Michigan's Fisheries
200 Years of Changes

A special report from the Huron River Watershed Council **ISSUED: 2014**

Michigan boasts 11,000 lakes, 36,000 miles of streams and rivers, and is surrounded by the largest system of freshwater lakes on Earth. Over the past two hundred years, European settlers and their descendents have done much to alter these natural systems and the creatures that inhabit them.

In this special report, Paul Steen, HRWC Watershed Ecologist, examines how humans changed fish diversity and abundance in Michigan since 1830 through greed, stewardship, ignorance and intention.

Sturgeon line the docks in this late 19th century photo. Sturgeon were initially killed and wasted, and later harvested to near extinction.
source: Public Domain, Freshwater and Marine Image Bank

1830-1873: A History of Abuse

In the 1830s, many immigrants settled in Michigan and set up homes, farms, and villages. Resource extraction from the land and water defined this period as the settlers worked hard, used Michigan's natural resources, and thrived. Iron, copper, timber, and fish were in plentiful supply.

During these early times, Michigan's fisheries seemed inexhaustible. Lake whitefish was deemed as "one of the highest quality food fishes ever discovered throughout the world" and it "rivaled the great forest of white pine or the buffaloes on the western plains." However, commercial fishing quickly depleted the abundant fisheries of early Michigan as the industry grew in the Great Lakes and major rivers. The Michigan Department of Natural Resources (DNR) Fish Division has estimated that at least 1.2 billion pounds of fish (whitefish and others) were taken from Lakes Superior, Michigan, and Huron from 1830-1890. As catches declined, the fishing industry developed new exploitive nets, gear, and techniques to keep the catch high. Other non-target species, known as "bycatch", suffered as a result.

A standard practice for fisherman was to destroy bycatch by dumping these fish on land or purposely injuring them and dropping them overboard to die. The sturgeon became the "poster child" of this pointless waste. In 1973, former DNR Fish Division Chief Wayne Tody wrote, "Today, we deplore the slaughter of the passenger pigeon, the American bison… But very likely, no single animal was ever subjected to such deliberate wanton destruction as was the lake sturgeon."

Lake sturgeon are very large (fifty pound fish were common, and many reached a length of nine feet). The bony plates covering the sturgeon would get entangled in fishing nets and tear the webbing. Also, as the sturgeon is a bottom feeder, fishermen mistakenly thought that these fish ate the young of the more valuable species. For these reasons, fisherman saw the sturgeon as a nuisance species and often killed them just to get rid of them. They piled the fish in long rows on shore and burned them and, because of the sturgeon's high fat content, they also burned the carcasses in boat boilers.

By 1860, a market for a whole variety of sturgeon products took hold, transforming sturgeon from a nuisance species to a commodity prized for its hide, meat, and roe (caviar). This market took the sturgeon out of the frying pan and put it into the fire and, in just two generations, the sturgeon of the Great Lakes would be harvested near to extinction.

Today the sturgeon can still be found. But it is a state-listed threatened species and a federal species of concern. Federal and state scientists have had

some success in protecting and building the sturgeon population by creating sturgeon habitat in Lake Erie and Lake St. Clair.

1873-1929: The Beginning of Fisheries Management — Stocking

Spurred on by a need to more carefully manage the resource, in 1873, the state government started the precursor of the Michigan DNR Fish Division – the Board of Fish Commission. The Commission's first responsibility was to "select a suitable location for a State fish-breeding establishment, for the artificial propagation and cultivation of White Fish and such other kinds of the better class of food-fishes as they may direct."

Commercial fisheries harvested over a billion pounds of lake fish from the Great Lakes in the late 1800s. source: Public Domain, Freshwater and Marine Image Bank

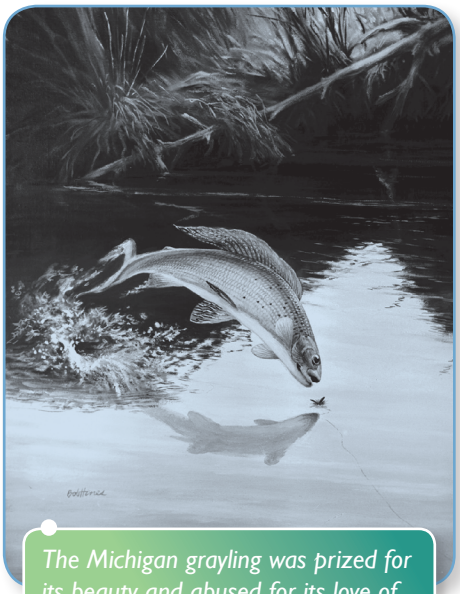
By 1890, after 20 years of attempting to revitalize the commercial fishery through rearing and stocking, the Fish Commission knew that their efforts were on a "break even" level. Whitefish commercial fisheries still existed, but the catch was very low and many of the fishermen could not earn enough to stay above the poverty level. With no regulations in place, the fishermen were keeping everything they caught despite size, and the fish stocked by the Fish Commission were not given enough time to mature and reproduce.

In 1897, the Fish Commission attempted a political route to fight depletion. However, the state legislature did not allow it to place limitations on the number of fisherman, the amount or type of gear, or even total catch. In addition, the state legislature questioned the Commission's effectiveness and cut its budget in half. Eventually the full budget was reinstated, but the legislature told the Commission that it could no longer allocate money toward the rearing and stocking of commercial fish. The fish rearing operations in Detroit were abandoned. After the turn of the century, under considerable pressure from commercial fishing enterprises, the federal U.S. Fisheries Commission began to operate these empty facilities – but the state government was officially done with assisting the commercial fishing business.

