Wisconsin salmonids: past, present and future

Coho and Chinook Salmon

By John Lyons

This past summer, I visited Port Washington, which is on Lake Michigan about 30 miles north of Milwaukee. I was struck by how busy, vibrant and prosperous the harbor was. It was a beautiful Saturday, and there were sailboats and sportfishing boats everywhere. Families strolled on the breakwaters past numerous anglers. Expensive-looking condos lined the shore.

I tried to imagine what the scene would have been 60 years earlier. Then, Port Washington was a very different place. Commercial fisheries for lake trout, chubs and lake herring had largely collapsed and sport fisheries were negligible. The lake was overrun with alewife, an invader from the East Coast. Periodically, the alewife would die unexplainedly in vast millions, and the carcasses would wash ashore, covering the beaches in piles of stinking rotting fish. The smell was awful. No one wanted to visit the shoreline, and Port Washington and other Lake Michigan communities turned their back on the lake.

But now it was so different, and Port Washington clearly had once again embraced the lake. I swung by the fish-cleaning station near the marina. A crowd had gathered to watch the mate from a charter fishing boat fillet an impressive pile of bright silvery fish up to 20 pounds.

These were Chinook salmon. The Chinook salmon and its smaller cousin the coho salmon, species native to the Pacific Northwest, had fundamentally changed Lake Michigan since their introduction in the late 1960's. They helped bring alewife under control, allowing the recovery of native species, and they created a fishery that had become worth millions of dollars a year.

It's no exaggeration to say that Port Washington owed much of its current prosperity to these two fishes. Let's explore how the Chinook and coho salmon transformed Lake Michigan as well as their roles in Lake Superior and inland waters.

What are Chinook salmon and coho salmon? Distribution and life history

The Chinook salmon and the coho salmon are both native to the Pacific Northwest, found in rivers from central California north to Alaska and across to far eastern Russian rivers and throughout the North Pacific Ocean. Each species has many local names, but the Chinook is most commonly also known as the king salmon and the coho as the silver salmon. Both species are anadromous, spending the early part of their lives in freshwater rivers and then migrating to the ocean for an extended time to grow before returning to freshwater, usually the same river reach where they were born, to spawn and then die.

For both species, there's a lot of variety within that life history summary. Although reproduction is in the fall, actual spawning dates range from September to December depending on the location and strain of fish. Fish that reproduce in river areas not far from the ocean may enter just a few days or weeks before spawning, whereas those reproducing hundreds of miles inland may begin their migration months in advance. Other strains may enter their rivers while still immature and hold in deep pools for long periods before maturing and completing their journey to the spawning grounds much later. Larger river systems may have multiple strains, each arriving in the river, moving through it, and spawning at different times and places.

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JUVENILE SALMON AND RAINBOW TROUT
Naturally produced juvenile coho salmon (top), Chinook salmon (middle), and rainbow trout (bottom) from a small unnamed tributary to the Sheboygan River, Sheboygan County.

This variability continues with the next generation. Upon hatching, juvenile Chinook and coho salmon may stay in the river of their birth for six to 18 months and grow to a size of four to nine inches, depending on the strain. They then begin a physiological transformation called smoltification that turns their bodies bright silver and allows them to survive in saltwater. Soon thereafter the smolts move downstream to the ocean.

Again, depending on the strain, they may remain in the ocean for one to eight years, feeding and growing, before undergoing another physiological change that eventually turns their bodies from lightly spotted and silver to heavily spotted and dark brown or reddish and allows them to return to freshwater.

As they enter rivers to complete their reproductive cycle, the salmon are at their largest, with some strains of Chinook salmon potentially over 100 pounds and some coho potentially over 30 pounds. Salmon lose weight as they move upriver, both from the rigors of migration and because they largely cease feeding.

Reproduction

Chinook and coho salmon reproduce in areas of gravel bottoms with moderate current. Chinook salmon, being generally larger, tend to spawn in somewhat bigger rivers and deeper water and stronger current than coho, which may spawn in surprisingly small streams.

