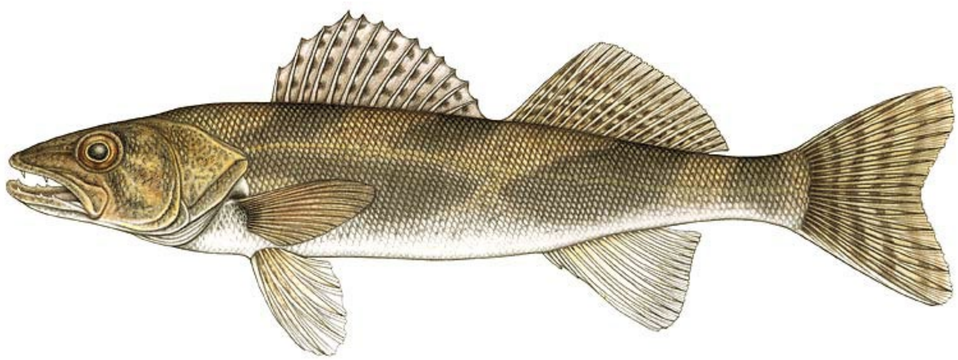
Ohio Sauger Restoration Plan for the Lake Erie Watershed



Ohio Department of Natural Resources
Division of Wildlife
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Guidance for Ohio's Sauger Restoration Efforts in the Lake Erie Watershed

Purpose

The Ohio Department of Natural Resources Division of Wildlife (DOW) intends to reintroduce Sauger *Sander canadensis* with the goal of restoring a naturally reproducing stock into select western basin Ohio tributaries that will ultimately return a native percid to Lake Erie and provide sustainable recreational fisheries in the tributaries and nearshore areas of Lake Erie. To achieve this, the DOW will develop the capacity to annually stock 500,000 fingerling Sauger for up to 10 years between the Maumee and Sandusky rivers, with stocking split between river and bay sites. Reintroduction will commence as early as 2026 as we build hatchery production capacity, and stocking strategies (life stage, density, location, etc.) will adapt as informed by additional research and assessment.

Introduction

Sauger are a native percid that ranges from the Great Lakes through the plains of the U.S.A. and Canada, particularly associated with large river systems like the Mississippi, Missouri, Ohio, Ottawa, and Illinois rivers. Sauger provide important recreational fisheries throughout their range. Though once historically abundant in Lake Erie, Sauger are now considered extirpated. There is considerable interest in Ohio in restoring native Sauger to their environmental niche and potentially creating a year-round sport fishery in tributaries, bays, and nearshore areas of western Lake Erie.

Background

Reliable reports of Sauger in Ohio can be found beginning in 1885, when commercial landings in Lake Erie ports surpassed 2.3 million kg (Smith and Snell 1891). Saugers occurred in shallow, turbid areas of Lake Erie, particularly in the western basin. In 1951, approximately 60% of commercial landings of Sauger in Ohio came from Management District 1 (west of the port of Huron), with the remaining 40% coming from District 2 and 3 combined (east of Huron; Cummins 1952). Landings of Lake Erie Sauger fluctuated and declined until 1968 (Figure 1), when the commercial catch for all ports in Ohio was only 28 kg (Applegate and Van Meter 1970; GLFC 2022). Since 1968, commercial fishing for Sauger has not been permitted (Trautman 1981).

The DOW stocked Sauger into Sandusky Bay from 1974 to 1976 (Table 1), and successful spawning was documented in both the Sandusky and Maumee rivers (Rawson and Scholl 1978). Additional stockings occurred from 1979 to 1983 in Sandusky Bay and the Grand River. These stockings resulted in a recreational fishery in the Sandusky and Maumee systems, particularly during summer months when walleye typically move east to cooler water; however, recruitment from natural reproduction remained insufficient to establish a self-sustaining population. After stocking efforts ended, recreational and commercial (Ontario Ministry of Natural Resources, personal communications) catches of Sauger in Lake Erie and its tributaries quickly declined to incidental levels (Snyder 1991; Leonardi and Thomas 1997).

Reasons for the failure of the first reintroduction attempt are unknown, but several factors seem likely. Despite improvements from the severe pollution and poor water quality of the 1960s, Lake Erie was still recovering in the 1970s. Habitat degradation, including the presence of dams blocking access to potential spawning habitats, may have prevented reproduction by stocked Sauger and successful recruitment. Additionally, broodstock used for stocking were sourced from available populations, which may not have been well adapted for Lake Erie conditions. Addressing these potential barriers to Sauger restoration has since become a management priority.

