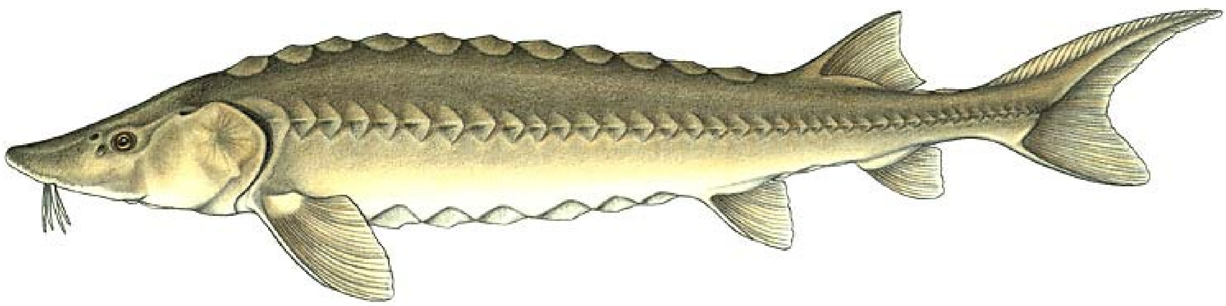
Ohio Lake Sturgeon Restoration Plan for the Lake Erie Watershed



Ohio Department of Natural Resources
Division of Wildlife
November 2025

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Prepared

November 2025

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Suggested Citation:
Weimer, E. J. 2025. Ohio Lake Sturgeon Restoration Plan for the Lake Erie Watershed. Ohio Department of Natural Resources, Division of Wildlife, Lake Erie Fisheries Research Units, Fairport Harbor and Sandusky.

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Guidance for Ohio's Lake Sturgeon Restoration Efforts in the Lake Erie Watershed

Purpose

This document describes the framework utilized by the Ohio Department of Natural Resources-Division of Wildlife (DOW) to make management decisions intended to restore self-sustaining spawning stocks of lake sturgeon (*Acipenser fulvescens*, hereafter referred to as "sturgeon") in Ohio's portion of the Lake Erie watershed. Management actions are intended to be long-term science-based decisions that will be dynamic as determined by outcomes measured through assessment and research. Success will only be possible through partnerships with state, provincial, and federal agencies, universities, municipalities, and non-governmental organizations.

Introduction

Sturgeon are an ecologically and culturally important native species that currently have greatly reduced abundance in Ohio waters of Lake Erie due to anthropogenic influence. Improvements in habitat and water quality, along with recent advances in population ecology and restoration science, suggest that reintroduction efforts could successfully reestablish self-sustaining spawning populations of sturgeon in historic spawning tributaries of Lake Erie. The DOW is working with key partners to assess conditions in these tributaries, evaluate the likelihood of successful sturgeon reintroduction, and identify reintroduction strategies in Ohio.

Background

Sturgeon are the largest and longest-lived fish in the Great Lakes and belong to one of the most threatened groups of vertebrates – order Acipenseriformes (Birstein 1993; Pikitch et al. 2005; Ludwig 2006). With a historical abundance estimated between 671,000 – 2.3 million fish (Haxton et al. 2014), sturgeon were once common throughout the Great Lakes. Anthropogenic impacts have led to the extirpation of sturgeon from many parts of their native range, reducing their populations to less than 1% of historic levels (Tody 1974). The widespread decline of sturgeon populations began in the mid-19th century through overharvesting and exploitation, degradation of critical habitats, construction of dams that blocked access to spawning habitat, and reduced water quality (Harkness and Dymond 1961; Scott and Crossman 1973; Trautman 1981; Auer 1996; Peterson et al. 2007).

Shifting perspectives on sturgeon utility - first regarded as a useless nuisance then as a valued commodity - had a profound impact on reducing their populations. Commercial fishermen initially regarded sturgeon as a nuisance because they often became entangled in nets and were therefore indiscriminately killed when encountered (Harkness and Dymond 1961; Scott and Crossman 1973). Sturgeon became a valued commodity with the establishment of commercial fisheries in the Great Lakes around 1860. Lake Erie, which historically contained a robust population estimated between 294,000 – 1.1 million adult fish (Haxton et al. 2014), supported the highest commercial harvest (Harkness and Dymond 1961; Scott and Crossman 1973). In Lake Erie, unregulated commercial harvest of sturgeon peaked at 2.3 million kg in 1885, followed by a rapid decline that reduced harvests by 80% within a decade (Harkness and Dymond 1961; Scott and Crossman 1973). By 1920, only a fragment of the Lake Erie fishery remained with an annual harvest of less than 2,300 kg, and all sturgeon commercial fisheries in the Great Lakes closed by the mid-1900's (Auer 1996).

