Wisconsin salmonids: Past, present and future

Brown trout: An import from other countries, but an important fish to anglers.

Words and photos by John Lyons

Brown trout present an ultimate challenge for trout anglers. An import from Europe, it is to many the most desirable of the Wisconsin salmonids, but to some an interloper ("spotted carp") which has replaced their beloved native brook trout. Regardless of how you feel about the brown trout, it has had a huge effect on the trout streams and fisheries of Wisconsin. It is the most numerous and widespread trout in southern and central Wisconsin and common in many areas of northern Wisconsin. It is able to thrive in streams where other salmonids often cannot, and it persists and can grow to large size, even in the face of high fishing pressure.

Brown trout are demonstrably the wariest and most difficult to catch of all of Wisconsin's stream trout, and their devotees spend countless hours and many dollars in pursuit. Occasionally, the fishing can seem almost impossible, but then on special rare days the fishing gods smile, and, if you have reasonable skills, nearly every good cast is rewarded with a strike. Most outings are of course somewhere between these extremes. But the appeal of brown trout is that each time you go out, you can never be sure which kind of a day you'll have.

The past: A new fish for Wisconsin

The brown trout is native to much of Europe, western Asia and a small part of North Africa. It is a highly variable species in terms of appearance, behavior, life history and potential size. Some forms are adapted to spend their entire lives in small streams, whereas some occupy lakes as adults and enter streams only for spawning, and some run to the sea like salmon. Most forms primarily eat insects and other invertebrates, and some lake dwellers focus on tiny zooplankton, whereas others mainly eat fish. Each form looks a little different, and Europeans have given many of them their own colorful common names such as Ferox or Gillaroo.

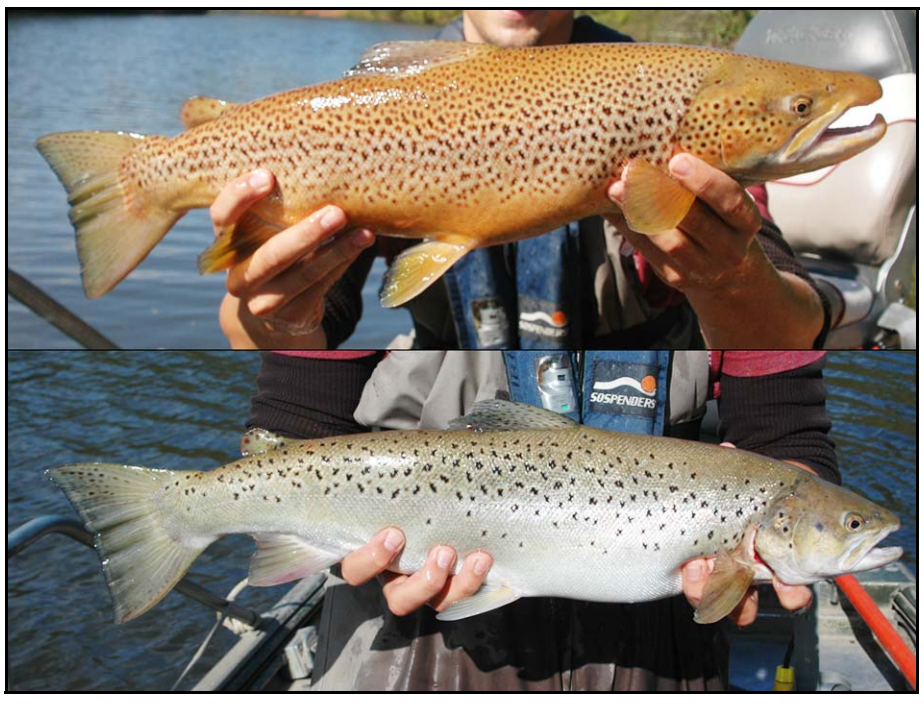
The brown trout first arrived in the United States in 1883. Fred Mather, a well-known early fish culturist, had journeyed to Germany and become enamored of the brown trout he encountered in Bavaria. He arranged for a shipment of brown trout, in the form of fertilized eggs, comprised of 20,000 bachforelle, German for "brook trout," a stream-dwelling insect-eating form of the Black Forest, and 60,000 seeforelle, "lake trout," a larger fish-eating form found in the lakes of the Alps. These eggs were sent to federally run hatcheries in New York State and northern Michigan, where they were hatched and raised for a year. The first official stocking in the U.S. took place in the Pere Marquette River in Michigan, a Lake Michigan tributary, in 1884.