Several projects have been completed as part of the reintroduction process to inform management decisions related to Sauger reintroduction. The first project determined the availability of genetically appropriate Sauger broodstock for restoration. While Sauger expanded from a single glacial refuge, at least some unique genetic traits appear to have developed within and among populations (Billington 1996, 1998; Billington et al. 2006). If the historical Lake Erie Sauger population was genetically distinct, then stocking fish from another genetic population may be detrimental to any remnant Lake Erie Sauger or may be at a competitive disadvantage in the Great Lakes. During the restoration attempt in the 1970s, Sauger from the Missouri River drainage were stocked in Lake Erie; perhaps this was a reason for the failure of this reintroduction attempt. To better understand the historic genetic makeup of Lake Erie Sauger and determine whether there is a better source of broodstock for the current reintroduction effort, Hartman et al. (2019) sought to use historic scale samples from Lake Erie Sauger to compare to contemporary Sauger populations from the Ohio River, Missouri River, Ottawa River, Lake of the Woods, and Lake Winnebago. Their work found genetic differentiation between potential donor populations and historic samples from Lake Erie Sauger, with Ohio River populations being most like historic Lake Erie Sauger. Their results suggest that broodstock collected from the Ohio River may provide the best chance at successful reintroduction (Appendix Tables a.1-3.; Appendix Figures A.1 & A.2).

A second project evaluated spawning habitat in the Sandusky and Maumee rivers to determine whether these systems are currently suitable for Sauger reproduction (Anderson 2025). An additional objective included whether Sauger spawning habitat in both rivers is spatially distinct from Walleye *Sander vitreus* spawning habitat, thereby minimizing the likelihood of hybridization. Although both rivers showed early signs of success during initial restoration efforts, these attempts ultimately failed. Both rivers also support naturally reproducing Walleye stocks, and overlapping of spawning habitat between the two species has been a concern among Lake Erie managers. Using

Habitat Suitability Index (HSI) models for Sauger and Walleye, Andersen found that there is sufficient Sauger spawning habitat in both rivers with little overlap between species (Appendix Tables A.4-6.; Appendix Figure A.3.). In addition, the removal of the Ballville Dam on the Sandusky River in 2018 restored access to 35 km of river, including 22 hectares (ha) of Walleye spawning habitat (Hunkins et al. 2025). While access to some spawning habitat may be reduced at high water velocities (Anderson 2025; Myers 2024), Sauger should still have access to more spawning habitat in the Sandusky and Maumee rivers than during the previous reintroduction effort.

With an appropriate source of broodstock identified, and models suggesting sufficient Sauger spawning habitat available and little impact to walleye spawning from overlapping habitat, the DOW will proceed with reintroduction in western Lake Erie. Barriers will be addressed as efforts are evaluated.

Management Authority and Guiding Principles

The DOW is responsible for the management of fish and wildlife resources as mandated by Ohio law as found in 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." The DOW has previously used this authority for native species reintroduction efforts in Lake Erie, including Lake Sturgeon *Acipenser fulvescens* and Lake Trout *Salvelinus namaycush*.

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 Sauger as a Rehabilitation Species.

Acknowledging the importance of Sauger in the Lake Erie ecosystem and their value to the citizens of Ohio, DOW follows a process for evaluating tributaries for reintroduction activities. For Sauger this process includes:

1. Determine historical documentation of Sauger spawning in tributary/ies, and that Sauger are no longer using it for spawning.
2. Develop and use an HSI model to determine whether current tributary habitat is sufficient to support an adult spawning population of sufficient size and quality to maintain future self-sustaining reproduction.
3. Determine whether a genetically appropriate source of fertilized gametes is available.
4. Determine appropriate stocking strategies (numbers, locations, duration, etc.).
5. Obtain LEC consent prior to initiating stocking efforts.

Barriers to Restoration

Potential barriers to successful reintroduction of Sauger into Lake Erie tributaries have been identified and will require additional research and monitoring. Other than some records of fry stocking in Lake Erie from the early 1900s, Sauger have not been hatched and reared in the DOW hatchery system (the fish stocked during the 1970s and 1980s were reared by the US Fish and Wildlife Service). However, Ohio has extensive experience hatching and rearing Walleye and saugeye (*Sander canadensis* × *vitreus*, Walleye x Sauger hybrid) in the hatchery system. Work is ongoing to determine whether Sauger gamete collection, hatching, and rearing to fingerling size is feasible within the Ohio hatchery system. Early results suggest that the limiting factor may be the collection of sufficient gravid female Sauger for egg collection from the Ohio River as testicular harvest techniques allow for sperm collection (Blawut et al. 2020; Blawut et al. 2018). Researchers at the DOW Inland Fisheries Research Unit are evaluating collection and rearing methodology to determine whether the annual production of 500,000 fingerling Sauger is feasible, a target based on the available habitat in the two rivers and bays at a stocking rate of 125-250/ha (Anderson 2025; Mammoliti 2007). If this target is not feasible, other stocking strategies need to be considered (stocking density, fingerling vs. fry, etc.). During the early stages of this work, any fingerlings produced will be stocked as pilot stockings until the annual production and stocking target is achieved.