The Commission, with their days managing Great Lakes commercial fisheries behind them, began to invest more heavily in inland waters and intensified their efforts to spread game fish species around the state. One of the Commission's main jobs was to move native species to new areas. By the turn of the century, the Commission spread brook trout from the Upper Peninsula to 1,500 different streams in the Lower Peninsula. Warm water fish were not ignored; the Commission spread bass, perch, and panfish to areas where they had not been, such as isolated lakes.

The Fish Commission also brought new species to Michigan by widely spreading both "German" trout and "California" trout. German trout became better known as brown trout, a name change precipitated by the general dislike of Germany during World War I. California trout were eventually called rainbow trout. It is a shame that neither of the old names stuck, since most people today do not know that brown and rainbow trout are not native to Michigan.

Like the commercial fishery, game fish suffered from poor management and non-existent regulations. Native brook trout populations declined because the introduced brown trout was more competitive and able to thrive in slightly warmer waters. However, of particular lament is the decline and loss of the beautiful grayling during this time period.



The Michigan grayling was prized for its beauty and abused for its love of the artificial fly. credit: Public Domain, U.S. Fish and Wildlife Service

The extirpation of the grayling was the result of overharvesting and habitat loss. As railroads spread, northern streams became more accessible to more people and, as F.A. Westerman, MDNR Fisheries Division Chief noted in 1961, "This greatly intensified the angling pressure on these beautiful fish, which for sheer beauty and gameness could not be excelled by any other fish… No fish responded more avidly to the artificial fly. Long leaders to which three and even four flies were attached often yielded successive catch of three and even four fish at a cast… soon the question arose, 'What had become of the grayling?'" William Montague, a pioneer at Paris, Mecosta County, recalled an adventure with grayling when interviewed in his old age. "One spring the grayling were running up the Hersey. We noted they had some difficulty in passing an obstruction in the stream, so we placed a canoe crosswise at that point and caught over seven

hundred in one afternoon." Needless to say, sustainability was not a mainstream concept in the late 19th and early 20th centuries.

Timber operations in particular caused extensive erosion, damming, and altered stream hydrology. White pine harvesting was in full swing in the latter half of the 19th century throughout Michigan. All of the prime grayling streams were also in watersheds that had tremendous expanses of white pine. Loggers used streams as the conveyance to transport the logs from upper parts of watersheds down to the Great Lakes, where they could be picked up by ships and carried to population centers like Chicago, Detroit, and Buffalo. It was common practice to build dams and create large impoundments to store the logs. Upon time to transport, the loggers would breach the dam and ride the logs down the river in a huge rush of water. As the logs traveled downstream, they destroyed the stream banks, and the released water scoured the streambed of important gravel and rock substrate.

Overharvesting and the timber practices took their toll on the grayling. Other members of the grayling family are still living in Montana, Europe, and the Arctic, but fisherman last reported catching the Michigan Grayling in 1935.

Unwise logging practices decimated river habitat in Michigan throughout the 19th century and into the 20th century, as seen in this picture of the Muskegon River. source: Used with permission, Bentley Historical Library, University of Michigan, BL005914

The Institute of Fisheries Research is located on the University of Michigan campus in the Museums Annex Building, seen here as it appeared on May 12, 1942. It hasn't changed much over the years. photo: C.M. Flaten, IFR

1930-1967: Fisheries Research

In 1921, the state legislature created the Michigan Department of Conservation (MDC), the forerunner to the current Department of Natural Resources. The legislature consolidated the various state natural resources agencies under the roof of the MDC, including the Fisheries Commission. In 1930, the MDC took a huge leap ahead for fisheries management with the founding of the Institute for Fisheries Research (IFR). The research produced from IFR quickly began to steer the course of fisheries management, not only for Michigan, but also for the whole country.

The IFR, located on the University of Michigan's Ann Arbor campus, was, and still is, a place for professional scientists to collaborate with students and professors to combine scientific research with practical on-the-ground management. From 1930 to 1945, IFR developed and implemented almost all of the modern day concepts of fisheries management. Activities included:

1) creel censuses – checking the catches of sport fisherman;

2) lake and stream surveys;

3) lake and stream habitat improvement structures;

4) nursery areas identification and protection;

5) migration studies;

6) disease studies; and

7) fish sampling techniques.

With the founding of IFR, fisheries management took steps towards more holistic management rather than management focused on maximizing commercial and recreational fish harvests. IFR used scientific principles to understand the life histories of fish – the why and how of fish life and reproduction and the management of habitat and populations.

Throughout this early era of fisheries research, managers and scientists continually formulated new ideas and improved methods. In particular, new stocking concepts and techniques evolved over time. MDC was no longer in favor of introducing new species of foreign game or fish food, which was a major change from the practices of the 19th and early 20th centuries. However, the MDC continued to move millions of native bass and perch to isolated inland lakes, and it continued to stock nonnative brown and rainbow trout.

For example, historically fish were stocked as fry, but more and more managers began stocking fish as fingerlings

– young fish that had grown enough to be about the size of a finger. Research initially had shown that fingerlings were far more likely to survive to spawn than younger fish.

By 1950, IFR had shown using creel surveys and marked fish that less than 2% of fingerling trout survived to be caught by a fisherman. Surveys after stocking legal-sized trout indicated that the return was much higher, and so stocking full-sized trout became a more common practice.