Soon brown trout stockings were being made throughout the country. Wisconsin received its first 1,000 brown trout eggs at the Bayfield Hatchery on the shores of Lake Superior, and the first stockings took place in 1887 in northern Wisconsin streams. In 1884, eggs from brown trout from Loch Leven, Scotland, arrived in the U.S., and they were raised in Wisconsin hatcheries and stocked in Wisconsin waters by the 1890's. By the early 1900's, all the major river systems and both Great Lakes in Wisconsin had been stocked with some form of brown trout.

Wisconsin brown trout strains

The German and Scottish brown trout looked different, with the German fish tending to have many red spots intermingled among black spots of a range of sizes, and the Scottish fish usually lacking red spots and having mainly relatively large black spots. Anglers in the late 1800's and early 1900's often distinguished between the two forms and identified the fish they caught as either "German browns" or "Loch Leven browns" based on spotting patterns. Even today, some anglers speculate about which type they've caught. However, both the German and the Loch Leven fish were routinely crossbred in hatcheries and were mixed in the wild soon after they arrived in the United States, and interbreeding appears to have eventually eliminated any "pure" types in Wisconsin waters.

What is interesting is that in Wisconsin Lake Superior tributaries such as the Bois Brule River in Douglas County and the Sioux River in Bayfield County, "resident" brown trout that remain in the river their entire lives differ genetically from "lake-run" brown trout that spend much of their adults lives in Lake Superior. Could this reflect the initial stocking of both the bachforelle (resident?) and seeforelle (lake-run?) forms? The problem with this idea is that there appears to be little genetic difference between bachforelle and seeforelle in their native Germany. But large genetic differences may arise relatively quickly when new populations are established from a small number of adults, which undoubtedly was the case with the first brown trout eggs that reached Wisconsin.



VARIATIONS IN LAKE-RUN BOIS BRULE BROWN TROUT
Two lake-run browns from the lower Bois Brule River during their spawning run, showing some of the variation in coloration and spotting patterns.

NAMEKAGON RIVER, A CLASSIC NORTHWOODS BROWN TROUT STREAM

It would be fascinating to use modern genetic methods to look at different Wisconsin populations and try to derive their ancestry from the various European forms. A recent study examined Lake Michigan and Lake Superior browns in Michigan and Wisconsin and found evidence of German and Scottish heritage but also some indication of genotypes from Denmark and the French Pyrenees. This finding suggests that the origins of Midwestern browns are more complicated than we thought.

Browns versus brookies

It is fair to say the brown trout saved Wisconsin trout fishing in the early 1900's. Browns were able to survive and even thrive in streams where brook trout had been eliminated, and many parts of southern and central Wisconsin would have had few trout if not for browns. This was not because brown trout could tolerate more extreme warm temperature or lower dissolved oxygen concentrations than native brook trout as some fishery biologists and anglers have assumed. Both laboratory and field studies demonstrate that temperature and oxygen tolerances are similar for both species, although brown trout do prefer and grow better at slightly warmer temperatures than brook trout.

What the brown seems to have been able to do was handle habitat degradation better, particularly sedimentation. Widespread poor agricultural and timber harvest practices in the late 1800's and early 1900's had led to massive erosion that choked streams with sand and silt. Brown trout were not immune to these impacts, but they were better able to deal with them than brookies. As stream pools filled and rocky substrates were covered by sediments, brook trout disappeared but brown trout often could hang on.

Brown trout also have more flexible spawning requirements. Brook trout need areas of strong groundwater input, which disappeared as the water table dropped from poor land use and former spawning areas were covered with silt. Brown trout like strong groundwater areas too, but they aren't as dependent on them, and they could often spawn in the gravel riffles that remained even after the groundwater areas were largely eliminated.

Brown trout were also harder to catch than brook trout and persisted in the face of fishing pressure that would have decimated brook trout populations. The difficulty in catching browns made them unpopular at first. The techniques used for brook trout often didn't work nearly as well on the more wary browns. Some anglers complained that they couldn't catch the new arrivals and lobbied for more stocking of brook trout and less of brown trout. But other anglers embraced the challenge and developed new approaches to catch the browns. As these new approaches become well-known and widely available, the clamor against brown trout subsided and eventually largely disappeared.