A second potential barrier to successful reintroduction is the current Walleye population in Lake Erie, particularly in the west basin. Walleye have become abundant over the last decade due to exceptional recruitment, with hatch indices in the west basin being above the long term mean in 8 of the last 12 years (Walleye Task Group 2025). This raises two concerns: first, what impact might this high-abundance predator population have on post-stocking Sauger survival? Secondly, will reintroduction efforts result in hybridization? The potential predation impact is unknown and may depend on Sauger behavior and movement post-stocking. Research utilizing acoustic telemetry and/or traditional diet sampling may address this unknown. Hybridization is currently less of a concern due to the Anderson (2025) work showing differences in spawning habitat between the two species, and natural hybrids are uncommon where their distributions overlap (Hartman et al. 2019; Trautman 1981). However, introgression with walleye may have contributed to the demise of Lake Erie Sauger (Hartman et al. 2019), and Walleye x Sauger hybrids do occur naturally in the Ohio River (White et al. 2005). Once natural reproduction is established, genetic testing of Sauger and Walleye may add insight into the amount of hybridization and its potential impact on Lake Erie Walleye and Sauger populations.

The impact of invasive dreissenid mussels on water clarity in Lake Erie is another potential barrier to restoration. First detected in Lake Erie in 1989, these mussels have become abundant. As filter feeders, one of the impacts these invaders have had is increased water clarity through feeding on phytoplankton. As Sauger are generally found in rivers and lakes with relatively high turbidity (Trautman 1981), it remains to be seen whether western Lake Erie remains as suitable for Sauger as it was historically. However, with Walleye, which are more tolerant of clear water (Trautman 1981), at current high abundance, it seems likely that Sauger will be able to tolerate western Lake Erie conditions.

A final barrier related to the development of a recreational fishery is associated with the current harvest regulations in Ohio's Lake Erie Sportfishing District. Currently, Walleye, Sauger, and saugeye are managed under the same regulations on Lake Erie, which includes a 15" minimum size. Sauger exhibit slower growth rates than Walleye, and, in some regions have a shorter life span. These factors may render a 15" minimum size limit too restrictive to support a dedicated harvest fishery. Sauger-specific regulations may be considered at some point if restoration is successful; however, this would likely require angler outreach efforts to improve sauger identification, especially amongst casual Lake Erie anglers. This would help prevent harvest of mis-identified walleye. One potential benefit of the current regulations would be that mature Sauger should have multiple opportunities to spawn prior to reaching legal size for harvest, further increasing the odds of establishing a self-sustaining population.

Stocking Strategy

This reintroduction plan is dynamic in nature, and the stocking strategy should be reevaluated as hatchery production capacity is determined, and survival of stocked fish is assessed. The following is the initial proposal for stocking implementation:

- 2026 and 2027 - Two years of hatchery production trials, with the resulting fingerlings or fry being used as initial pilot stocking. During these years, fingerlings should be evenly split between the two watersheds, unless the total number produced is less than 100,000. When less than 100,000 fingerlings, or if only fry, are produced, only the Sandusky watershed will be stocked.
- 2028 through 2037 - Ten years of production stocking with an annual target of 500,000 fingerlings to be split into two groups based on available habitat in each watershed (Sandusky and Maumee). Within each watershed three stocking locations of equal numbers of fingerlings will be selected, one location in each of the following regions: upper river, lower river, and bay (see Figure 2 for potential stocking locations in each region).
- Life stage - Fingerlings will be prioritized over fry. After fully allocating fry to production ponds, excess fry will be stocked in the rivers as determined appropriate.

- Marking - Regardless of life stage, stocked fish for at least one watershed should be consistently marked with Oxytetracycline (OTC) treatments to evaluate survival and growth by river and contributions from natural reproduction.
- Broodstock - Adult Sauger from the Ohio River will initially be used for fingerling production. Initial sauger research (FIDR26 and FIDR26) indicates that collecting mature female sauger is likely to be the bottleneck. If collection of broodstock from the Ohio River limits our ability to meet production requests, collecting adults from Lake Erie tributaries can be evaluated if survival of stocked fish results in access to adults during spring spawning migrations.

