EXECUTIVE SUMMARY

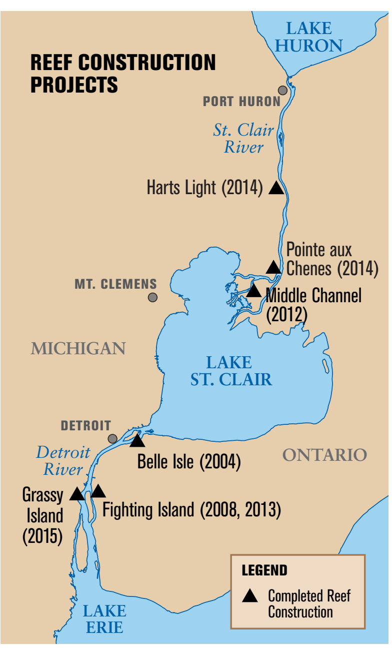
Science in Action: Lessons Learned from Fish Spawning Habitat Restoration in the St. Clair and Detroit Rivers

THE CASE FOR FISH SPAWNING HABITAT RESTORATION

In the Great Lakes region, the St. Clair and Detroit rivers historically served as some of the most important spawning grounds for fish such as lake sturgeon, walleye, lake whitefish and cisco.

However, many of the natural spawning grounds — limestone reefs and rocky areas — were destroyed when shipping channels were constructed. Similar spawning areas in tributary rivers were made inaccessible by dams or were damaged by shoreline development and sedimentation.

The waterways connecting Lake Huron and Lake Erie continue to support the largest remaining population of lake sturgeon in the Great Lakes, despite massive population declines overall. Restoration efforts in these rivers could help rebuild native fish communities throughout the Great Lakes. Many scientists believe that the recovery of lake sturgeon is hindered by a lack of accessible, high-quality habitat, including the rocky habitat needed to successfully incubate fish eggs.



Map of completed fish spawning reef projects in the St. Clair and Detroit rivers.

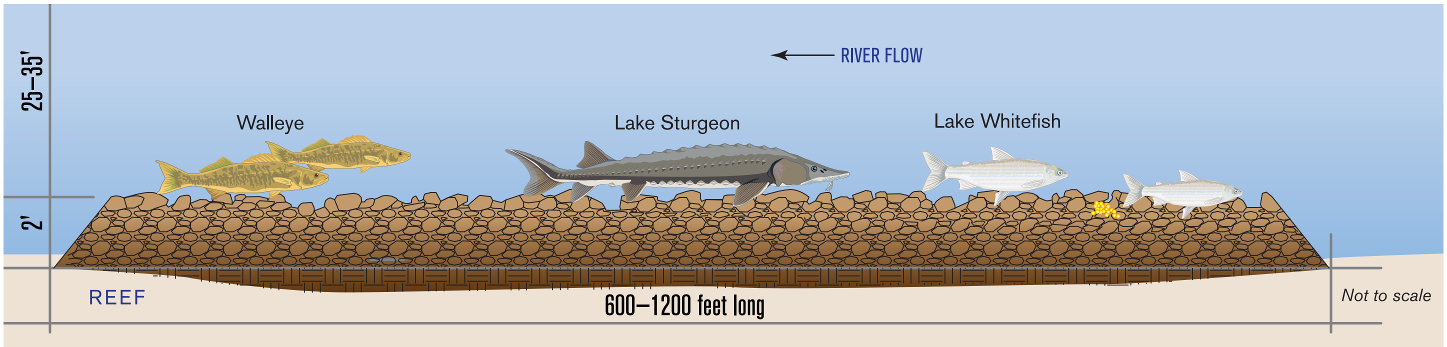
In 2001, a diverse team came together to restore rocky habitat in the river system by creating fish spawning reefs. By applying an adaptive management process when developing each project, the team has advanced scientific understanding and improved conditions for native fish. This process has led to new strategies for siting, designing and constructing spawning habitat and for facilitating productive adaptive management.

The team has distilled the lessons learned through six reef restoration projects completed between 2004 and 2015 in the St. Clair and Detroit rivers in a new report, which is summarized here.

AN ADAPTIVE MANAGEMENT FRAMEWORK

Adaptive management can be difficult to fully implement, and clear, applicable examples can be hard to find. The framework the restoration team adopted provided a structured process for experimentation, monitoring and decision making that identified and addressed the inherent uncertainty in ecological restoration. The team learned important lessons at each stage of the following adaptive management cycle.