Another reason for their acceptance was that brown trout grew much larger than brookies in most streams. Whereas a typical adult brook trout in an inland stream might be only about 8-10 inches, an adult brown trout could easily be twice that. Many anglers were drawn to the possibility of a trophy brown trout referred to in pounds rather than a brook trout referred to in inches. Eventually, some anglers came to prefer brown trout to brook trout.

However, the dislike of brown trout among other anglers never completely faded out, in large part because in many instances brown trout displaced brook trout. The reasons for this aren't completely clear. Some experimental studies show that brown trout are more aggressive and able to chase brook trout away from the best feeding and resting areas. But other studies show that among fish of the same size there is little difference in competitive abilities between the species or even that brook trout may sometimes be able to outcompete brown trout.

I speculate that the dominance of brown trout in many Wisconsin streams may lie in their faster growth rates and larger ultimate size compared to the brook trout. At water temperatures from the 60's to the low 70's, which is typical of

many Wisconsin trout streams in summer, brown trout grow faster and reach a larger size than brook trout. This size difference may give browns an advantage in competitive interactions. Generally speaking, larger trout dominate smaller trout in experimental studies and field observations. Browns that grow larger than a foot or so also become a predatory threat to brook trout, further contributing to their advantage.

Whatever the reasons, introduced brown trout have often replaced native brook trout, even in streams that otherwise remained suitable for the brook trout. Only in the coldest waters, where brown trout have less of a growth advantage, in tiny headwaters, where the larger size of brown trout may actually be a disadvantage, and in areas of northern Wisconsin with particularly long and cold winters, which brown trout may not tolerate quite as well, have brook trout consistently been able to hold their own.

Brown trout distribution

By the mid 1900's, brown trout were widespread on the Wisconsin landscape. They were found in hundreds of inland streams throughout the state, and resident and lake-run populations were established in the Lake Superior basin. Stocking was extensive, but many self-sustaining populations were also present. However, despite many early stocking attempts, brown trout remained essentially absent from Lake Michigan until only about 50 years ago.

Unlike in the state of Michigan, where self-sustaining lake-run populations had developed by the early 1900's, few if any browns were found on the Wisconsin side of Lake Michigan before the mid 1960's. This was because Wisconsin tributaries were too warm for successful spawning and rearing of young. But by the mid 1960's, Lake Michigan was a very different place than when brown trout had first arrived in the late 1800's. The lake's native top predators, lake trout and burbot, had been devasted by overfishing and non-native species, especially the parasitic sea lamprey. With few predators, populations of the non-native alewife, a small herring species that became established in the 1950's, exploded and reached tremendous numbers.

To take advantage of this resource, the state of Michigan, quickly followed by Wisconsin and other Great Lakes states, began stocking coho and Chinook salmon, steelhead (rainbow trout), and once again brown trout in Lake Michigan. With potential food everywhere and little competition, these stocked fish thrived and quickly grew to very large sizes, creating a tremendous fishery. Brown trout never became as popular or numerous as the salmon or steelhead, and they never reproduced successfully in Wisconsin's portion of Lake Michigan, but their continued stocking created a valuable nearshore trophy fishery, particularly in harbors and bays.

The present: Current status

Today, brown trout are common statewide. Rough estimates are that there are about 4,000 miles of inland streams with completely or largely self-sustaining populations and another 3,500 miles with populations maintained mainly or completely by stocking. These streams encompass the largest and most storied trout fisheries in the state. Lake Michigan has only stocked populations. Lake Superior has several self-sustaining lake-run populations in the larger tributaries, although some stocking also occurs.

Brown trout in Lake Superior tributaries have two life histories. There are resident fish that never leave their tributary system even though they could. These fish reach a typical maximum size of 2-3 pounds and their life cycle is like that of browns in inland streams. In contrast, lake-run fish are born and spend one or sometimes two (rarely three) years in the same tributary as the residents. But they then migrate downstream to the lake where they live for one or usually two years before returning to spawn in that same tributary at age 3 or 4. At this point they usually weigh 4-8 pounds.