Ultimately this plan will only be considered successful if sustainable natural reproduction removes the need to stock. While a total of 12 years of stocking has been proposed, it is acknowledged that numerous factors could lead to changing, discontinuing, or extending the plan. This plan is an attempt to reestablish a native Lake Erie sport fish, but other priorities may dictate significant changes to the proposed reintroduction. This plan will be updated as strategies clarify/change and will be informed through assessment and research.

Assessment and Evaluation

No Sauger-specific surveys are currently planned to assess post-stocking survival and movement; however, surveys currently in place by DOW and partner agencies will likely provide data to evaluate reintroduction efforts. Nearshore electrofishing is conducted in mid-summer at up to 20 sites along western Lake Erie, including several sites in the Maumee and Sandusky bays. Several trawl survey sites are located near Maumee Bay, and one in Sandusky Bay, which are sampled monthly from May through September, and fall gill net surveys may catch adult Sauger in Lake Erie proper. Partners work regularly in these rivers and bays, including grass carp *Ctenopharyngodon idella* removal efforts by the University of Toledo and USFWS, and invasive species and lake sturgeon sampling by USFWS. These surveys should provide Sauger catch data for assessing stocking success, growth, and movement.

In addition, marking fingerling Sauger prior to stocking may be used initially to identify differences in survival between fish stocked in different locations (Figure 1) and contributions from natural reproduction. Oxytetracycline treatments of fingerlings can leave a chemical signature on the otolith of Sauger, and OTC marking of fish being stocked into one system will allow managers to compare relative success during the first years of restoration (prior to establishing numbers of sexually mature adults in these systems). This could also be used to compare river and bay stocking survival during these first years. As mature adults are established from early stocking, OTC marking all fingerlings can assess the contribution of natural reproduction among collected Sauger.

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Table 1. Ohio sauger stocking records in Lake Erie from prior reintroduction efforts. This table was compiled from various unpublished sources, and in some cases, there were discrepancies between the sources. This should be considered as a subjective summary.

Year	Number	Life Stage	Location
1974	229,100	fingerlings	Sandusky Bay
	330,000	fry	Sandusky Bay
1975	213,000	fingerlings	Sandusky Bay
	285,000	fry	Sandusky Bay (unconfirmed location)
1976	110,000	fingerlings	Sandusky Bay
1979	100,000	fingerlings	Sandusky Bay
	10,000	fingerlings	Grand River
1980	85,000	fingerlings	Sandusky Bay
1981	51,000	fingerlings	Sandusky Bay
	241,500	fry	Sandusky Bay
	10,500	fingerlings	Grand River
1982	76,650	fingerlings	Lake Erie (likely Sandusky Bay)
1983	262,487	fingerlings	Sandusky Bay

