Upwellings

An upwelling occurs in a lake or ocean when strong, steady winds push warm nearshore surface water away from shore causing colder, nutrient-rich water to rise.

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In this edition of Upwellings, we profile the Great Lakes fishery from several different angles. Michigan Sea Grant recently completed the third edition of *The Life of the Lakes: A Guide to the Great Lakes Fishery*. The information included throughout this newsletter is drawn from the 120-page, full color book, published by Michigan Sea Grant.

Producing this edition of Upwellings allowed us to profile the science, culture, history and management of Great Lakes fishery that play such a significant role in our lives here in the region. We are linked to the fishery — and it to us. Over the years, that connection has meant many different things.

Learning and teaching about the Great Lakes, is a priority for many of us. The Great Lakes are Michigan’s greatest natural asset; the history, the current state, the ecology and the future of the Great Lakes provide interesting stories that we hope you find engaging too.

A notable trend is that the number of sport anglers in U.S. and Canadian waters is dwindling. Anglers have steadily declined since the first U.S. and Canadian sport angling surveys were administered in the early 1990s. Since that time, the number of Great Lakes anglers has dropped by 43 percent in U.S. waters and 56 percent in Canadian waters.

Fewer people participating in outdoor activities may result in less interest in natural resource conservation. Giving people a reason to love the Great Lakes, for example as anglers, is an important aspect of building a citizenry that has a stake in protecting the Great Lakes now and in the future. This is also the core of Michigan Sea Grant’s mission, creating an educated population of stakeholders, decision-makers and users of Michigan’s Great Lakes resources.

As you read through this issue, consider the importance of our fishery — and your involvement in it. Whether it’s through casting a line, watching what you pour into your sewer drains, learning about the lakes or one of the many other ways of interacting with the lakes, you play a part in keeping the Great Lakes our best natural asset.

— Jennifer Read, Ph.D.
Acting Director
The Great Lakes and the people who live in the region have been intricately intertwined, one influencing the other, throughout history. Perhaps the most dynamic relationship in that history has been with the Great Lakes fishery.

Through studying the Great Lakes fishery, we learn about the people and cultures that have depended on the productivity of the Great Lakes.

The story of the fishery also reflects the story of aquatic ecosystems, biodiversity, water quality and environmental change, degradation and rehabilitation throughout the region. The Great Lakes fishery is the thread running through all these aspects, serving as the gauge of resource sustainability and quality of life for people in the region.

Here we look at a condensed version of that story, based on content from *The Life of the Lakes.*
The Great Lakes support an abundance and diversity of life, including fish, plants, birds and other organisms. Each lake's fish community is closely tied to the whole set of living and nonliving lake components — collectively called the ecosystem.

Ecology is the study of the interaction between abiotic (non-living) and biotic (living) factors. Trophic zones, food chains and food webs, the impact of non-native species, fish life cycles and life requirements combine to provide a picture of the ecological life of the lakes. Because of their size and varied geography, geology and ecology, the Great Lakes include sub-regions that vary in climate, sunlight, temperature, depth, nutrients, chemical composition (such as oxygen concentrations), water movements, shoreline, and other physical and biological characteristics. This variation means that some areas of the lakes support more life than others.

**DIVERSITY IN THE GREAT LAKES**

The Great Lakes provide a variety of species with different habitats — where fish can find all their life requirements: food, water, shelter, and space. At least 179 different species of fish are found in one or more of the Great Lakes, their tributaries and the connecting waterways.

**THE LAKES BY THE NUMBERS**

- Lake Michigan has the greatest number of fish species with 136 identified species.
- Lake Erie has the second highest number of fish species with 129.
- Lake Ontario has more fish from the (glacial era) Atlantic drainage than any of the other lakes, with 119.
- Lake Huron has 117 fish species.
- Lake Superior has fewer fish species than the other lakes with 83 species. However, this northernmost lake has three unique, native subspecies of lake trout — including the “lean,” the “humper,” and the extremely fatty “siscowet.”
- Lakes Superior, Ontario and Erie, with an east-west orientation, have more species in their southern tributaries than in their northern streams and rivers. This is probably because many fish moved into the region from the south, as glaciers melted and the climate of the region warmed.