The spawning run of lake fish in the Bois Brule River begins surprisingly early compared to resident and inland populations. Lake-run spawners first appear in July, peak in August and early September, and wind down in October, just as spawning is beginning in inland streams. Lake-run fish are capable of returning to Lake Superior for another year or two, reaching a weight over 10 pounds, and then spawning again, but relatively few survive the rigors of their first spawn, and repeat spawning is relatively uncommon.

ELK CREEK IS A CLASSIC DRIFTLESS AREA BROWN TROUT STREAM

VARIATIONS IN DRIFTLESS BROWN TROUT

Two inland brown trout from the Driftless Area, showing some of the variation in shape and mouth size that exists. Top: Trout Creek, Iowa County; Bottom: Sugar River, Dane County.

Stocking

Stocking practices for brown trout have changed over the last 30 years. Prior to the 1990's, brown trout stocking in inland waters was almost exclusively of the domesticated "St. Croix" and "Wild Rose" strains, named after the Wisconsin hatcheries where they were first developed in the 1950's and 1960's. These strains could be efficiently raised in large numbers to catchable size and could handle well the rigors of handling and transport to the stocking site, but their long-term survival in the wild was often poor.

In the early 1990's, the Wisconsin Department of Natural Resources began experimenting with rearing eggs taken directly from wild self-sustaining populations and stocking the resulting offspring. Although they were more difficult to rear and did not reach as large a size in the hatchery, these "wild" stocked fish did much better than the domestic fish in streams. Indeed, they sometimes established a self-sustaining population in places where previously the domestic fish had supported only a short-term "put and take" fishery.

Eventually, culturing of "wild" brown trout became widespread in DNR hatcheries, and stocking began to incorporate a mix of wild and domestic fish. For a given amount of money, space and effort, the domestic fish could be raised in larger numbers and to a larger size, but the wild fish survived much better once stocked. Currently, streams in which the goal is rehabilitation of a population tend to receive wild-fish stockings whereas those that have inadequate conditions for natural reproduction or that have high fishing harvest early in the season tend to get domestic fish.

Brown trout stocking in the Great Lakes has also changed. In 1991, the DNR began stocking the "Seeforellen." Although originally derived from fish from the same area of Germany as the initial seeforelle stockings of the 1800's, the modern Seeforellen is a semi-domesticated strain developed in the United States. Compared to existing domesticated strains, Seeforellen have the desirable quality of tending to stay in the lake for one or two years longer before migrating into tributaries or nearshore areas to spawn and consequently can reach a larger size. Seeforellen also migrate for spawning later in the fall, extending the nearshore fishing season into the early winter.

Seeforellen are cultured like "wild" inland stocked fish, and each fall DNR crews collect eggs from Seeforellen adults running out of Lake Michigan and then raise the offspring to fingerling size at a hatchery until stocking the following year. In recent years, nearly all the brown trout stocked in Lake Michigan have been Seeforellen.

Initial Seeforellen stockings went well and contributed to a popular fishery. But by 2000, stocked trout survival and angling success began to drop precipitously. The declines were lake-wide but were particularly acute in Green Bay. It remains uncertain what the cause was, but possible explanations include a major decrease in alewife abundance, fundamental shifts in the lake food web caused by the proliferation of non-native zebra and quagga mussels, and in Green Bay, a large increase in potential predators such as muskellunge, walleyes and smallmouth bass.

Efforts were made to improve survival of newly stocked Seeforellen in Green Bay by acclimating them to the lake in net pens before release or by stocking them offshore to avoid nearshore predators. However, results so far have been equivocal, and brown trout populations in Lake Michigan remain down from their 1970's-1990's heyday. But the remaining fish are large, and the state record brown trout, a 40.6-inch, 41.5-pound monster was a Seeforellen from Lake Michigan caught in 2010.

Stocking of Seeforellen browns has also occurred in Lake Superior despite the presence of self-sustaining lake-run populations.

*See **BROWNS**, page 24*

LAKE-RUN SEEFORELLEN BROWN TROUT

A lake-run Seeforellen brown trout from the mouth of the Oconto River near Green Bay.