Scientists were experimenting with the planting of adult-sized fish through the 1940's and this became the standard practice during the 1950's. photo: IFR, 1947

Stocking methods also changed after research showed that stocking itself might be harmful to naturally reproducing populations. Fifteen years after the founding of IFR, Fisheries Division chief F.A. Westerman presented a rather revolutionary idea: "The evidence… leads to the conclusion that stocking is unnecessary, uneconomical, or even harmful if the species suited to the environment are already present." While stocking is still widely used across Michigan as a fisheries management tool, it is typically done in a more thoughtful and rigorous way than what was done in the 19th century and most of the 20th century.

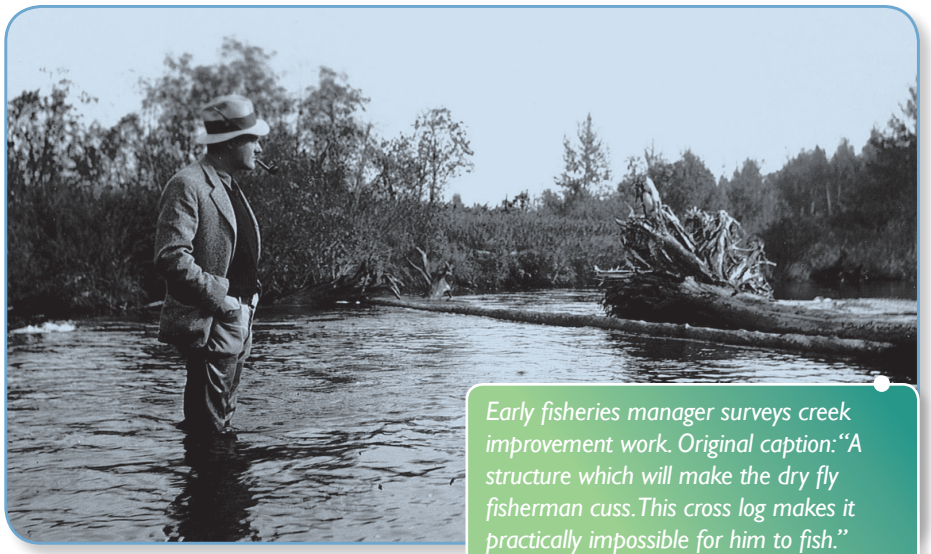
A New Management Technique

IFR researchers and MDC field staff developed "stream improvement" technology in this era and used it as a tool to increase the total amount of fish that a stream could sustain. Stream improvement structures were contraptions made of wood and rock and placed into streams to provide additional fish habitat or alter the flow, substrate, or stream banks. For example, fishery managers could copy natural overhanging banks by putting wooden boxes in the stream and covering them with rock, or scour away excess sand by placing rock vanes or boards into the stream to constrict the channel size and increase water velocity. Stream improvements were primarily used in trout streams, although they were occasionally used in warm-water streams or lakes as well.

In Michigan, stream improvement work began in the early 1930's on the Little Manistee River, followed soon after on the Huron, the Rouge, and the East Branch of the Black. The MDC built several thousand structures in the first five years using department labor as well as the Civilian Conservation Corps. At this time, fishery managers regarded stream improvements as a miracle that would transform recreational fishing. In instructions on how to properly build a stream improvement project, IFR founder Carl Hubbs stated that "any project, even when built improperly or in the wrong position in the stream, would still probably do more good than harm."

Yet, as the principle aim was to quickly increase the quantity of habitat, little regard was paid towards maintaining the stream's natural appearance. Improvements often consisted of wooden boards and heavy rebar that looked out of place in a stream setting. In addition, managers based their plans more on the expectation of what the structures would do rather than on hard evidence or experience. It wasn't until many years later that research began to accumulate on whether the structures actually were favorable for fish. In hindsight, it is very possible that these structures were not doing anything other than concentrating the fish in the stream and making it easier for fishermen to catch them, and were not aiding reproduction in any fashion.

Stream improvement practices eventually improved. In 1967, Wisconsin scientists wrote *Guidelines for Management of Trout Stream Habitat*

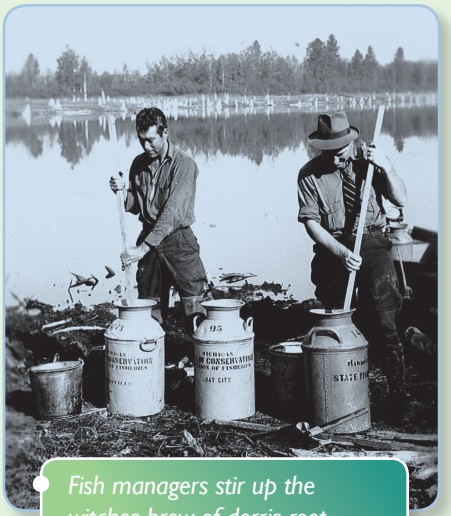


Early fisheries manager surveys creek improvement work. Original caption: "A structure which will make the dry fly fisherman cuss. This cross log makes it practically impossible for him to fish." photo: IFR, 1936

in Wisconsin, which managers and scientists were quick to dub "The Bible" of stream improvement. In this publication, the authors introduced a new theory on stream improvement. In contrast to what Carl Hubbs taught in 1932, they saw that improvement structures had the potential to damage the stream if built improperly. They put a greater emphasis on using vegetation, rock, and other natural materials in constructing stream habitat, so that an improved stream looked less like a construction zone and more like a natural river. However, despite these advancements in stream improvement projects, their success was still varied. Research showed, as often as not, that the "improvements" were not doing anything in terms of actually improving conditions for fish.