**MANAGEMENT OF THE GREAT LAKES**

Fisheries science is the systematic scientific study of fish, aquatic resources, their uses and users. This science involves understanding the structure, dynamics and interactions of habitat, aquatic organisms and humans. Fisheries management is an area within fisheries science that involves decision-making related to human interaction with fish and aquatic ecosystems. That often requires managers to translate data and information about people, aquatic populations and habitats into usable information that helps define strategies. The information is then used to form goals for particular aquatic populations or ecosystems.

**LESSONS LEARNED**

Lessons in fisheries production and management have come from historic challenges and management attempts. Great Lakes fish populations have declined over the past century due to a combination of factors such as overfishing, poor environmental quality and pressure from invasive species. For example:

- Atlantic salmon in Lake Ontario probably declined as a result of habitat loss from early logging, dam building and overfishing;
- Lake sturgeon, which grow and mature slowly, were also affected by changed habitat, fishing and other pressures throughout the Great Lakes;
- Lake trout declined due to factors such as sea lamprey predation, habitat degradation, nutrient deficiency, overfishing and waning prey.

Noting changes in populations is important because when populations of one particular fish species change significantly, it has an impact throughout the food web. Understanding the biological basis for these changes in the fishery is also important when managers are making decisions about the best course of management action. Grasping how the systems interact and making informed decisions about the management of the Great Lakes is critical.
With such an abundance of resources in the Great Lakes, it is not surprising that fishing — commercial, recreational and tribal — has been so instrumental in shaping the culture, economy, quality of life and people in the region throughout history. Though it was changed over time, this influence continues to shape the Great Lakes region today.

People continue to use Great Lakes fishery resources in many different ways. While sport and commercial fisheries are the major fisheries in the Great Lakes, subsistence and tribal fishing, as well as aquaculture, are also part of the landscape of the Great Lakes fishery.

**SPORT FISHING**

Fishing the Great Lakes means different things to different people. The type of recreational fishing trips pursued by individuals often depends on angler preference and the resources available to them. Some anglers invest in large boats and expensive tackle to target salmon in Lake Michigan or walleye in Lake Erie. Other anglers participate in the Great Lakes recreational fishery by casting from a local pier for yellow perch or smallmouth bass.

The most recent U.S. Fish and Wildlife surveys show that approximately 1.5 million anglers spent nearly 18 million days fishing the U.S. waters of the Great Lakes in 2006. In the Canadian waters of the Great Lakes, the surveys indicated more than 440,000 anglers fished more than 4.8 million days in 2005. When analyzed, the data indicates that approximately 19 percent of licensed anglers in Great Lakes states — nearly one in five — are directly participating in Great Lakes fishing activities.

However, numbers of sport anglers in U.S. and Canadian waters have steadily declined since the 1990s. In that time, the number of Great Lakes anglers has dropped by 43 percent in U.S. waters and 56 percent in Canadian waters. There is mounting concern over the assumed resulting disconnect between people and the natural environment — and less engagement means less investment in natural resources.

For instance, in the Great Lakes, sport fishing contributes to the economy and identity of many communities in region.

The sport fishing industry, valued in the billions across the Great Lakes, has brought new life to many Great Lakes coastal towns. Bait and tackle shops and other support industries are commonplace. Some areas develop and build fishing gear, like lures, that are marketed and used worldwide. Fishing gear, such as the downrigger, was originally developed in this region to meet the needs of Great Lakes anglers and is now used across the world.

**COMMERCIAL FISHING**

Commercial fishing, when managed properly, can provide an important and sustainable Great Lakes food source — and can help support a lake-based economy. Many people who do not fish may still enjoy a meal of Great Lakes fish. Commercial fisheries help provide food fish, like walleye, for these markets, and they capitalize on other fishery resources. For example, they seek out other fish species that the average sport, charter or tournament anglers do not usually target, such as whitefish or carp.

Great Lakes fishing treaties date back hundreds of years. However, modern regulations focus on an allocation of fish species. For example, some tribes focus their commercial fishing efforts on whitefish, while others target traditional sport species. Harvest of species, such as lake trout, that are of both sport and commercial interest are split 50-50 between state anglers and tribal fishers. The agreement addresses the issues of gear and social conflict by designating specific areas, seasons, equipment and allocations of fish in ways that maximize benefits for tribal, commercial and sport anglers sharing the Great Lakes fishery resources.