***BROWNS**, from page 27*

The logic has been that Seeforellen might produce larger fish. However, a recent genetic analysis in Chequamegon Bay indicated that Seeforellen survival was relatively low and that most brown trout that anglers caught in the bay had been produced naturally in the nearby Sioux River and other tributaries. The latest Seeforellen stockings have focused on the western end of the lake near Duluth-Superior, where lake-run fish are scarce.

The future: Threats on the horizon

At the moment, brown trout distribution and abundance in Wisconsin's inland waters are probably as high as they've ever been. Years of improved land use, intensive in-stream habitat improvement, better fisheries management and the incorporation of "wild" strains into stocking programs have expanded the range of brown trout and increased natural reproduction and abundance in many streams. Unfortunately, however, we may be at the high-water mark for the species. Two major threats are looming: Poor land-use and climate change, and these may soon cause sharp declines in brown trout numbers.

Too much manure

Although there have been substantial improvements in agricultural practices over the last 85 years, in some ways we are now moving in the wrong direction. The widespread consolidation of cattle, hog and poultry rearing, culminating in massive Concentrated Animal Feeding Operations CAFOs), has led to huge volumes of manure that need to be stored and ultimately disposed of. Storage facilities, often excavated lagoons or large containment vessels, have a disturbing tendency to leak or fail. Because manure is largely liquid, it runs downhill when it escapes and too often ends up in the nearest stream. Once in the stream, chemical and biological processes break down the manure, producing toxic chemicals such as ammonia and using up the dissolved oxygen in the water. The result is dead trout and other fishes and aquatic invertebrates.

Many livestock producers spread their manure on their crop fields as a fertilizer. While this is good use in concept, in practice sometimes too much manure is spread or the spreading occurs just before snowmelt or a heavy rain, again resulting in runoff to streams and fish kills. Excessive spreading on sandy soils or areas of shallow limestone bedrock, which encompass much of Wisconsin, can also lead to contamination of the groundwater and drinking water wells with nitrates.

Efforts to develop "digesters" to convert the manure into natural gas show promise to reduce impacts. But at present digesters have formidable up-front costs to install and a steep learning curve to operate efficiently and economically, hindering their adoption by many livestock producers. We can only hope that the costs come down and more effective operating procedures are developed going forward.

Alternative livestock rearing practices such as intensively managed or rotational grazing, also known as regenerative agriculture, are far better for the health of the land and streams and are gaining adherents, particularly in the Driftless Area. But they represent a fundamental change in operations that many producers are reluctant to embrace without more information and incentive. Thus, there are alternatives to the unacceptable status quo for manure management, but whether these will be widely adopted remains to be seen. And until manure management is improved, trout streams in agricultural areas will be under constant threat.

Suburbanization

Urban sprawl is another serious challenge for Wisconsin trout streams. Occurring on the margins of the larger cities in the state, sprawl often happens at the expense of agricultural lands. Given all the problems with manure management, maybe this is a good thing? Unfortunately, the answer is no. On a per-acre basis, urbanization, or perhaps more appropriately, "suburbanization," has an even greater negative effect on trout streams than farming.

The biggest problem with urban sprawl is altered stream hydrology. The houses, commercial buildings, sidewalks, driveways, roads and parking lots that are constructed as an area is developed are all types of "impervious surfaces" that don't allow rainfall or snowmelt to soak into the ground to replenish the groundwater. Instead, water is repelled and runs off, usually into a ditch or storm sewer where it is transported quickly to the nearest stream. This runoff also carries the fertilizers and pesticides from our lawns and the oils and chemicals that get spilled on our driveways, streets and parking lots.

Although rapid drainage is good for moving water away from buildings and roads, it is bad for streams. As development and runoff grow, the frequencies and severity of floods increase to the detriment of trout, their habitats and the aquatic insects they feed on. More ominously, the reduction in the amount of water soaking into the ground leads to a lowering of the water table and a decrease in stream flows. During droughts, streams may dry up or get too warm for trout.

It doesn't take a "concrete jungle" for urbanization effects to occur. Suburban development of less than one third of a watershed can cause problems for trout streams. There are building and drainage practices that lessen urbanization's effects, but they usually make development more expensive and may not be practical in some settings and so often aren't employed. Continued expansion of our urban footprint is likely to lead to the decline and even demise of the trout streams adjacent to our cities.