However, the Wisconsin document went well beyond attempting to fix the 1930's era of stream improvement. It also promoted ideas about preventing habitat degradation in the first place. The authors supported the position that managers should help the stream fix itself. They argued for using rock riprap to stabilize stream banks and erecting fencing around cattle crossings. If managers could reduce incoming sediment, a stream would be able to eventually flush excess sediments downstream with no additional human aid. In addition, they proposed that managers must begin to study the streams as a whole instead of as individual reaches. These concepts were novel in 1967 and started to make first steps towards our current approach of watershed management and stream restoration.

This "V" deflector (foreground) and "boom" bank cover (background) were installed in the East Branch of the Black River in 1931. Photo: IFR



Fish managers stir up the witches brew of derris root (rotenone) and water in order to poison Clear Lake in Alcona County. photo: IFR, 1938

Fish Kill on Ford Lake

Not all of the management techniques developed in this era are viewed positively by the framework of early 21st century environmentalism. Rotenone is a poison extracted from plants in the pea family that indigenous people often used for fishing. In the 1930's, IFR scientists developed rotenone as a tool that could remove, sample, or destroy fish populations. They performed studies to determine lethal doses for different fish species, sizes, and habitats. Scientists and managers used rotentone to sample fish where non-lethal methods would not be effective. However, rotenone was also often used to eradicate the "rough" fish (non-game large fish) in inland lakes, to reduce competition for newly introduced trout and other game fish.

In 1973, the Michigan Department of Natural Resources (DNR) used rotenone on Ford Lake in Ypsilanti in order to kill the common carp, suckers, and bullhead and open up the water for stocked walleye, rainbow trout, and bass. The whole episode was a debacle. First, in order to make the limited amounts of rotenone more effective, upstream dams reduced water flow to Ford Lake in order to drop the water level by three feet, creating drought like conditions throughout the Ann Arbor and Ypsilanti reaches of the Huron River. Second, the organizers expected to have one thousand volunteers to help with the cleanup, but only twenty-five people showed up. Apparently picking up dead fish is not a very appealing volunteer event. The small number of people could not handle the tons of dead fish, and the rotting carcasses lined the lake for two weeks. A local government official eventually brought in prisoners to clean up the fish. Third, the dam operator on the downstream end of Ford Lake accidently opened the dam, releasing the poison into Belleville Lake and unintentionally killing thousands more fish. All told, over 400 tons of fish died in the two lakes. The day after the Belleville kill, an embarrassed DNR put a short-term ban on the use of rotenone. Ironically, Ford Lake has a thriving carp population today, showing that this fish is not so easily removed.

IMPROVED MANAGEMENT

With improved knowledge of fish and ecosystem science, fisheries managers were able to create more effective rules and regulations. Through 1930-1965, fishing licenses catch limits, closed seasons, and minimum fish sizes were introduced and enforced. All of these regulations were designed to prevent excessive harvesting and allow fish to reach adult size and reproduce successfully.

HIGHLIGHTS:

- 1931: The first recreational trout licenses were required ($1.75 for adults), and the first catch limits were set (15 brown and 15 rainbow trout per day).
- 1933: The MDC established closed seasons for several species – times of the year that fishermen were not permitted to fish.
- 1935: People using dynamite on fish were given high fees ($100-300) and/or jail time (90-120 days).
- 1939: Catch limits were placed on Great Lakes smallmouth bass (10 fish per day).
- 1945: Tougher catch limits were placed on trout (15 fish or 10 pounds), and limits were placed on panfish (25 per day).
- 1955: Snagging fish was deemed illegal (keep a fish after putting a hook through a fin or the body).
- 1959: Size limits were set on pike (at least 20 inches).
- 1964: "Trout streams" were designated giving special restrictions on lures, catch limits, and size limits.
- 1965: Brook Trout become the State Fish of Michigan.

This lamprey mouth seems like something from a sci-fi horror movie, but to a fish it is an all-too-real threat to survival. credit: U.S. Fish and Wildlife Service

1930-1973: Invasives Attack!

Throughout the 19th, 20th, and 21st centuries, there have been numerous intentional and accidental fish introductions into the Great Lakes and its tributaries. Only some of these species were able to establish reproducing populations. As mentioned previously, non-native brown and rainbow trout were intentionally introduced and thrived, and are major contributors to Michigan's sport fisheries. The American eel and the cutthroat trout are two examples of fish that were introduced but failed to establish reproducing populations. Fish introductions can be considered good or bad depending on any particular person's perspective. For example, the common carp has been around for almost 150 years and is widely considered a nuisance species, although many anglers like the challenge of landing such a large fish. Regardless of perspective, there is no argument that the Great Lakes fishery ecosystems have changed irreparably.

Coho and Chinook salmon were introduced in the early 20th century but did not thrive as a sport fishery until they were actively stocked starting in 1966. The stocking of these two salmonids in particular is a very interesting ecological story of the interactions between the salmon, the native lake trout, and two invasive species: the alewife and the sea lamprey. The interactions of these species irreversibly changed the ecology of the Great Lakes.

The story begins with sea lamprey, native to the Atlantic Ocean. Sometime in the 19th century, the sea lamprey entered the Great Lakes – most likely through the Erie Canal, which runs from the Hudson River in New York State to Lake Ontario at Buffalo, New York. From there, the fish used the Welland Canal to bypass Niagara Falls and enter Lake Erie, where it was first officially recorded in 1921. By 1938, sea lamprey were spawning in the rivers that flow into Lake Michigan and Lake Huron, and by 1948 the fish appeared in Lake Superior.