The most prominent fisheries in the Great Lakes vary in many ways, including purpose, scope and gear used. Yet, they also overlap because the same species are often harvested for different uses. There is one significant commonality: each fishery is dependent upon a healthy Great Lakes ecosystem.

**TRIBAL FISHING**

Great Lakes Indians developed a life patterned around lakeside fishing villages with small gardens to supplement their diets. Fish was a primary food source and some used the leftovers for other things such as fertilizing crops or using fish bladders to tan animal hides. The Great Lakes fishery is still central to some tribes throughout the region. However, today tribal fishing is carried out and regulated in different ways.

**TODAY’S SECTION INCLUDES:**

- Sport fishing including recreational, charter and tournament
- Commercial fishing, harvests and regulations
- Tribal treaties, harvests and subsistence fishing today
- Aquaculture and hatcheries
Waves of change have always moved through the lakes. Taken together, those changes make today’s Great Lakes fisheries quite different than they were hundreds of years ago. To understand what the fisheries are today and what they may be in the future, it is important to review their complex and evolving history.

EARLY DAYS
Native Great Lakes peoples were fishing as early as 3000 B.C. These early anglers developed techniques for spearing fish like lake sturgeon, northern pike and suckers and angling for fish from a canoe or through the ice. Spears were made of copper, bone and antler. Fishing hooks and gorges — straight tools similar to hooks — were made of copper or bone.

When Europeans first began exploring the “New World,” approximately 60,000-117,000 native people lived in the region. Great Lakes fish populations were thought to be unlimited and inexhaustible.

ENVIRONMENTAL CHANGES
In the 1800s, the Great Lakes region became a popular migration destination for Europeans. As a result, habitat degradation due to increased populations and human activity — and the arrival of invasive species — were major environmental changes that began to influence Great Lakes fisheries. The Lake Ontario basin was the first in the region to be altered by canals and dams. Changes that occurred there during the 1800s were progressively echoed in the other lakes.

Logging had a profound impact on the Great Lakes and was one of the first large-scale environmental changes. Logging activity peaked first in New York in the mid-1800s, and then moved westward to Michigan in the 1860s to 1870s. These logging and settlement activities caused the first in a series of environmental change: loss of fish habitats and damming of rivers and streams.

INVASIVE SPECIES
The sea lamprey was noted in Lake Ontario by the 1830s and traveled, via an upgraded Welland Canal, to the upper lakes after the turn of the twentieth century. The alewife, a cool-water fish from the Atlantic Ocean, became established in Lake Ontario by 1873. The effects of the invasive alewife would be widely felt throughout the Great Lakes food web within a few decades. Other invasive species, arriving through canals and the ballast of ships, continue to affect the Great Lakes ecosystem.

After the U.S. Civil War, the Great Lakes region experienced more settlement. Railroad construction expanded, and large shoreline cities such as Chicago grew even larger. More Native American reservations were established as lands in the region were ceded to the U.S. government and surrendered to the British government in the British Canadian colonies. Some sport fishing began to develop — for example, daily sport fishing excursions were offered on Lake Erie starting around 1885.

The technological advancements during this period continued to increase the efficiency of commercial harvests. The Great Lakes were still considered inexhaustible by some; however, the levels of harvest would prove to be unsustainable at best, and devastating at worst.

THE MID-1900s
By the 1950s, the cumulative impact of human population growth and technological advances had forever modified the Great Lakes fisheries. Many of these changes had occurred over a relatively short time. In fact, some had their roots in the earliest technological changes at the beginning of settlement and commercial fishing in the area. Social, technological (including overfishing) and environmental changes (e.g., forest cutting and settlement, and invasions by aquatic species) had profound impacts.

1960s - 2000
The presence of chemical contaminants in the system was recognized in the late 1960s and early 1970s, when people began to observe their effects on fish and wildlife. Some
species, such as the bald eagle, had nearly disappeared from the Great Lakes region. Meanwhile, scientists developed the technology to measure smaller and smaller concentrations of chemical contaminants in water and animal tissue. When the Cuyahoga River caught on fire and Lake Erie was declared dead in the 1960s, the public took notice.