- **ASSESS THE PROBLEM.** A range of evidence, as well as input from a diverse group of experts, helped develop working hypotheses to guide the team's strategy.
- **BUILD CONSENSUS.** Ongoing engagement with scientists, agency personnel, funders, stakeholder groups and residents ensured that the restoration projects were well supported and became part of a larger initiative to remediate the rivers.
- **DEVELOP A RESTORATION PLAN.** Each spawning reef project served as a large-scale experiment, with a carefully chosen location, design and monitoring plan. Each reef built on lessons learned during earlier projects, with the purpose of tackling remaining questions.
- **IMPLEMENT RESTORATION ACTIONS.** The team learned to expect setbacks during each project's permitting and construction processes. Unanticipated challenges often led to an improved design or new relationship with a stakeholder group.
- **MONITOR AND EVALUATE OUTCOMES.** By leveraging the resources of several state, federal and university research groups, the team was able to consistently conduct pre- and post-restoration assessments, capitalize on ongoing agency monitoring programs, and support discrete research projects to tackle emerging issues.



Cross section of a typical constructed fish spawning reef.

- **MAKE ADJUSTMENTS BASED ON LESSONS LEARNED.** Time, resources and communication were essential for fully analyzing and reviewing results. The team made a range of adjustments to the restoration process, including modifying hypotheses about which species would benefit from constructed reefs, changing the way restoration locations were chosen, expanding their team and improving the stakeholder consultation process.

AN ADAPTIVE MANAGEMENT TEAM

The reef team worked best when it included participants fulfilling distinct roles, including scientists, grant managers, team facilitators and coordinators, fishery managers, professional engineers, outreach specialists, local champions and a range of advisors. Key lessons learned include:

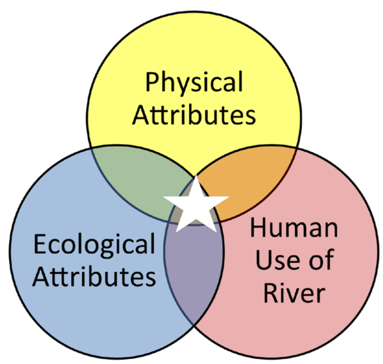
- Personal relationships and regional collaborations, such as the St. Clair–Detroit River System Initiative, helped the team coalesce and remain together for more than 10 years without a formal agreement.
- Team coordination and grant management required dedicated time and skills, which the team was able to build into budgets. Quarterly team meetings and regular email updates helped team members participate in ongoing decisions.
- Outreach and consultation were incorporated into all stages of project planning, using the connections of everyone on the team. The team regularly engaged stakeholders and members of the public, who often offered unanticipated assistance or objections.
- Shared decision making helped ensure that issues were anticipated and solved collectively, and everyone felt responsible and comfortable with plans. The contributions of team members were consistently acknowledged and good press was shared by all project participants.

PLANNING A SPAWNING REEF PROJECT

In the St. Clair and Detroit rivers, spawning reefs could not be created in the places where that habitat had once naturally existed — areas that had been altered by the construction of shipping channels. Therefore, the team was faced with the challenging task of finding the next-best location to create a reef, ideally in a location fish could find and where the rock would remain relatively free of algae and sediment.

The team reviewed studies about target fish species and combined this with knowledge of local fish populations and existing and historical spawning locations in the river system. Candidate restoration sites were identified using a GIS model that integrated siting criteria and helped the team to think systematically about the whole corridor. An iterative process that included modeling, field work and consultations allowed the team to locate projects based on ecological and physical attributes of an area, as well as human uses of the river. Ideal locations included the following key attributes:

- Deep waters, 25-50 feet, to limit algae growth
- Fast flows, at least 0.5 meters/second, depth averaged
- Outside of dredged navigation channels
- Connected to potential downstream nursery areas through water flow
- No known sediment contamination or point sources of pollution
- On the U.S. side of the border (for projects funded through U.S. grants)
- Areas where sturgeon travel and/or spawn based on telemetry studies
- Smooth, relatively flat, solid bottom with no existing habitat
- Shoreline property owners willing to provide permission
- No potential interference to marine navigation



Venn diagram illustrating the criteria used to select candidate restoration sites.