Lampreys were not unknown to the Great Lakes prior to the sea lamprey invasion. In fact, the Great Lakes system has four native lamprey species: chestnut, silver, American brook, and northern brook lampreys. Both the chestnut and silver lamprey are parasitic fish, meaning that in their adult stage they feed on the blood of other fish. However, they rarely kill their host fish.

On the other hand, sea lampreys are parasitic fish that quite readily kill their hosts. The sea lamprey picked the lake trout, the top predator of the Great Lakes, as its preferred host. Prior to the sea lamprey invasion, commercial harvests of lake trout averaged

15 million pounds per year. By the 1960s, the catch had dwindled to 300,000 pounds per year. The lake trout population was in rapid decline, and eventually the species became extinct in Lakes Ontario, Huron, Erie, and Michigan. A small population of lake trout was able to survive in Lake Superior. Other Great Lakes fish like whitefish, walleye, and steelhead (lake-run rainbow trout) were also hit hard by the sea lamprey, though not as severely as the lake trout.

One sea lamprey would be enough to make life miserable for this poor lake trout; two spells certain doom.
credit: U.S. Fish and Wildlife Service

A fisheries manager applies TFM to the Manistique River in order to kill spawning sea lamprey.
credit: T. Lawrence, Great Lakes Fisheries Commission

Invasive Control Success

The sea lamprey is one of the few Great Lakes invasive species that fisheries managers have successfully controlled. In the 1950s, scientists developed a lampricide called TFM (3-trifluoromethly-4-nitrophenol) which killed only the sea lamprey and had no discernible effect on other wildlife. This chemical, sprayed into lamprey nursery streams, is quite effective, although expensive. Eventually other techniques were developed, like placing barriers at the mouths of the nursery streams and releasing sterile male lampreys to compete with the normal males. All of these techniques helped reduce the Great Lakes populations of sea lamprey by 90% from their peak abundance. The control efforts are still ongoing today, since it has proven impossible to eradicate the sea lamprey altogether.

Lake trout populations have increased since the effective control of the lamprey. Lake trout have returned to all of the Great Lakes, with varying success. Their population in Lake Superior was noted as "good" and "improving" in a 2009 EPA document, while the other Great Lakes have populations described as "poor" and "mixed." In general, lake trout populations remain far below historic levels, and heavy restrictions on commercial and recreational lake trout fishing remain.

1966-1972: Using Fire to Fight Fire

At the same time the sea lamprey were decimating the top predators of the Great Lakes, a small forage fish, the alewife, entered the Great Lakes through the same route as the sea lamprey. The decline of top predator fish allowed the alewife population to grow unchecked. In addition, the alewives out-competed native forage fish (lake herring, emerald shiner, some species of chub, and yellow perch). By the 1960s, the alewives ate so much of the plankton crop of the Great Lakes that they exhausted the bottom of the food web and reduced competitor populations. Ironically, they put such a strain on the food web that millions of the alewives themselves died each summer, washing up on Great Lakes beaches and creating a stinky mess requiring tractors and bulldozers to rake, pile, and clear away the carcasses.

DEFINITIONS:

Native or indigenous: species that exist in an area as the result of natural processes, with no human intervention.

Non-native or exotic: species that have been introduced either accidently or intentionally by humans. Accidental introductions include fish entering through freighter ballast water and the construction of canals. Intentional introductions happen through rogue individual actions like dumping a pet fish into a lake or through purposeful management like the stocking of salmon into the Great Lakes. A non-native species may or may not be considered invasive depending on the consequences.

Invasive: non-native species that negatively affect the physical and/or biological components of the natural ecosystem.

Dead alewives cover this Lake Michigan shoreline. credit: Great Lakes Fisheries Commission

In 1965, Dr. Howard Tanner, chief of the Michigan Department of Natural Resources Fisheries Division, directed research to look at how the current condition of the Great Lakes could be improved for both sport fishing and ecosystem stability. Fisheries researchers noted that steelhead were doing very well in Lake Michigan where alewives were abundant. Since steelhead lived in upper river tributaries for the first two years of their lives, and then swam down to the Great Lakes for their adult lives, the fish were large enough that they did not eat the same items as the alewife, so they were unaffected by alewife competition. In fact, the steelhead were often big enough to eat the younger alewives themselves.

After this observation, DNR management decided to embark on a large scale effort to stock other fish that could grow in stream tributaries, live as adults in the Great Lakes, and feed on the excess numbers of alewives. They desired to find a fish that could fit into the top predator role that was lost with the decimation of the lake trout. Managers began cultivating millions of the non-native Coho and Chinook (king) salmon in the State's fish hatcheries and planted year-old fish into tributaries. The program proved very successful: the salmon survival rate was extremely high, and the alewife provided a plentiful food source. In Lake Michigan, Coho were able to grow from one ounce to ten pounds in 17 months. The annual summer die-offs of millions of alewife also largely ceased, although smaller die-offs still occurred.

The arrival of the sea lamprey and alewife mark a distinct milestone in the life of the Great Lakes. The overharvesting of whitefish and sturgeon in the late 19th and early 20th centuries altered many ecological interactions of the Great Lakes, but the sea lamprey, alewife, and subsequent salmon stocking radically changed the ecosystem to such a great extent that today, most people are not aware of which fish species are indigenous to the Great Lakes.