Despite the closing of the commercial fishery, sturgeon populations were already imperiled, and the species became extirpated from many areas where it once thrived.

While overfishing may have significantly depleted sturgeon populations, their decline was compounded by dam construction and extensive habitat degradation. The widespread implementation of dams impeded access to critical spawning areas and reduced habitat availability. Additionally, deforestation, siltation, log sluicing, and pollution from manufacturing further degraded remaining areas (Harkness and Dymond 1961; Trautman 1981; Auer 1996). Life history characteristics, such as slow growth and maturation, imprinting and returning to natal streams for spawning, and intermittent spawning allowed sturgeon to thrive for the last 100 million years. However, these same characteristics now exacerbate pressures influencing their decline (Rochard et al. 1990; Birstein 1993; Auer 1996; Beamesderfer and Farr 1997).

Lake Erie currently supports two self-sustaining spawning stocks of sturgeon (Upper Niagara River and St. Clair/Detroit Rivers, Figure 1; Withers et al. 2019; Mettler et al. 2022), down from the 19 spawning stocks historically present throughout the lake (Goodyear et al. 1982, Collier et al. 2022). There is no evidence of self-sustaining spawning stocks remaining in Ohio waters, where sturgeon are a State-listed endangered species. With low population numbers, regional extirpation, and unique life history characteristics, management intervention is needed to rehabilitate populations.

Management Authority and Guiding Principles

The DOW is responsible for the management of fish and wildlife resources as mandated by Ohio law through the Ohio Constitution, the Ohio Revised Code Sections 1531 and 1533, and the Ohio Administrative Code. The DOW's mission is to "conserve and improve fish and wildlife resources and their habitats for sustainable use and appreciation by all." Sturgeon's endangered status in Ohio allows DOW to adopt additional rules regarding take and possession and provide direction for the allocation of personnel time and funds in management programs and projects.

As a shared jurisdictional resource, Lake Erie fisheries are managed through consensus between Ohio, Michigan, New York, Pennsylvania and the province of Ontario via participation in the Great Lakes Fishery Commission's Lake Erie Committee (LEC). The LEC has established Fish Community Objectives (Francis et al. 2020), which identify sturgeon as a Rehabilitation Species, with the following Objective and Status Indicator:

- **Objective:** Support the preservation of existing spawning stock and rehabilitation of spawning stocks in historic spawning locations.
- **Status Indicator:** Maintain or increase adult abundance in existing spawning sites (SCDRS, Upper Niagara River, and Buffalo Harbor) and establish an adult spawning stock in at least one new spawning location.