The process of spawning is complicated and dynamic for both species. Males compete for access to court the female, who chooses which male she will spawn with. Usually, she prefers the largest male, the "alpha," which, once chosen, tries to keep the smaller "satellite" males at bay. However, while the alpha is chasing away some of the satellites, other satellites may move in and try to court the female.

As spawning begins, the female digs a depression in the gravel known as a redd, where her eggs will be deposited. The alpha male and female line up over the redd and release the eggs and milt (sperm) simultaneously, maximizing the chance of successful fertilization.

During spawning, smaller satellite males sometimes dart in and try to "sneak" fertilization of a few eggs before being driven away. When the female has released all of her eggs, she covers them with gravel and guards the redd for a time from other females that may attempt to spawn in the same place, an issue if the spawning run is particularly large or suitable habitat is limited.

After spawning, the male and female salmon die. Their carcasses nourish the stream, providing food for a host of microorganisms, aquatic insects, other fish and a variety of birds and mammals, most famously bears. The microorganisms and insects end up being food for the young salmon, which hatch and emerge from the gravel the following spring.

In that way, the death of the parents benefits the survival and growth of their offspring. Nutrients from salmon work their way through the food chain and are incorporated into and improve the growth and survival of many of the plants and animals living along the river. If the salmon run is reduced by pollution or overfishing or completely eliminated by an impassable dam, the entire ecosystem suffers.

The origins and early days of Chinook and coho salmon in Wisconsin: The earliest days

Although we think of salmon as a relatively recent addition to the Wisconsin fish fauna, Chinook salmon were among the first fish non-native species stocked in the state.

The federal fish hatchery established on the Shasta River in northern California in the 1880's that was so important in the spread of rainbow trout also produced Chinook salmon eggs. These were shipped around the country and first arrived in Wisconsin about 1890.

They were stocked in Lake Michigan and many deeper inland lakes such as Mendota and Geneva with great fanfare and promises of valuable new fisheries. But as far as anyone could tell, no salmon were ever captured from any of these introductions.

Egg and newly hatched fry stockings continued sporadically until the early 1900's without success.

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NICE LAKE MICHIGAN CHINOOK OFF DOOR COUNTY
Kyle Piller, formerly of UW-Madison, with a nice Chinook salmon from Lake Michigan off of Door County.

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SPAWNING-RUN COHO FROM THE SIOUX RIVER IN BAYFIELD COUNTY

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FRESH 21-INCH COHO FROM THE SISKIWIT RIVER IN BAYFIELD COUNTY

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SPAWNING CHINOOK ON THE BOIS BRULE
Wisconsin DNR biologist Justin Haglund holding a spawning-run Chinook salmon from the Bois Brule River, Douglas County.

Coho fever

The origin of the current salmon populations in the Great Lakes started in 1964. At that point, fisheries managers were in despair over the state of Lake Michigan's sport fisheries. Howard Tanner, at the time the chief of Fisheries for the Michigan Department of Conservation (today's DNR), hoped to find a gamefish that might take advantage of the abundant alewife and decided to try stocking salmon again in the lake, this time coho salmon.

In 1964, he and Wayne Tody, who replaced Tanner as Chief of Fisheries in 1966 when Tanner moved to Michigan State University to become a professor, obtained more than 1 million eggs of an unspecified coho strain from Oregon. However, instead of stocking the eggs immediately, as had been done in the past, they had the eggs hatched and reared to a smolt size of 5-7 inches. Then the surviving fish, about 860,000, were stocked in 1966, 650,000 in Lake Michigan at the mouths of the Platte and Manistee rivers along the northwestern shore of the Lower Peninsula, and 210,000 in Lake Superior at the mouth of the Huron River along the north shore of the Upper Peninsula.

In 1967 more than 2 million additional coho smolts and 836,000 Chinook smolts, raised from eggs of uncertain strains obtained from Washington and Alaska, were stocked in the same areas of Lake Michigan and Lake Superior. Fingers crossed, Tanner and Tody waited to see if their stockings would work.