The Lakes' original ecosystem cannot be restored, and it will continue to change with every new invasive species that is established. The zebra and quagga mussels and round gobies are among the newer non-natives that have joined the Great Lakes ecosystem; the silver and bighead carp (aka Asian carp) are potential invaders just waiting for an electric barrier to fail. With so many potential variables, it is difficult to predict the future for fish in the Great Lakes.

2000-Present: Modern Issues

Stocking

From the 19th century, when brown trout and rainbow trout were first introduced, to the mid-20th century, when the Coho and Chinook salmon were stocked to control alewives, fish stocking has shaped and defined Michigan's fisheries. Fisheries managers' primary purpose in stocking fish has always been to meet commercial fishing and recreational fishing

Fish Species Introduced into the Great Lakes

Successful, intentional introductions

Atlantic salmon[2]
Brook trout [1, 3]
Brown trout [1]
Chinook salmon [1]
Coho salmon [1]
Common carp [1]
Goldfish [1]
Margined madtom [2]
Mosquitofish [2]
Oriental weatherfish [2]
Pink salmon [2]
Rainbow smelt [1]
Rainbow trout [1]
Redear sunfish [1]

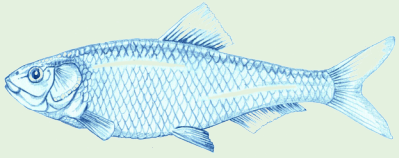
Unsuccessful, intentional introductions

American eel
American shad
German whitefish
Chum salmon
Sockeye salmon
Japanese salmon (masu)
Cutthroat trout

Accidental introductions, with destructive results

Sea lamprey
Alewife
Round goby
Tubenose goby
Rudd
Ruffe
White perch

1 Highly successful introductions; widespread distribution.
2 Limited success; narrow distribution or small populations.
3 Brook trout only had a narrow range in Michigan's Upper Peninsula prior to widespread stocking, which is why this species is considered non-native.



demands without altering the ecosystem's overall integrity. However, over the years there have been many changes to what species and size of fish are stocked in an attempt to meet these demands. The Michigan Department of Natural Resources DNR) once stocked trout as fry (1875-1920), then as fingerlings (1920-1950), and then as legal-sized (large enough to keep while fishing) adults (1950-1960). Currently, the DNR stocks fingerlings or very close to legal size, depending on the situation.

Brook trout were once stocked very extensively (about 16 million fry per year from 1910-1920), but in 2012, only 100,000 brook trout were stocked. On the other hand, rainbow trout were stocked more extensively in 2012 than any other time in Michigan's history with about 3.2 million near-legals planted. The stocking of other game fish species similarly has fluctuated over time as determined by fisheries science, management needs, and the current values of the DNR and other stakeholder groups.

In the past, stocking was seen as a panacea. It is now used more judiciously, and usually in cases where aquatic habitat supports growth and survival of a desired species, but for some reason reproduction is insufficient to maintain desired abundance. Fisheries scientists are also now concerned more with survival of stocked fish rather than how many they can stock.

2012 - MDNR FISH STOCKING NUMBERS

Species	Number	Average Size (inches)
Walleye	10.0 million	2.5*
Rainbow trout	3.2 million	7.8
Chinook salmon	2.6 million	3.5
Brown trout	2.0 million	6.1
Coho salmon	1.7 million	5.4
Lake Trout	450,000	11.7
Splake	215,000	8.0
Fathead minnow	130,000	1.7
Brook trout	100,000	8.0
Atlantic salmon	90,000	6.6
Muskellunge	28,000	10.2
Channel catfish	13,000	9.0
Bluegill	9,000	4.8
Black crappie	6,000	5.6
Lake sturgeon	6,000	5.3
Pumpkinseed	5,000	3.4
Redear sunfish	3,000	4.0
Yellow perch	2,000	6.4
Hybrid sunfish	2,000	6.7
Northern pike	800	12.3

** Walleye do not grow well in hatcheries and smaller fish are planted than other species.*

Stream improvement and watershed management

In the 1930s, the DNR founded the Institute of Fisheries Research in Ann Arbor. Institute researchers created a diverse range of fish sampling and fishery management techniques including "stream improvement", which involved building structures in the stream to enhance fish populations. The success of these projects was often mixed, when they were assessed at all. Fish often used the artificial stream habitat, but it was difficult to determine if the habitat improvements were increasing fish populations or simply concentrating the existing fish around the structures.

Over time, DNR attitudes towards stream improvement projects changed. In a 1989 memo that marked a shift in stream improvement theory, Dave Borgeson Sr., former Assistant Chief of the DNR Fisheries Division, placed a moratorium on any new Division involvement with "traditional instream habitat improvement work." He believed that these structures were expensive to build, expensive to maintain and oftentimes, not maintained at all. In addition, Borgeson stated, "Their benefits are rarely demonstrated." Instead of stream improvement work, Borgeson urged the division to address broader watershed concerns, such as road crossings, culverts, ORV trails, and farming practices. "We can accomplish more in the long run by using our knowledge of the resource and our analysis of what it needs than we can by work projects."

Under this perspective of stream improvement, the Fisheries Division adopted a more cooperative approach focusing on working with private landowners, conservation districts, and non-governmental organizations. Currently, the Division often uses its expertise in helping these groups plan projects and acts in a support position in implementing them, but it will not take the lead in paying for or building these projects.

Instead, the Fisheries Division began to focus on a watershed approach. The first watershed level report, which focused on the Huron River watershed, was issued in 1995. The Division has completed 18 watershed assessments since then, covering most of the major watersheds across the state. The purpose of the assessments is to describe the characteristics of the watersheds and their biological community, to identify and solve problems within the aquatic system and fisheries of the watersheds, and to provide an organized long-term reference for agencies and citizens.