High-capacity wells

Both farming and urban development require large amounts of water, in agricultural areas for irrigation of crops grown in sandy soils and for watering livestock, and in suburban areas for household and commercial uses. Much of this water demand is met by high-capacity wells drilled into the shallow aquifer. As farming becomes more intensive and urban areas have expanded, the number and size of these wells has increased. Heavy pumping by these wells can deplete the local water table, particularly during droughts. A depleted water table leads to reduced stream flow and warmer water temperatures, neither good for trout. In some cases, heavy pumping has caused small trout streams to dry up temporarily, and fish kills have occurred.

A warming planet

Agricultural and urban impacts are bad enough, but the biggest threat to inland trout streams statewide is climate change. Although the numbers aren't as dire as for brook trout, the latest projections are that Wisconsin brown trout stream habitat will decline by 33 percent by mid-century without intervention. And if the root cause of global warming, rising concentrations of greenhouse gases such as carbon dioxide and methane in the atmosphere, isn't addressed, habitat losses will continue and likely accelerate as we approach 2100.

As I covered in more detail in the brook trout article in the last issue of Wisconsin Trout, the most important order of business is to reduce greenhouse gas emissions and to manage the oceans and the land to better absorb existing gases. This must be a global process. But at a local level, groups like Trout Unlimited can advocate for watershed land-use and stream-management policies that protect and enhance resilience to the warmer and more variable climate of the future.

Suitable water temperatures in Wisconsin trout streams are maintained primarily by groundwater inputs and to a lesser extent by sun exposure and shading. Foremost to protecting groundwater are land-use practices throughout the watershed that enhance the absorption of precipitation into the ground to recharge the water table. This can be accomplished by minimizing impervious surfaces and directing runoff to wetlands and other areas of natural vegetation and to rain gardens and other constructed infiltration zones. Many local, state and federal programs provide information about and support for proven practices that protect groundwater. These same practices can also help offset impacts from urban sprawl.

Reducing sun exposure and increasing shading is tricky. Constant shade keeps water temperature cool but also blocks light to the understory vegetation, often leading to bare banks, greater erosion, reduced habitat quality and tougher fishing. Many current habitat improvement practices are effective for trout but reduce shading. This will be problematic as air temperatures climb. New and innovative techniques need to be developed to balance in-stream habitat needs with protection from rising temperatures.

What about the Great Lakes?

Future climate change effects on Great Lakes brown trout remain unclear. The Great Lakes are huge, and even under mid-century climate conditions they should retain plenty of water cold enough for trout and salmon. Of course, if greenhouse gases continue to increase unchecked, then eventually the Great Lakes will become too warm. But within our lifetimes, they should have suitable thermal habitat. The big question is, will the Great Lakes food web continue to support trophy fish?

Trout and salmon stocking of Lake Michigan is massive, with many millions of fish stocked per year. There are serious concerns that this annual input of predators might overwhelm the prey base, as appears to have already happened in Lake Huron. Trout and salmon in Lake Michigan feed primarily on alewife, but alewife numbers are now only a small fraction of their 1960-70's peak. Some of the alewife decline has been driven by predation but changing ecosystem dynamics have also played a role. The invasion and rise to astronomical numbers of first zebra mussels and now quagga mussels have shifted lake productivity from the water column to the lake bottom and decreased the abundance of the zooplankton on which the mid-water alewife feed. How a warming climate will affect the future interactions between mussels, zooplankton, alewife and trout and salmon is hard to predict.

Lake Superior may be less threatened by climate change than Lake Michigan, at least in the short term. Projections indicate that major tributaries like the Bois Brule and the Sioux will continue to have water cold enough for trout, although the total amount of suitable stream habitat will drop. The lake itself is currently too cold to be ideal for brown trout growth in offshore areas, and it's plausible that a warming climate might actually increase brown trout habitat in the lake over the next 30-40 years. But again, the big unknowns are how warmer water will affect the food web of the lake and if the changes will help or harm brown trout.

Conclusion

The brown trout has gone from a newly introduced species with a contentious reputation to the most widespread and abundant salmonid in Wisconsin's inland waters and an important trophy species in the Great Lakes. At the moment, brown trout are generally doing well and support very popular and valuable fisheries statewide. But dark clouds are on the horizon, and without active and targeted conservation measures, brown trout numbers are likely to decline in the future, perhaps precipitously.

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