To say that the stockings were a success in Lake Michigan would be damning with faint praise. The results were stunning. With no predators to speak of and an almost unlimited prey base of alewife, the coho prospered beyond anyone's wildest expectations. In a mere 16 months many had reached 10-20 pounds, incredible growth, almost unheard of in their natural range. By late summer 1967, schools of large coho salmon cruised the shoreline.

The public quickly took notice, and "coho fever" began. Anglers streamed into Michigan from all over the country, choking the few boat launches available at the time. Fist fights broke out at crowded landings as novice anglers struggled to launch and pilot their crafts. Every motel room in northwestern Michigan was full, restaurants and bars were constantly busy, and tackle and boat stores throughout the region ran out of stock.

Despite usually having the wrong sorts of gear and minimal experience salmon fishing, most people caught fish. A gold-rush mentality quickly developed, and anglers frantic to catch coho took to the lake in all manner of boats, many completely inappropriate for big water, such as canoes and small rowboats and sailboats. This led to tragedy on September 23, 1967, when a sudden storm sank dozens of sportfishing vessels and drowned seven anglers.

Coho fever in Lake Michigan continued well into the 1970's. The chaos of 1967 diminished steadily as better launch and harbor facilities were built and anglers and manufacturers learned which boats and techniques were most appropriate. Chinook salmon also survived and grew well in Lake Michigan and eventually supplanted coho in popularity because of their larger size. Chinook over 20 pounds were common, and the largest fish reached more than 40 pounds.

In Lake Superior, stocking results were less dramatic. Here, alewives were scarce, overall lake productivity was lower, and some potential smolt predators, most notably lake trout and burbot, still remained. Coho and Chinook survival, growth and maximum size were noticeably lower. But, unlike in Lake Michigan, the coho and Chinook that did survive spread widely and began to reproduce successfully in many different Upper Peninsula streams.

Coho fever rapidly spread to surrounding states. The coho and Chinook salmon stocked in Michigan moved widely, and some showed up in Wisconsin waters. Once Wisconsin anglers started catching these fish, they clamored for more, and Wisconsin began its own coho and Chinook hatchery stocking program in Lake Michigan in late 1960's.

Lake Superior was stocked with both species soon thereafter. Successful salmon reproduction was minimal in Wisconsin's Lake Michigan tributaries, but in Lake Superior self-sustaining runs of coho and Chinook salmon became established in the Bois Brule River in Douglas County, and coho runs also developed in the streams of the Bayfield County, beginning in the early 1970's.

Because of the excitement generated by the Lake Michigan fishery, an effort was made to bring coho salmon into inland lakes. An experimental stocking program for coho salmon began in 10 small northern Wisconsin lakes in 1969. Two of these lakes, Pallette and Stormy in Vilas County, had detailed evaluations. The Pallette Lake stockings were unsuccessful, with poor survival and growth and almost no fish caught by anglers. Anecdotal angler reports also suggested that very few fish survived in the eight unevaluated lakes.

However, Stormy Lake had better results, with fish up to a pound produced after two growing seasons in the lake (compared to 10-20 pounds in Lake Michigan). Anglers caught and harvested many fish and liked the program. However, after three years of stocking, the Wisconsin DNR decided that the coho would be more valuable if stocked in Lake Michigan, and the inland lake coho program was ended.

The mature sport fishery

By the early 1980's, coho and Chinook salmon had become the cornerstone of the Lake Michigan sport fishery and associated shoreline economy, generating tens of millions of dollars in direct and indirect expenditures in Wisconsin and other Great Lakes states. The Wisconsin DNR made major investments in hatcheries and personnel to support salmon stocking and management.

Guiding and charter boat fishing became important occupations. Infrastructure associated with fishing and tourism such as docks and marinas, boat launches and fish cleaning stations, fishing tackle and boat shops, restaurants and bars, motels and resorts, grew to match a heavy demand.

The changes in the Lake Superior economy were not nearly as dramatic, but the new salmon fisheries were popular and benefited shoreline communities. However, the sailing was not all smooth, and several major challenges arose.