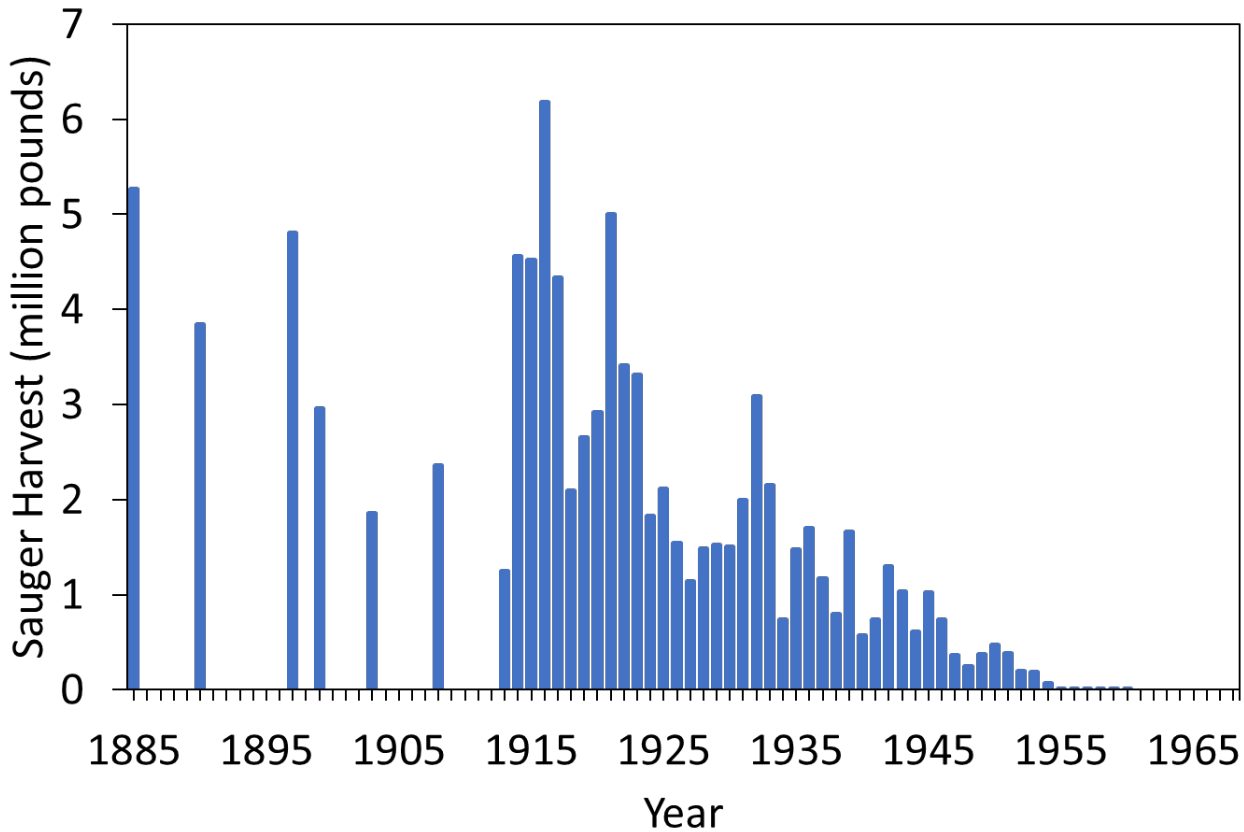
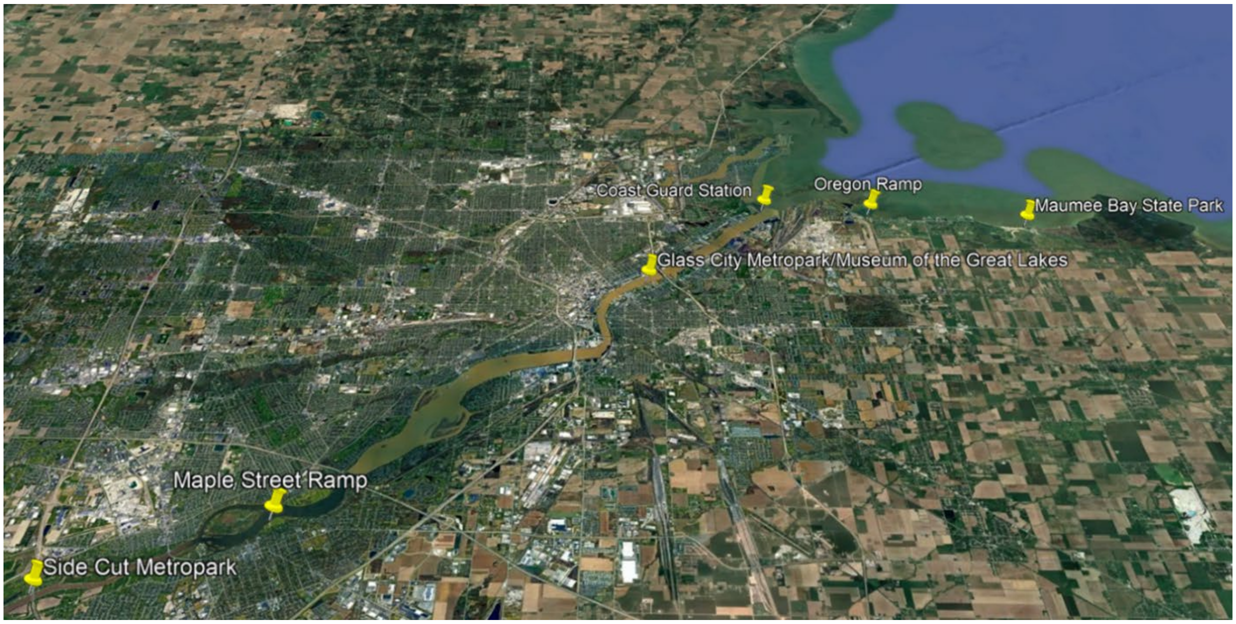


Figure 1. Commercial harvest (million pounds) of sauger in Ohio's waters of Lake Erie, as reported in GLFC (2022). Harvest reporting prior to 1914 is likely incomplete and underrepresented.