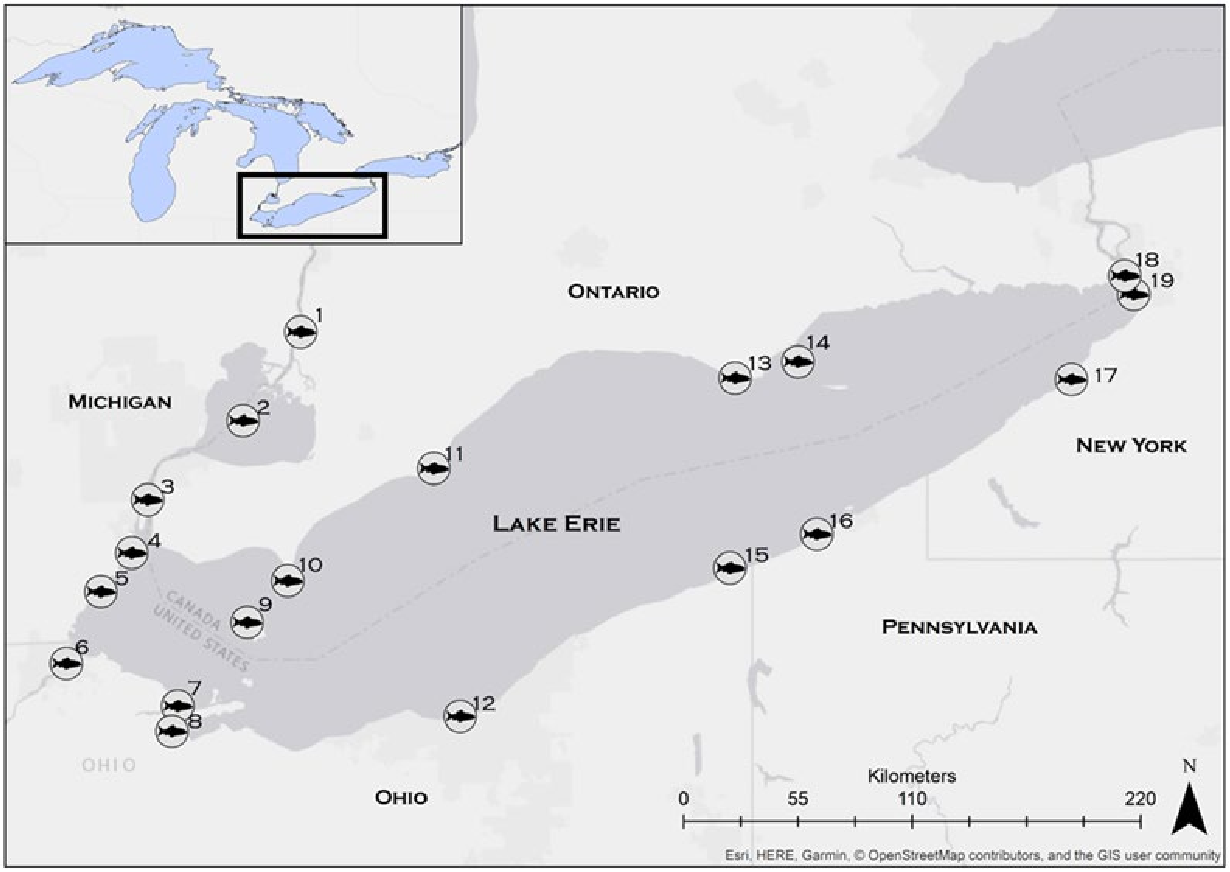

Figure 1. Map of historic sturgeon spawning sites in the Lake Erie basin based on data from Goodyear 1982. The fish icons indicate the historic spawning sites and the corresponding numbers represent the following site names: 1. St. Clair River; 2. Lake St. Clair; 3. Detroit River; 4. Huron River; 5. Stony Point; 6. Maumee River; 7. Portage River; 8. Sandusky River; 9. Pelee Island; 10. Point Pelee shoals; 11. Rondeau Harbor; 12. Cuyahoga River; 13. Clear Creek; 14. Long Point Bay; 15. Conneaut (nearshore); 16. Walnut Creek; 17. Cattaraugus Creek; 18. Upper Niagara River; 19. Eastern basin. Figure reprinted from Collier 2018.

Acknowledging the importance of sturgeon in the Lake Erie ecosystem and their value to the citizens of Ohio, the DOW, in partnership with the USFWS and other agencies, universities, and conservation-minded organizations, has established a process for evaluating tributaries for reintroduction activities. This process includes:

1. Determine historical documentation of sturgeon spawning in tributary, and that sturgeon are no longer using it for spawning.
2. Develop and utilize a Habitat Suitability Index (HSI) to determine whether current tributary habitat is sufficient to support:
    a. Adult spawning population of sufficient size and quality to maintain future self-sustaining reproduction.
    b. Juvenile habitat of sufficient size and quality to support future larval/juvenile growth and survival.
3. Determine whether a genetically appropriate source of fertilized gametes is available.
4. Determine stocking strategies (numbers, locations, duration, etc.)

Documentation

Documenting the use of specific tributaries is key to justifying efforts in the following steps of the process as these are reintroduction efforts and not attempts to establish spawning populations where they were not historically present. Reviews of established scientific literature, especially those centered on historical distributions of sturgeon, are especially useful. However, searching through historical archives from newspapers and other local documents can help establish sturgeon presence in some locations. Fisheries assessments can be used to document whether sturgeon are presently found in historic spawning tributaries. For example, trotlines, gill nets, and electrofishing were used to verify that sturgeon adults were not using the Maumee River during seasonally appropriate spawning conditions in the late 2000s (Boase 2008).