First, as delicious as they were, it became apparent that eating too many salmon might not be healthy. Testing revealed that salmon had elevated levels of microcontaminants, particularly polychlorinated biphenyls (PCBs). PCBs are a class of manufactured industrial chemicals long discharged into the Great Lakes. They can cause birth defects and neurological and developmental problems in young children and also are suspected of increasing the risk of cancer in adults. As the PCB problem became apparent, governmental agencies scrambled to develop safe fish consumption guidelines. A silver lining was that in response the public began to clamor for a stoppage and clean-up of many years of improper industrial dumping. Over time, PCB levels gradually dropped, and salmon slowly became safer to eat.

Second, as stocking ramped up and additional predatory sportfish species were added to the mix (lake trout, brown trout, and steelhead), alewife numbers began to drop in Lake Michigan, and salmon survival and growth declined. To bring salmon numbers more in line with the carrying capacity of the lake, the Wisconsin DNR and other state and federal resource management agencies around the lake proposed capping and even reducing stocking, which was not a popular idea. The fishing was still good and the fish still large, but it was not quite as spectacular as it had been, and some anglers began to grumble.

In the late 1990's, bacterial kidney disease (BKD) significantly impacted coho and especially Chinook populations. It took several years for improvements in hatchery practices to bring the disease under control and restore salmon numbers, further frustrating anglers.

Third and finally, the Lake Michigan ecosystem began to change dramatically as new invasive species disrupted the food web. In the 1980's, the zebra mussel entered the Great Lakes and carpeted the bottom of many nearshore areas. By the 2000's the zebra mussel had been replaced by quagga mussels, which further expanded onto the bottom in deeper areas. In the late 1990's, the round goby arrived and took over the bottom-dwelling fish community, displacing and reducing several native species.

*See **SALMON**, page 24*

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TROUT, SALMON COUNTNG WIER ON THE BOIS BRULE
The wier also serves as a lamprey barrier.

***SALMON**, from page 15*

The mussels filtered plankton from the water and the gobies ate bottom dwelling invertebrates, reducing food for young alewives and decreasing their growth and abundance.

Because coho and Chinook salmon fed mostly on alewives in Lake Michigan, any decline in alewives had a strong impact on salmon survival and growth. This was illustrated in Lake Huron. When the alewife population there collapsed there in 2003, never to fully recover, the salmon fishery soon foundered. Alarm grew that the same scenario could play out in Lake Michigan. Zebra and quagga mussels and round gobies also entered Lake Superior but never achieved the same wide distribution and high densities and had much less of an impact on the ecosystem.

Coho and Chinook salmon today: Lake Superior

At present, coho salmon remain an important component of the Lake Superior fishery. Anglers catch coho through the ice during the winter, trolling offshore during the summer, trolling or shore fishing river mouths in late summer, and by wading and casting during the spawning runs up tributaries in the fall. Runs are completely self-sustaining, and no coho salmon have been stocked in many years. Mature coho usually begin entering their spawning streams in early September (Photo 5). The run peaks in late September and early October and gradually tapers off until ending in mid-November, although in some years fresh fish may enter into December. Most spawning takes place far upstream in small tributaries and headwaters. The largest run is in the Bois Brule, where a counting weir tracks the total number entering the river each fall. Since 1990, the annual run has averaged about 2,200 fish, but has varied substantially, ranging from 1,001 to 5,674 per year. Spawning coho usually average 21-22 inches and 3-4 pounds, with an occasional fish up to 27-29 inches and 8-9 pounds.

The early life history of coho salmon has been studied in the Onion River and Whittlesey Creek in Bayfield County as well as in several tributaries in Michigan. Eggs hatch in early April and the juveniles remain in the stream for one or sometimes two growing seasons. Fingerlings inhabit pools and runs and feed on aquatic insects. Small coho are aggressive and will displace brook trout and brown trout of similar size. Once they reach about 4-5 inches later in their first summer of life, juvenile coho are commonly caught by anglers fishing for trout.

