they return to spawn.

There are 24 distinct populations of sockeye that spawn on the Fraser River's tributaries. These populations are so well adapted to their spawning environment that if a species were to disappear from one tributary, it's unlikely that another one could be successfully reintroduced there.

What is causing the decline?
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“Wild salmon policy is all about assessing the status of our salmon runs and their habitat and then coming up with recovery plans for the ones that need them,” says B.C. conservationist Aaron Hill. “You can't do that without knowing how the salmon runs are doing.”

YVA WOIWATYUK/66 JOHN EASTCOTT/MINDEN PICTURES



World's longest wooden fish ladder bypasses the Whitehorse hydroelectric plant

Dams are one of the causes of the salmon crisis. Salmon need cool water to survive. Dams heat up the river by decreasing river flow and creating huge reservoirs that soak up the sun.

VIEW FROM THE LADDER

What a CWF project in Yukon will tell us about the state of salmon spawning

Just outside Whitehorse is the world's longest wooden fish ladder: 366 metres long and 15 metres high. It transports spawning chinook salmon past the Whitehorse hydroelectric plant. Here, amid the roar of the Yukon River, researchers with the Canadian Wildlife Federation are tagging fish, gathering data they hope will help solve the puzzle of the river's declining chinook salmon run.

The Yukon River boasts the longest salmon run in the world. About 100 spawning grounds are spread along its various tributaries in the Canadian portion of the river alone. The chinook that journey farthest upriver after exiting the ocean must swim 3,200 kilometres against the current to reach their home streams.

Before 1997, an average 300,000 chinook entered the Yukon annually. In 2013, only 37,000 fish returned. As a result, in 2014, and again in 2015, fishing for chinook was banned entirely on both sides of the Alaska-Yukon border, an unprecedented move. A modest rebound in 2016 and 2017 when 62,000 made it through to the spawning grounds has raised hopes, but some fishing restrictions still prevail.

In the past, 10,000 salmon were harvested annually upstream of Whitehorse, but in the past few decades only about 1,200 have been passing the dam. Fish continue from here to the spawning grounds and in some cases must still travel another 200 kilometres to reach their home streams. "We're trying to fill in gaps in knowledge on either side of the ladder," says senior CWF conservation biologist Nick Lapointe. "We are expecting that we will learn all of the places where chinook salmon spawn upstream of Whitehorse and what proportion of the population spawns where. We also hope to understand what proportion of the fish that approach the ladder pass it, how long this takes and whether delays at the ladder have any effect on migration success." — K. BANKS

caused pens to implode, releasing 300,000 fish from a Washington state farm near the Canadian border.

According to DFO's own data, Atlantic salmon have been found in 81 B.C. rivers and streams. However, Byron Andres, the department's senior biologist with aquaculture environmental operations, says there is no evidence of farmed salmon interbreeding with Pacific salmon or becoming established in B.C. waterways.

The question of what kind of negative impact fish farms may be having on wild salmon stocks remains unresolved, but there is no denying their economic impact. There are now 120 fish farms, holding 1.3 million fish, 90 per cent of which are Atlantic salmon. Virtually all these enterprises are Norwegian-owned, and most of the harvest is shipped overseas. In fact, farmed Atlantic salmon is now B.C.'s top seafood export, valued at about \$525 million per year.

The situation is a complete reversal from 30 years ago. In 1990, there were 18,000 tonnes of farmed salmon produced in B.C. and 100,000 tonnes of wild salmon harvested. Today, farmed salmon production is up to 80,000 tonnes, while the wild salmon harvest is down around 20,000 tonnes.

In June 2018, the B.C. government introduced new rules that may change the way salmon farming is done in the province. To get their fish farm licences renewed, companies will need to obtain consent from local First Nations, and DFO must also certify that the operation will pose no risk to wild salmon stocks. However, these rules won't take effect until 2022, reportedly because most of the sites have federal licences that won't expire until 2022. Adam Olsen of B.C.'s Green Party slammed the delayed time frame. "It's like surgeons announcing that starting in 2022 they are going to start washing their hands before procedures. This should have been the standard all along."

SWIMMING UP

Of course, the loss of wild stocks is much more than simply an economic question. Salmon are a keynote species, essential to the health of the ecosystem. When they die, their rotting bodies return valuable nutrients to river systems, and supply food for other animals and nitrogen for the soil. As David Montgomery writes in his book *King of Fish*, "Up to a third of the nitrogen in valley-bottom forests swam up the river

as a fish. Trees growing along salmon-bearing streams grow up to three times faster than those growing along salmon-free streams."

In the midst of this mood of spiralling doom, one looks for signs of optimism. Hope begins with the fish itself—it's a resilient species that evolves quickly, produces a multitude of offspring and maintains a diversity of populations. Evidence of how salmon can rebound with the proper support is clear in the revitalization of lost salmon streams such as Vancouver's severely polluted Still Creek, which saw a miraculous return of salmon for the first time in nearly 80 years in 2012. It has continued to host a salmon run each year since.

There is also the inspiring story of Okanagan sockeye. In the mid-1990s, this population, which must navigate past nine dams to reach its spawning grounds in the B.C. Interior, was near extinction. But thanks to the efforts of a coalition of groups, the sockeye are back with a bang. In fact, there are now so many sockeye in Okanagan Lake that DFO was recently able to open up a recreational fishery. There had never been one here before.

On a strategic level, Michael Price would like to see a transition away from

ocean mixed-stock commercial fisheries that catch salmon near a river's mouth toward terminal fisheries that catch the fish closer to their spawning stream.

"Interestingly, this was the system that had been used for several thousand years by First Nations on B.C.'s coast. We need to learn from the past if we want to be sustainable in the future," says Price. "This approach allows us to target only those populations considered abundant and enables depressed populations to escape fisheries and spawn in their natal streams."

Aaron Hill believes the building blocks for a salmon recovery are in place. "We have a strong Wild Salmon Policy; we have an excellent Water Sustainability Act and an improved new Fisheries Act. We need to get politicians to live up to the laws and regulations that are already on the books and restore lost protections."

If hope for recovery starts with salmon, it ultimately ends with people. From public surveys his organization has undertaken, Hill is convinced there is keen public support for improving the management of salmon. "People want salmon to be around because they feel they are an integral part of our cultural identity. Where there is a will, there is a way." 🐻

Salmon are vital in the food chain, with 137 species relying on them as part of their diet. Much like a canary in a coal mine, salmon play a key role as a biosensor: their health is an indicator of general ecosystem vitality.



Grizzly bear mother and a first-year cub feeding on salmon in the Chilcotin, B.C.