PROJECT PERMITTING, CONSTRUCTION AND MONITORING

Implementing a restoration effort involved a series of steps that did not always proceed in a linear fashion. Key lessons learned include:

- **FUNDING:** By showing success through initial pilot projects, the development of spawning reefs became part of the remediation plans associated with the St. Clair River and Detroit River Area of Concern programs. As a result, the team was able to attract funding through the Great Lakes Restoration Initiative for four of the six spawning reef case study projects. The team benefited from open communication with funders about successes, challenges and necessary project adjustments and delays.
- **REEF DESIGN:** The most recent projects consist of a single reef bed, 2 feet thick, covering 1.5 to 4 acres of river bottom. A long, narrow rectangle, oriented parallel to water flow, allows water and sediment to move smoothly over and around the reef.
- **ROCK TYPE:** The team experimented with a number of rock types during early reef projects and found that 4-8 inch angular, quarried limestone worked well for lake sturgeon and did not support sea lamprey spawning.
- **PERMITTING:** Each reef project has undergone a long and explicit review process, including state and federal permits. The team now consults with stakeholder groups early in the design process, including river remediation advisory councils, the commercial shipping industry, fishing groups and local residents.
- **CONSTRUCTION:** Water depth and shipping traffic influenced the selection of rock placement methods. Multiple project partners provided oversight through independent surveys and site visits.
- **MONITORING:** Before and after restoration, research teams evaluated the following criteria associated with each reef project: adult fish use of the area, egg deposition, larval fish production and physical conditions. Assessment techniques often needed to be modified for use in a large, busy river.

AVOIDING ISSUES WITH NAVIGATION AND SEDIMENTATION

Extra attention has been devoted to making sure constructed reefs do not interfere with commercial shipping and other uses of the river. Therefore, direct consultations with ship operators and others were conducted to understand how a particular location is used. In one location, the team decided a test reef was the only way to fully assess feasibility and potential impacts from commercial freighters.

Excessive sediment infilling and algae growth are known to deter fish from spawning in rocky areas. After realizing that sections of two reef projects were trapping more sand and silt than expected, the restoration team consulted with additional experts and significantly enhanced the site selection and project design process. Key lessons learned include:

- **IDENTIFY POTENTIAL SEDIMENT SOURCES.** A number of clues — such as dredging records and the current and historical shape of the river — can help identify areas within a river that typically experience erosion and deposition and identify potential sediment sources such as muddy tributaries or eroding shoals.
- **LOOK FOR INDICATORS OF SEDIMENT PROBLEMS.** The team used sidescan sonar, scuba divers and underwater cameras suspended from a boat to characterize the river bottom at a proposed restoration area. The team found that areas with significant loose sediment with visible waves or ripples should be avoided, while zebra and quagga mussel beds indicate a more stable river bottom that could be suitable for reef development.
- **MEASURE WATER VELOCITY CAREFULLY.** The team used Acoustic Doppler Current Profilers to measure and map water velocity and selected a specific reef locations with steady, high velocities.
- **MAKE USE OF MODELS.** Measuring sediment transport in the field is very challenging, so the team made use of river flow models and more recently, lab and computer simulations to evaluate locations and improve reef siting and design.

REEF PROJECT SPECIFICATIONS AND LAKE STURGEON SPAWNING OBSERVATIONS

REEF PROJECT NAME	BELLE ISLE	FIGHTING ISLAND	MIDDLE CHANNEL	POINTE AUX CHENES	HARTS LIGHT	GRASSY ISLAND
Project Specifications						
River	Detroit	Detroit	St. Clair	St. Clair	St. Clair	Detroit
Community	Detroit, MI	La Salle, ON	Clay, MI	Algonac, MI	East China, MI	Wyandotte, MI
Year Built	2004	2008, 2013 (expanded)	2012	2014	2014	2015
Size (acres)	0.3	2.0	1.0	1.5	3.8	4.0
Lake Sturgeon Spawning Observations						
Before Restoration	Absent	Absent	Absent	Absent	Few eggs	Absent
After Restoration	Adult fish, but no spawning detected	Spawning confirmed	Spawning confirmed	Spawning confirmed	Spawning confirmed	No data yet