During the winter, Lake Superior juvenile coho remain relatively active and spread-out in pools, which contrasts with their behavior in their native streams on the West Coast, where they aggregate in backwaters, sloughs, or log jams and become notably less active and aggressive. The following spring, most juvenile coho drop down to Lake Superior at a size of 5-7 inches.

However, a few remain in the stream until the fall or the following spring when they leave for the lake at a size of 7-10 inches. They remain in the lake for one or usually two years before returning to their home tributary to spawn and die.

The Chinook salmon population in Lake Superior is much smaller than the coho population but also self-sustaining. No stocking has taken place since 2007. Because of their scarcity, the fishery is small, and the few fish that are caught are usually taken by anglers trying for something else. Chinooks typically enter their spawning streams a little earlier than coho, with their peak in mid-September. The Bois Brule River has the largest spawning run, but it only averages about 200 fish per year. Much smaller numbers enter Pikes Creek and the Sioux River in Bayfield County.

Spawning Chinook do not run as far upstream and spawn in bigger water than coho. The typical size of spawning Chinook is 25-32 inches and 6-12 pounds. The eggs hatch in early April, and the fry spend a relatively short time in the stream, usually moving down to the lake by early summer at size of 2-4 inches, although a few fish may remain in the stream until the following spring and leave at a size of 5-6 inches. Once in the lake they feed and grow for 3-5 summers, typically 4, before returning to the river of their birth to spawn and die.

Lake Michigan

Coho and Chinook salmon continue to be the mainstays of the Lake Michigan sport fishery today. Coho generally have a three-year life cycle in the lake, spending their first summer in the stream where they were born or, much more commonly, in a hatchery. They then usually spend two summers in the lake before returning during late September through early December to the stream of their birth or to tributaries near their release point from the hatchery to spawn and then die.

Limited natural reproduction occurs in a few small Lake Michigan tributaries in Wisconsin, but it is not nearly enough to maintain the fishery, and the vast majority of Wisconsin cohos are stocked.

More natural reproduction occurs on the Michigan side of the lake, but even there, most coho are of hatchery origin. Wisconsin collects eggs for its hatcheries from spawning coho entering the Kewaunee River in Kewaunee County and the Root River in Racine County. Fish raised from these eggs are stocked the following year at a size of 5-7 inches in tributaries and harbors from Kenosha to Kewaunee. About 400,000 to 500,000 coho are released into Wisconsin waters each year.

Once in Lake Michigan, cohos have a characteristic migration, aggregating in far southern Lake Michigan during the winter and then gradually moving north over the summer, before either returning south for the following winter or entering streams to spawn and then die. The fishery follows this migration, with cohos first being caught by anglers off Kenosha in May, gradually appearing further north over the summer and reaching Door County by mid-August, and then finally being encountered in tributaries in the fall.

Fish in their third year of life are typically 18-21 inches and 2-3 pounds when they first arrive off Kenosha but have grown to 24-27 inches and 5-7 pounds by the time they enter streams to spawn. The Wisconsin state record is 38 inches and 26 pounds 1.9 ounces and was caught off Milwaukee in 1999.

Chinook salmon generally have a longer life cycle than coho, usually 3-4 years, but sometimes 5. They also have a shorter residence time in the streams of their birth or the hatchery, moving to the lake or being stocked early in the summer of their first year of life at 3-5 inches. Natural reproduction in Wisconsin tributaries has a negligible contribution to the fishery in Lake Michigan but is observed occasionally.

However, natural reproduction has become major in several Michigan streams, and those Chinook migrate to Wisconsin waters each summer. Now half or more of the Chinook caught by anglers in Wisconsin during the summer are of natural origin from Michigan. These fish return to Michigan in late summer to spawn in the streams of their birth in September and October, so Wisconsin stocks about 800,000 to 1,200,000 Chinook each year in tributaries and harbors to enhance the summer offshore fishery and to insure a large spawning run into Wisconsin streams in the fall. Eggs for Wisconsin hatcheries are collected from spawning fish in Strawberry Creek near Sturgeon Bay in Door County. The typical size of adults in late summer as they prepare to enter tributaries to spawn is 30-35 inches and 10-20 pounds. The state record for Wisconsin is 47.5 inches and 44 pounds 15 ounces from off of Door County in 1994.