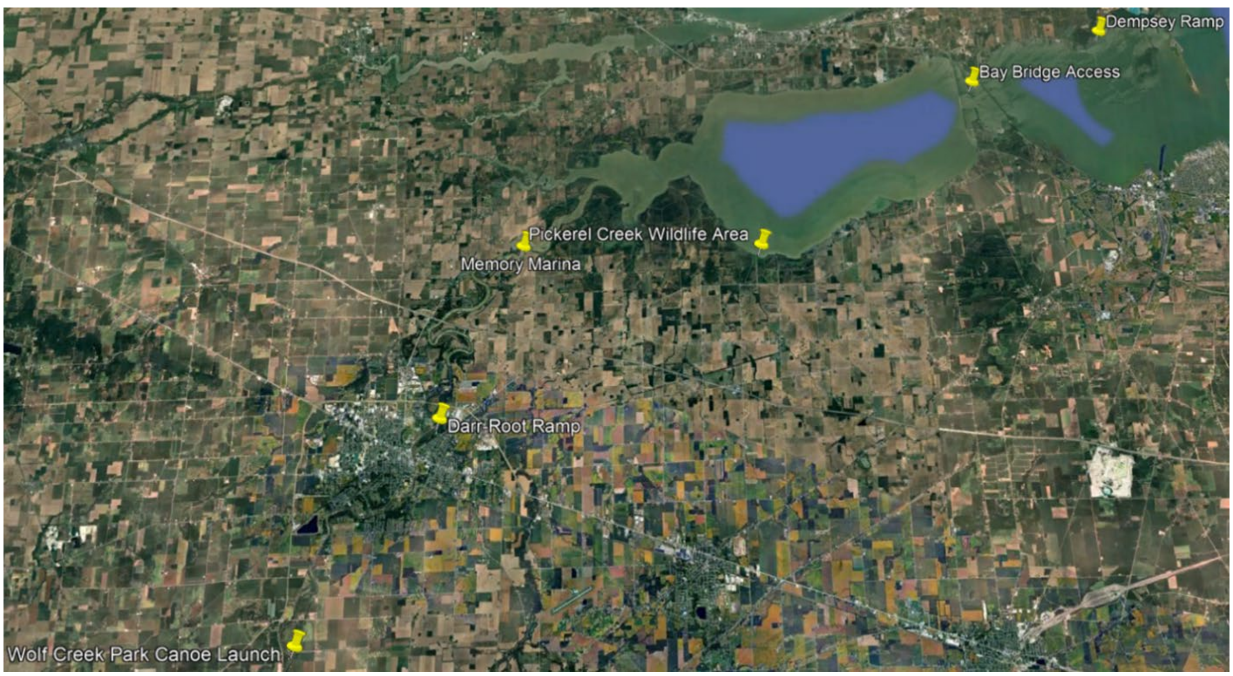


Figure 2. Potential sauger stocking locations in the Maumee (top) and Sandusky (bottom) rivers and bays. Images were created with Google Earth.

Appendix

Table A.1. Collection sites and sampling years for sauger used in genetic analyses (Hartman et al. 2019).

Collection Site	River/Lake	Total Sample Size	Year								
			1932	1955	1957	1958	2008	2009	2010	2011	2013
Moreau River	Missouri River	1									1
Oahe	Missouri River	25									25
Lake Sharpe	Missouri River	12									12
Francis Case	Missouri River	22									22
Lake of the Woods	Lake of the Woods	63								63	
Lake Winnebago	Lake Winnebago	61									61
Meldahl	Ohio River	60							60		
Bellville	Ohio River	60							60		
New Cumberland	Ohio River	53							34	19	
Western Lake Erie	Lake Erie	30		28	1	1					
Port Clinton	Lake Erie	90	90								
Lake Temiscaming	Ottawa River	19					19				
Allumette	Ottawa River	1					1				
Lac Deschenes	Ottawa River	41						41			
Dollard des Ormeaux	Ottawa River	7						7			

Table A.2. Ecological conditions of systems for potential source populations of sauger for Lake Erie Restoration (Hartman et al. 2019).

Potential Source	System Type	Size	Depth	Trophic Status	Secchi Depth	Substrate
Western Lake Erie	Natural lake with large tributaries	328,000 ha	Mean = 7.4 m Maximum = 19 m	Mesotrophic to eutrophic	0.5–3.5 m	Silt/clay/sand/gravel
Ohio River (Meldahl, Bellville, and New Cumberland pools)	Lotic	1550–8,800 ha	Mean = 8 m Maximum = 15 m	Mesotrophic to eutrophic	<1 m	Silt/clay/gravel/cobble
Lake Winnebago	Natural lake with large tributaries	55,700 ha	Mean = 4.7 m Maximum = 6.4 m	Eutrophic	0.75–2.0 m	Silt/sand/gravel
Ottawa River (lakes Temiscaming, Allumette, Deschenes, and Dollard des Ormeaux)	Reservoirs with moderate-sized tributaries	4600–32,000 ha	Mean = 5.2–36.0 m Maximum = 49–200 m	Oligotrophic to mesotrophic	1.8–2.5 m	Silt/clay/sand/gravel/rock
Missouri River reservoirs (Lakes Sharpe, Francis Case, and Oahe)	Reservoirs with large tributaries	25,000–145,700 ha	Mean = 9.5–18.5 m; Maximum = 23–24 m	Mesotrophic to eutrophic	1.0–4.0 m	Silt/clay/sand/gravel
Winnipeg River (Lake of the Woods)	Natural lake with large tributary	427,000 ha	Mean = 7.4 m; Maximum = 64 m	Mesotrophic to eutrophic	1.1–1.6 m	Silt/sand/gravel/rubble