By the end of this era, broad-ranging legislative initiatives to control some more obvious sources of pollution were put into place. The Great Lakes Water Quality Agreement was signed by the United States and Canada in 1972. The Federal Clean Water Act was also signed in 1972 because of the polluted state of rivers and lakes across the country. The Great Lakes, including Lake Erie, began to recover from both chemical contaminants and nutrient over-enrichment.

The history of the Great Lakes is a long and varied one. Starting with the first people who lived in the region, the fisheries helped guide and shape the culture that developed around it. Today's Great Lakes fisheries are quite different than they were thousands of years ago. In the last century, and particularly in recent decades, the pace of change has accelerated. However, one thing remains the same: the people of the region remain connected to the Great Lakes in many ways.

Past, current and emerging issues affecting the Great Lakes will define the future of the Great Lakes fisheries. That future will include a variety of challenges such as existing and new invasive species; changes in the status of certain fisheries; changes to and rehabilitation of habitats; lingering and new contamination; and ongoing joint management of a vast international resource.

Three primary areas are core to mapping the future of the Great Lakes fishery:

**UNDERSTANDING AND ADAPTING TO HABITAT AND ECOSYSTEM CHANGES**

The Great Lakes are comprised of very large, diverse and dynamic ecological systems. These ecosystems are always changing and particularly so when human activities alter habitats or introduce new non-native species. Even with the management tools of stocking, harvest regulation and habitat restoration, managers have only have so much control over these broad ecological processes. In the end, how we use and manage the Great Lakes fishery is dependent on our understanding of these ecosystems and how we adapt to change.

**POLICY, MANAGEMENT AND DECISIONS**

Resource managers often have to make decisions using imperfect knowledge. Management decisions are not just about how one piece of the puzzle will affect the rest of the ecosystem. It is also understanding how people use a resource and gauging their responses to management decisions. Another part of the management challenge is providing decision-makers and the public with science-based and compelling information about the fisheries.

**STAKEHOLDER AND USER ENGAGEMENT**

Stakeholders are important to fisheries management and their role will only grow in the future. While it may appear like natural resources decisions — or most policy decisions — are made at a distinctly high level, user groups have significant influence on how decisions are made. However, stakeholder needs vary, and balancing conflicting demands is not simple. It is very important for resource managers to understand users — as well as policy and ecology.

The key to managing for the future is to remember that the Great Lakes are a dynamic and resilient ecosystem.

Want to learn more about the Great Lakes and the fishery? Check out the third edition of *The Life of the Lakes: A Guide to the Great Lakes Fishery*, now available through the Sea Grant Bookstore, see: www.miseagrant.com

specs: 120 pages, softcover, perfect bound and more than 280 graphics, pictures and charts. Dimensions: 8.5 x 11 in. ISBN: 978-1-885756-07-7

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MICHIGAN SEA GRANT
WATER SAFETY

SURVIVING DANGEROUS CURRENTS
The Great Lakes produce currents that can be dangerous for swimmers. Rip currents and channel currents are the two types of hazardous currents swimmers are most likely to encounter. The key to survival is learning what to do if you or someone else is caught in a current.

FLIP, FLOAT, FOLLOW YOUR WAY TO SAFETY
- Flip over onto your back and figure out which way the current is flowing.
- Float to keep your head above water and conserve energy.
- Follow the current until it weakens. Currents can dissipate quickly. Ride it out and swim perpendicular to the current back to shore.

PLAN AHEAD
Before you head out to the beach, check the beach conditions. The National Weather Service provides weather and water hazard forecasts and warnings throughout the U.S. That information can be used to make an educated decision about swimming at different times in different locations.

MORE INFORMATION
National Weather Service Forecast:
- Great Lakes Currents
  www.crh.noaa.gov/mqt/?n=rip_toc
- Surf Zone Forecast
  www.ripcurrents.noaa.gov/forecasts.shtml
- Learn more about Great Lakes currents:
  www.miseagrant.umich.edu/rip

RIP CURRENT
Rip currents are powerful currents of water moving away from shore. They can sweep even the strongest swimmer out to sea.

CHANNEL CURRENT
Wind and lake currents can create channel currents. Be careful when swimming near a tombolo (sand bar connecting an island to the mainland).

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