Habitat Assessment and HSI Development

Habitat assessment is an important step to determine whether sturgeon habitat quality is sufficient to support restoration of a spawning population. Sturgeon are lithophilic broadcast spawners that prefer coarse substrates – such as gravel, cobble, or boulders ranging from 10 to 50 cm in diameter - along with water depths from 0.3 to 6.0 meters, and water velocities from 0.3 to 1.77 m/s for successful spawning (Harkness and Dymond 1961; Scott and Crossman 1973; Kempinger 1988; LaHaye et al. 1992; Threader et al. 1998; Bruch and Binkowski 2002; Manny and Kennedy 2002). Water temperatures from 9-16 °C are also required. Coarse substrates with interstitial spaces are essential for protecting demersal eggs and newly hatched larvae from predation, while also facilitating water circulation to oxygenate the eggs and keep them clean of particulates in the water column. Larval sturgeon remain in the interstices of coarse substrates until the yolk sac is absorbed (Kempinger 1988). In most systems, age-0 sturgeon disperse to habitats characterized by fine sediments (i.e., sand, silt, and gravel; Threader et al. 1998; Holtgren and Auer 2004), slightly slower water velocities ranging from 0.1 to 0.7 m/s (Auer and Baker 2002; Benson et al. 2005; Dittman and Zollweg 2006), and water depths similar to those used by adults, typically between 0.2 and 6 m (Kempinger 1996; Threader et al. 1998; Benson et al. 2005; Friday 2004).

Habitat assessments that target the key habitat parameters mentioned above (substrate type, water velocity and depth) are necessary for evaluating the potential success of sturgeon reintroduction efforts. Substrate surveys can incorporate physical and remote sampling techniques, depending on stream reach characteristics. Physical sampling along cross-stream transects has been used to collect substrate data for later extrapolation, but the use of sidescan sonar is becoming increasingly popular due to its ease and speed in mapping substrate features. Often, both methods are used when streams have areas too shallow for accurate sidescan data collection. Water velocities are typically surveyed using an Acoustic Doppler Current Profiler (ADCP) in cross-stream transects and expanded to the entire river reach. Because water velocity is correlated with depth, these parameters are commonly modeled and extrapolated across geospatial grid cells (e.g., 1mx1m or 3mx3m) throughout the stream reach. Hydrologic Engineering Center River Analysis System (HEC-RAS) models have been applied in Lake Erie tributaries in Ohio to model depth across various discharges that represent both spawning and juvenile habitat conditions. Temperature data are collected from either USGS gauging stations or using temperature loggers. Finally, habitat classifications are delineated using geospatial software, and targeted physical sampling and satellite imagery are used for ground-truthing. For additional information on the habitat assessment in Lake Erie tributaries, please see Boase 2008, Collier 2018, Schmidt et al. 2020, Myers et al. 2024, and Fischer in prep.

Once these habitat surveys have been completed, Habitat Suitability Index (HSI) models are used to estimate the amount of good quality sturgeon spawning and juvenile habitat available within a tributary. These estimates are critical for determining whether reintroduced sturgeon populations will become self-sustaining following stocking efforts. HSI outputs are also used to inform decisions about annual stocking rates and to help predict the expected size of the adult stock that the habitat can support. Prior research from scientific literature has been used to develop HSIs for spawning adult sturgeon and juvenile sturgeon (Collier 2018). The means of each habitat layer are used to generate an HSI score (scaled from 0 to 1) for each geospatial cell.

Once these HSI scores are calculated for each cell in the river reach, the amount of good/moderate/poor spawning and juvenile habitat can be calculated and used to determine whether sufficient habitat is available to restore a self-sustaining spawning population of sturgeon. In the Great Lakes region, stable or increasing populations of sturgeon consist of a minimum of 750 sexually mature adults (Welsh et al. 2010). For small systems, a minimum of 750 adults should be the target for a 25-year stocking program, though that number may vary depending on management goals and habitat availability. Dumont et al. (2011) suggests that 3.6 hectares of spawning habitat is needed to support 750 spawning females, and Bruch and Binkowski (2002) used 0.07 hectares as the minimum patch area required to support spawning. The results of the HSI are used to determine whether these minimums are met. Generally, tributaries in Ohio contain abundant soft sediments that are required by juvenile sturgeon and are not considered limiting like adult spawning habitat.

For additional information on the sturgeon HSI development and use in Lake Erie tributaries, please see Collier (2018, 2022), Baril et al. (2019), and Fischer et al. (in prep).

Gamete Source and Collection

It is important to stock sturgeon from a source population that is genetically appropriate for Lake Erie and nearby spawning stocks. Welsh et al. (2010) grouped similar sturgeon stocks into Genetic Stocking Units (GSU) to identify genetically appropriate sources for stocking throughout the Great Lakes. For Lake Erie, the St. Clair River spawning stock, which consists of 20,000 to 30,000 sturgeon, has been identified as an appropriate source of gametes for reintroduction efforts in Ohio.