Table A.3. Descriptive genetic statistics for sauger collections. SD = standard deviation; H_o = mean observed heterozygosity; H_e = mean expected heterozygosity; N_a = mean number of alleles per locus; R_a = mean allelic richness per locus; F_{1s} = inbreeding coefficient.

Collection	H_e	SD(H_e)	H_o	SD(H_o)	N_a	SD(N_a)	R_a	SD(R_a)	F_{IS}
Lake Oahe	0.783	0.059	0.754	0.033	10.143	4.845	4.227	1.800	0.037
Lake Sharpe	0.760	0.059	0.714	0.049	7.571	3.690	4.043	1.546	0.063
Lake Francis Case	0.777	0.064	0.704	0.037	9.714	5.529	4.524	1.680	0.096
Lake of the Woods	0.740	0.076	0.772	0.020	11.857	7.128	4.364	1.673	−0.044
Lake Winnebago	0.766	0.078	0.763	0.021	12.143	8.630	4.576	1.582	0.004
Meldahl Pool	0.776	0.063	0.756	0.021	11.429	6.079	4.554	1.484	0.026
Bellville Pool	0.756	0.071	0.760	0.021	11.000	5.745	4.474	1.474	−0.006
New Cumberland Pool	0.763	0.068	0.733	0.023	10.571	4.962	4.572	1.551	0.039
Western Lake Erie	0.746	0.056	0.621	0.037	8.714	5.090	4.311	1.338	0.174
Port Clinton	0.718	0.073	0.640	0.021	13.857	7.128	4.942	1.830	0.11
Lake Temiscaming	0.730	0.063	0.748	0.038	8.000	4.546	4.592	1.825	−0.025
Lac Deschenes	0.669	0.072	0.686	0.028	8.429	4.860	3.766	1.296	−0.026

Table A.4. Literature review summary of habitat component information for sauger spawning used to create HSI curves (Anderson 2025).

Habitat Component	**Source**	**Information**
Substrate	Seigwarth et al. (1993)	Gravel optimal
	Crance (1987), Loukmas (2013)	Cobble and gravel optimal
	Rawson and Scholl (1978)	Found spawning over sand-gravel substrate, cobble-boulder riffles, and shale bedrock ridges
	Bureau of Reclamation (1997)	Spawning occurs over rubble, cobble, fine gravel, and pebble. Eggs settle in gravel and boulder spaces.
	Jaeger et al. (2005)	Boulder, rocky substrates, and bedrock reefs are optimal. Soft, erosive substrates are avoided.
Velocity	Seigwarth et al. (1993)	0.7 m/s optimal
	Bozek et al. (2011)	0.33-0.98 m/s optimal
	Bureau of Reclamation (1997)	In Missouri River, spawning observed at 0.54-1.4 m/s. In upper Mississippi River, spawning observed at 0.85-1.2 m/s surface velocity, and 0.42-0.88 m/s deep velocity
	Loukmas (2013), Hickman et al. (1989)	0.09-0.61 m/s optimal
Depth	Seigwarth et al. (1993)	Spawning occurred between 2.4-3 m
	Bozek et al. (2011)	As shallow as 0.6 m, as deep as 5.6 m (lit review summary)
	Scott and Crossman (1973)	0.6-3.6 m
	Bureau of Reclamation (1997)	Optimal depth > 1 m, upper threshold varies
	Hickman et al. (1989)	Spawning observed at 0.6-3.7 m