The struggling Great Lakes

Invasive species everywhere

In the past two hundred years, more than 140 new non-native species have colonized the Great Lakes and its

tributaries. These include fish (round goby, tubenose goby), crustaceans (spiny water flea, rusty crayfish), mollusks (zebra mussel, quagga mussel), plants (eurasian water milfoil, phragmites, purple loosestrife), and even a virus (Viral Hemorrhagic Septicemia- VHS). Some new species seem to have had little effect, but many have interfered with the ecosystem's normal processes through fast growth and rapid reproduction (e.g. phragmites), high dispersal ability (e.g. zebra mussel), competitive ability (e.g. round goby), and outright fish death (e.g. VHS).

Viral Hemorrhagic Septicemia (VHS) is a dangerous fish disease that originated in northern Canada and traveled to the Great Lakes Region in 2005. While this gizzard shad shows outward symptoms, not all infected fish do. credit: M. Faisal, Michigan State University

VHS is a recent threat. It appeared in the Great Lakes basin in 2005 and is believed to have originated from the maritime region of Canada. VHS causes hemorrhaging in fishes' liver, swim bladder, spleen, and intestines, and the fish eventually die from organ failure. Large fish kills have occurred in freshwater drum, muskellunge, and yellow perch. Smallmouth bass, crappie, and bluegill kills have also been confirmed. To date, removing the virus once it has spread has been impossible. Limiting the transfer of fish between water bodies and teaching anglers to clean boating equipment will reduce VHS spread. This is an issue that affects the Great Lakes and inland lakes. VHS has even been found in the Huron River watershed – in Baseline Lake in 2009.

This steelhead plunged into the Red Cedar River during a stocking event in April of 2013 at Michigan State University. credit: MSU Today

What invasive species lie around the corner? Scientists, governments, and the public alike are well aware of the threat posed by several species of Asian carp that are encroaching on the Great Lakes through the Mississippi River system. Yet the political will is lacking to make a permanent barrier by closing the Chicago canal, which connects Lake Michigan to the Mississippi River system. This disagreement over how to manage a known invasive species is a strong indicator of future regulatory conflicts that Great Lakes' communities may face as even newer invasive species enter the Lakes' ecosystem.

Record low populations of forage fish

The Great Lakes fisheries are not doing well. Native forage fish populations are currently near record lows, including cisco, bloater, mottled sculpin, Johnny darter (in near-shore areas), and yellow perch. Even the populations of two non-native forage fish, the alewife and rainbow smelt, are close to record lows. All of these species are extremely important food sources for the larger Great Lake predators. An analysis from 2002-2004 showed that the energy content of alewife was 23% lower than in 1979-1981, meaning that each individual fish is less nutritious for predators.

What is the cause for this major decline in these species? As in all science, causation is difficult to show, but some scientists theorize that the major cause of the decline is zebra mussels and quagga mussels sequestering energy and nutrients that used to support fish. However, other scientists believe that while these mussels do play a role, other factors such as poor reproduction, increased predation by salmon, and alterations to fish habitat are a bigger concern.

Round gobies are also causing problems for forage fish, in particular along the Great Lakes coastline. Round gobies first appeared in the Great Lakes basin in 1997, and in that time are believed to have largely eliminated mottled sculpin and Johnny darter from near-shore areas due to egg predation and aggressive behavior. Round gobies also eat sturgeon eggs and therefore have had a negative impact on sturgeon restoration

attempts. Recent evidence shows that predators (in particular burbot and smallmouth bass) are learning to eat round goby, which is promising. If predators consistently recognize gobies as good food, then the worst effects of the round goby will be alleviated.

Low predator populations

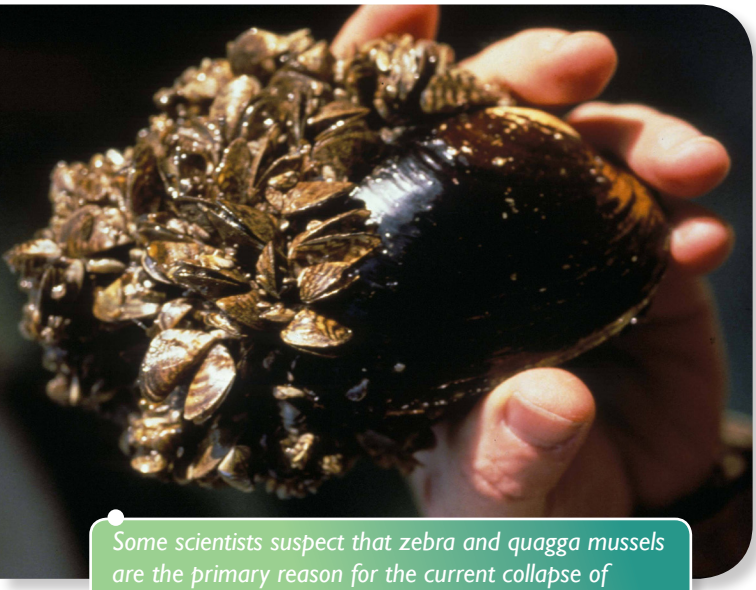
Chinook salmon were at record low body weights in 2003, followed by poor growth recorded in 2004; this was certainly related to the reduction in forage fish. In recent years, stocking of Coho and Chinook has been greatly scaled back in order to strike a better balance with the underlying, depleted food web. In 2012, the amount of Chinook and Coho stocked was about half the amount stocked in 1980.