Management of the salmon fishery in Lake Michigan has become increasingly complex for fisheries managers. Chinook salmon are the most desirable sport fish in Lake Michigan because of their large size, superb fight and excellent taste. This has led to near constant pressure from anglers and shoreline communities to maintain and, if possible, increase the Chinook population in the lake, which is already the most numerous of Lake Michigan's trout and salmon.

Because of their high abundance and large size, Chinook are also by far the largest consumer of alewife, which is the primary food of all the trout and salmon in the lake. As alewife numbers have dropped in Lake Michigan, concern has grown among fisheries managers that predation from trout and salmon, particularly Chinook, might overwhelm and collapse the alewife population, as happened in Lake Huron. If that were to occur, the consequences could be dire for the trout and salmon fisheries and for the people and communities who rely on them for their livelihoods. But convincing anglers and shoreline communities to curtail Chinook stocking has been difficult and contentious.

The increasing natural reproduction of Chinook salmon in Michigan tributaries and of lake trout in the lake proper has made managing the total population of alewife predators even more complicated, as densities of these two gamefish are now driven to a large extent by uncontrollable and unpredictable natural forces rather than relatively controllable and predictable hatchery production and stocking quotas.

Alewife are still common in Lake Michigan, although their abundance is only a tiny fraction of what it was in the 1960's and their numbers fluctuate dramatically from year to year in response to natural variation in spawning success. Managers worry that if Chinook numbers surge too high due to an especially good year of natural reproduction while alewife simultaneously drop low due to particularly poor reproductive success, elevated Chinook consumption could crash the depressed alewife population and doom the Lake Michigan fishery.

The future of coho and Chinook salmon

For the moment, coho and Chinook salmon are doing well in Wisconsin's Great Lakes, but the future is uncertain. Sharp declines in the coming years are certainly plausible. Both non-native species and climate change could have major negative impacts. In Lake Superior, warming lake temperatures could make the lake more hospitable for some of the non-native species that have so modified the food web of Lake Michigan, particularly quagga mussels and round gobies.

The main foods for coho and Chinook in Lake Superior are non-native rainbow smelt and native ciscoes. If quagga mussels and round gobies become more common, both smelt and ciscoes are likely to decline, making for less available food and resulting in slower growth and poorer survival for salmon. Warming will also reduce suitable spawning habitat in the tributaries, although projections suggest that some will remain at least through the middle of this century. But if climate warming continues unabated, this remaining habitat will eventually disappear, and with it the salmon.

In Lake Michigan the big question is whether trout and salmon prey consumption, particularly by Chinook, can be balanced against large annual variations in alewife abundance. So far, consumption has not exceeded alewife production, but it may only take one bad year for alewife for the situation to get dicey. And as weather conditions become more variable with climate change, alewife reproduction and population fluctuations are likely to be more extreme.

The specter of new non-native species, such as Asian carp, entering Lake Michigan and further disrupting the food web makes the situation even more fraught with risk. Ideally, management agencies would be allowed to take a precautionary approach and substantially reduce salmon and trout stocking to leave a bit of a cushion for the alewife, but this has been a hard sell with fishing groups, shoreline communities and the Wisconsin state legislature. Whether agencies can continue to walk the tightrope between public pressures and ecological realities to maintain a vibrant salmon fishery remains to be seen.

Conclusions

Coho and Chinook salmon, introduced into Wisconsin in the 1960's, have become the key game fishes in Lake Michigan and an important component of the sport fishery in Lake Superior.

At present, both lakes support fine salmon fishing, which in turn provides important social and economic benefits for both local communities and the state as a whole. But management of these two species is complicated by major recent and anticipated future changes in the Great Lakes ecosystem driven by non-native species invasions and climate change, and the future of the salmon fishery is by no means assured.

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