FISH SPECIES OBSERVED ON REEF PROJECTS

	Belle Isle	Fighting Island	Middle Channel	Pointe Aux Chenes	Harts Light
Fish that show signs of spawning activity on reefs					
Black redhorse*		■			
Emerald shiner	●		▲		
Golden redhorse*			■	▲	
Lake sturgeon	■	●	● ▲	●	●
Lake whitefish	●	●			
Northern hog sucker*	● ■			▲	
Quillback*	●	■			
Rock bass	■	▲	▲	▲	▲
Round goby (non-native)	▲	● ▲	▲	▲	▲
Shorthead redhorse*	● ■	▲	■	▲	▲
Silver redhorse*	● ■	■	■	■	
Smallmouth bass	▲	■			
Stonecat		▲	■		▲
Trout-perch	●	●			
Walleye	● ■	● ■	● ■	● ■	● ■
White bass^	■	■	■		
White perch (non-native)^	■	■			
White sucker*	● ■	■	■	■	■
Fish that seem to be using the reefs in other ways					
Burbot		▲		▲	▲
Channel catfish		▲			
Common carp					▲
Creek chub			▲		
Darter			▲		
Gizzard shad	▲			▲	
Logperch	▲				
Mudpuppy		▲	▲		
Northern madtom	▲	▲	▲		▲
Northern pike	▲				
Slimy sculpin			▲		
Spottail shiner		▲	▲		
Tubenose goby	▲		▲		
Yellow perch	▲	▲			

● Eggs deposited on mats placed on reef
■ Spawning ready adults caught on reef
▲ Other adults or juveniles observed on reef

Table illustrates species caught on spawning reef sites between 2005 and 2015, after construction. Observations are influenced by sampling methodology and effort, which varies from site to site.

* A variety of sucker eggs were found at all reef sites, but were not usually identified to species, and therefore were not included in this table.

^ White bass and white perch eggs were found at sites with spawning ready adults, but eggs were not identified to species and were not included in this table.

SPAWNING REEF PROJECT CASE STUDIES

In 2004, the restoration team established its first pilot spawning reef project near Belle Isle in the Detroit River. The team has now developed three spawning reef sites in the St. Clair River and three sites in the Detroit River, with two additional locations possible as part of the Detroit River remediation plan to restore fish and wildlife habitat and populations. The full report includes detailed case studies of each reef project.

Pre- and post-restoration monitoring illustrates the fish species associated with constructed reefs (see table). Monitoring egg deposition on reef sites prior to restoration found no, or very limited, signs of sturgeon spawning. After the reefs were built, sturgeon spawning was confirmed on four of the five constructed spawning reefs.

Many other fish species have been observed using the reef projects; 18 native fish species have shown signs of spawning activity, including lake whitefish, walleye and a range of sucker species. Another 15 species have used the reefs in other ways, including northern madtom, a fish listed as endangered in Michigan. Initial results are promising; however, it will take many years and a multi-faceted monitoring effort to determine if the spawning reefs are increasing fish populations in the river system.

While most people will never see a constructed spawning reef on the river bottom, the projects are contributing to river-wide restoration efforts with benefits for local communities. For example, the St. Clair River has a popular catch and release and limited-take fishery for lake sturgeon, which attracts anglers from around the region. The gradual recovery of lake sturgeon and other native fish serves as an important symbol of how urban rivers can be restored and people can connect with their unique natural resources.

St. Clair – Detroit River System Initiative

Great Lakes RESTORATION

Restoration partners for the spawning reef case study projects include: Michigan Sea Grant, University of Michigan Water Center, U.S. Geological Survey, U.S. Fish and Wildlife Service, SmithGroup JJR, Michigan Department of Natural Resources, Essex Region Conservation Authority, Ontario Ministry of Natural Resources, Michigan Wildlife Conservancy, and St. Clair-Detroit River Sturgeon for Tomorrow. In addition to in-kind support from partner agencies, funding for reef restoration projects was provided by: Great Lakes Restoration Initiative, National Oceanic and Atmospheric Administration's Restoration Center, Sustain Our Great Lakes, U.S. Fish and Wildlife Service Coastal Program, Great Lakes Fishery Trust, Michigan Coastal Zone Management, Environment Canada, Ontario Ministry of Natural Resources, BASF, DTE Energy, and Michigan Wildlife Conservancy.

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For more information or to download the full report, visit: www.miseagrant.umich.edu/restoration