Gametes are collected by USFWS staff from late-May to early-June in Port Huron, Michigan, using set lines. To maintain genetic diversity, a target of 7 females and 28 males (1 female:4 males) are collected to achieve an annual effective population size $\geq$ 20 (Welsh et al. 2010). Sturgeon are held until females are ready to spawn, after which eggs from each female are fertilized with milt from multiple males. Fertilized eggs from each individual family (male/female cross) are held and reared separately to track family survival and growth and to ensure genetic diversity is maintained at stocking. Most eggs/juveniles are reared at the USFWS Genoa National Fish Hatchery in Genoa, Wisconsin, although some are reared in streamside facilities to compare stocking success and return rates between traditional and streamside hatcheries.

For more information on gamete collection, fertilizing, and rearing, please see Fischer et al. in prep.

Stocking Strategies

Juvenile sturgeon will be transported from the rearing facility to the stocking site in early October, ideally once they reach a mean total length greater than 180 mm and survival is expected to exceed 80% (Baker and Scribner 2017). Each sturgeon will receive a passive integrated transponder (PIT) tag several weeks prior to transportation, which allows linkage of each individual fish to rearing, biological, and genetic family information. Fish will be held in transport tanks for less than 24 hours prior to stocking; however, this duration may be exceeded due to the logistics of release locations and scheduled public outreach activities.

The number of sturgeon stocked will vary by river, reflecting differences in target population sizes and potentially different juvenile survival rates. Where the target is 750 adult sturgeon and fingerling survival is estimated at 50%, the stocking rate will be 750-1,500 fingerlings annually for 25 years, depending on availability (both in terms of total numbers and equal family size; Welsh et al. 2010). Estimates of survival for stocked sturgeon in the Maumee River will be applied to other tributaries in Ohio (McKenna et al. in prep). Larger tributaries with abundant spawning habitat may support larger populations of sturgeon. In Ohio, reintroduction efforts are currently underway in three Lake Erie tributaries, each with a different stocking rate. In the Maumee River, sturgeon have been stocked at a rate of 3,000 fish annually since 2018 and will continue through at least 2038. Stocking began in the Cuyahoga River in 2025, with 1,500 sturgeon scheduled to be stocked annually through 2045. Habitat evaluation in the Sandusky River has recently been completed and annual stocking of 750 sturgeon commenced in 2025. See Appendix 1 for additional stocking strategy information for each tributary.

Ongoing Efforts

Sturgeon reintroduction will be informed by ongoing research and assessment. Since reintroduction efforts began in 2018, a subset of stocked sturgeon in the Maumee River have been implanted with acoustic transmitters to evaluate post-stocking movement and survival (McKenna et al. 2025; McKenna et al. in prep). These projects have shown that annual juvenile survival post-stocking is generally high (19-71%), which has informed stocking strategies for future reintroduction efforts in the Maumee and elsewhere. This work has also shown that sturgeon typically spend little time in the Maumee River after stocking, migrating to Lake Erie within a few weeks. However, during low flows, stocked sturgeon may remain in the river significantly longer (M. Kindler, pers. comm.).

Results from the 2024 pilot project indicate that transmitter-tagged juvenile sturgeon in the Cuyahoga River exhibit post-stocking movements similar to those observed in the Maumee River. However, fish stocked farther upstream spend significantly more time in the river than those stocked downstream (M. Acre, pers. Comm.). Also, sturgeon appear to move downstream mostly after dark and will pass through areas with extensive bedrock substrates faster than areas with different substrate characteristics. These results may be used to refine future stocking locations to maximize river acclimation and survival.

As we approach 10 years of stocking sturgeon in the Maumee River, partner efforts to assess sturgeon abundance in Lake Erie and the tributaries are increasing. The USFWS has been assessing sturgeon abundance in several locations for years, and those efforts will continue as more sturgeon, especially males, reach maturity and may return to their stocked rivers. Partners will plan for additional efforts, including netting, electrofishing, and possible PIT tag arrays in the future to document returns and guide future reintroduction efforts.

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Appendix 1. Available ‘Good’ spawning and juvenile sturgeon habitat (as determined by HSI modelling, reported in hectares (ha)), spawning population objective, annual stocking numbers, and year stocking began in Ohio tributaries of Lake Erie to restore a self-sustaining spawning population.

Tributary	‘Good’ Spawning Habitat (ha)	‘Good’ Juvenile Habitat (ha)	Spawning Adult Objective	Annual Stocking Objective	Year First Stocked
Maumee River	156	529	1,500	3,000	2018
Cuyahoga River	22.6	107.7	750	1,500	2025
Sandusky River	15.5	N.A.	750	750	2025