Lake trout have never fully recovered from the sea lamprey; they had disappeared from all of the Great Lakes except for Lake Superior. However, good lamprey controls are in place, keeping the populations down and making it possible for managers to work on helping the lake trout achieve self-sustaining populations. Research on improving sea lamprey control is still ongoing. Michael Wagner from Michigan State University recently published a paper on how scents from dead lampreys actively repel live lamprey. Such pheromones could be used to create "chemical dams" that would block the lamprey from Great Lakes tributaries.

Lake trout has been reintroduced into all of the Great Lakes. Up until the last couple of years, management efforts to establish populations of lake trout have proved futile. However, scientists have recently reported that spawning is occurring in parts of Lake Michigan and Lake Huron and that the wild lake trout fry are surviving and maturing to reproducing adults. Scientists have theorized that alewife predation on lake trout fry has been a major impediment on lake trout reproduction, and it is possible that the record low alewife populations have allowed for lake trout rehabilitation.

The Great Lakes originally contained a vast resource of lake whitefish, which were severely exploited by commercial fishing in the 19th century. Nearly 20 million pounds of whitefish were harvested from the Great Lakes every year from 1830 -1890. The populations have long since dwindled, but a commercial fishery still exists for whitefish today. Harvest reached a modern peak of production in 1993, with 7 million pounds of whitefish caught. In 2004, the fishery hit a modern low at 4 million pounds of whitefish. Catches since have averaged around 5 million pounds.

Just like the other species mentioned above, invasive species have likely stressed whitefish populations by depleting the base of the food web. Invasive species also have made whitefish harder to catch, as filamentous algae and zebra and quagga mussels foul and tangle fishing gear. In addition, an increase of water clarity due to zebra mussels has forced the whitefish to deeper waters, outside the reach of fisheries that use trap-nets.



Some scientists suspect that zebra and quagga mussels are the primary reason for the current collapse of Great Lakes fish populations. credit: US Fish and Wildlife

Recent sampling indicates that the beautiful lake trout may be making a comeback. credit: US Fish and Wildlife Service

The lake sturgeon recovery

Sturgeon have several known remnant populations and reports have indicated that the population is increasing but far from re-established. The sturgeon is still listed as "very rare," "endangered," or "threatened" depending on the exact wording used by various state and federal agencies. There is strong interest in restoring lake sturgeon and many actions are underway. Substantial portions of the sturgeon's historical spawning habitats have been blocked by dams; passage specially designed for sturgeon has been put in on the Manistique River and Menominee River. In the St. Clair River, managers have installed artificial rock reefs to provide spawning habitat and refuge areas. Sturgeon are beginning to use these, and harvest restrictions are now providing protection for long-lived adults so they may spawn repeatedly for decades without risk of capture.

Improving Great Lakes management

Lake management plans have been developed by the federal and state governments to address pollutants and stressors on each of the Great

Lakes. The focus of these plans is on using a holistic ecosystem approach and meeting the concerns of all involved stakeholders. Priority goals include restoration and protection of fish health and habitat. In addition, the Great Lakes Restoration Initiative, started in 2010, is the largest investment in the Great Lakes in twenty years and involves eleven federal agencies. One of the major priorities of this initiative is to prevent the introduction of new invasive species.

Although populations are far from historic peak levels, good management has created a sustainable fishery in the Great Lakes for commercial fisheries. Certainly commercial fishery management has improved over time with better fish population models and more realistic goals.

Dredging, ditching, and draining has reduced coastal wetlands on the lower four Great Lakes by approximately 75% from pre-European settlement. These wetlands are extremely important for young-of-the-year fish growth. Wetlands are also heavily affected by phragmites and purple loosestrife, which are known to disturb the natural hydrologic cycles. However, in 2000, the Great Lakes Wetlands Consortium was started to monitor wetland health and restore wetland habitat. This group provides scientific support for monitoring and finds funding for a variety of management projects. Progress is also occurring on reducing phragmites in Great Lakes wetlands, and projects to reconnect many isolated wetlands to the Great Lakes are enjoying spectacular results. A reconnected wetland within the Ottawa National Wildlife Refuge on Lake Erie provided new habitat for millions of fish that moved in and out of the habitat each week.

Conclusions

The fish in the lake and river ecosystems in Michigan and throughout the Great Lakes basin are feeling the stress that has come from 200 years of management and mismanagement. From overfishing in the 19th century, to intentional species introductions and relocations in the 20th century, to the dominance of invasive exotic species at the beginning of the 21st century, there has certainly been a long history of "fishy" social and scientific problems.

The current situation in the Great Lakes is dim, but a myriad of intelligent people from universities, non-profits, environmental businesses, and all varieties of federal and state agencies are working on the problems. Certainly there is hope that wise management can turn things around. Good data collection and scientific analysis, pro-active policies and laws, and better public awareness are all important components in reaching this goal!

– Paul Steen
HRWC Watershed Ecologist

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Huron River Watershed Council

Please direct all questions, reprint requests, and other inquiries regarding this publication to:
Paul Steen, Watershed Ecologist
Huron River Watershed Council
734-769-5123 x 601
psteen@hrwc.org
1100 North Main
Ann Arbor, MI 48104

The DNR's Huron River Watershed Assessment is available for download at www.hrwc.org/the-watershed/. The primary challenges to the Huron River as described in this report are fragmentation from dams, degradation from non-point pollution, and urban sprawl.

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