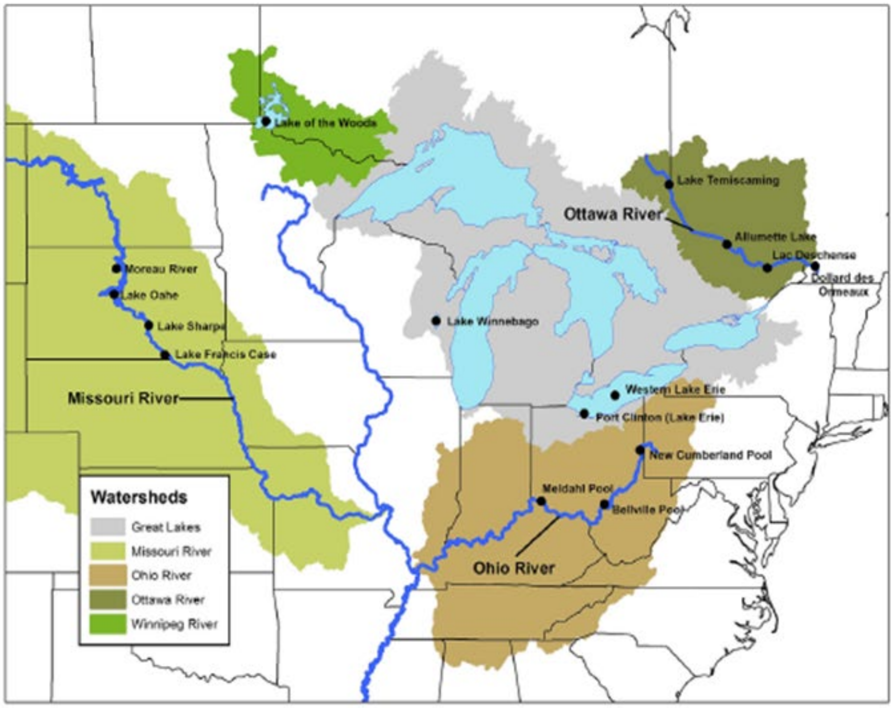
Table A.5. Manning's n Values for River Substrates. Values based on Myers et al. 2021, USGS 1989, and Chow 1959 (Anderson 2025).

River Substrate	Manning's n
Fines (Silt, Clay)	0.022
Sand	0.012-0.026
Gravel	0.024-0.035
Cobble	0.03-0.05
Boulder	0.04-0.07
Bedrock	0.022-0.025
Organic	0.04

Table A.6. Manning's n Values for Floodplain Land Covers. Values based on Myers et al. 2021, and USDA 2016 (Anderson 2025).

Floodplain Land Cover	Manning's n
Mixed Forest	0.10-0.16
Woody Wetland	0.045-0.15
Grassland	0.025-0.05
Developed	0.06-0.14

a)



b)

Figure A.1 a) Sample locations for sauger used in genetic analysis (black circles), b) Details of locations in Lake Erie. State and Provincial boundaries are indicated by black lines.

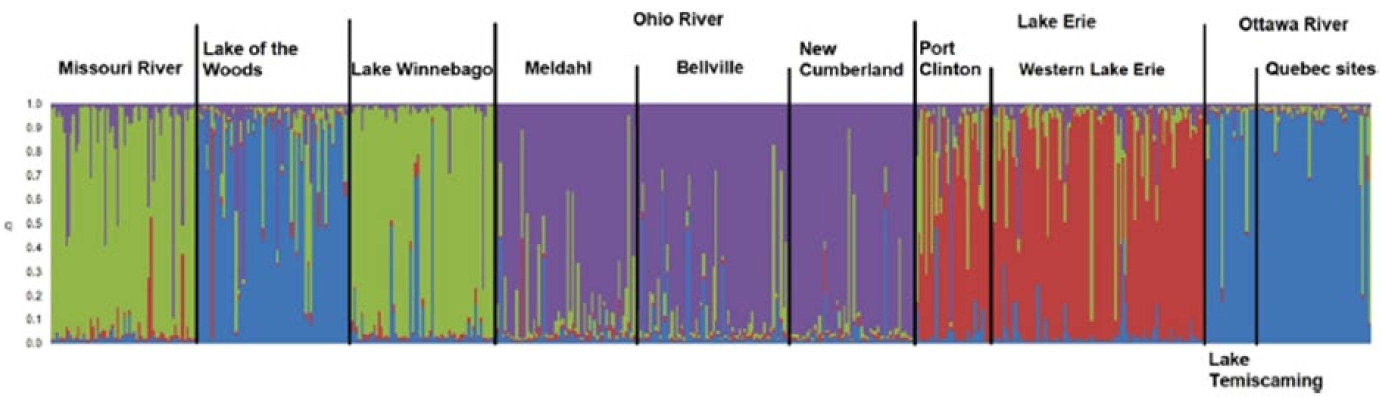


Figure A.2. Bayesian estimates of population composition for K=4 using results from STRUCTURE. Each vertical line represents one fish and the samples are grouped by the river or lake in which collection sites are found. The colored segments of each line represent the proportion of an individual's genotype belonging to each of the seven genetic dusters.

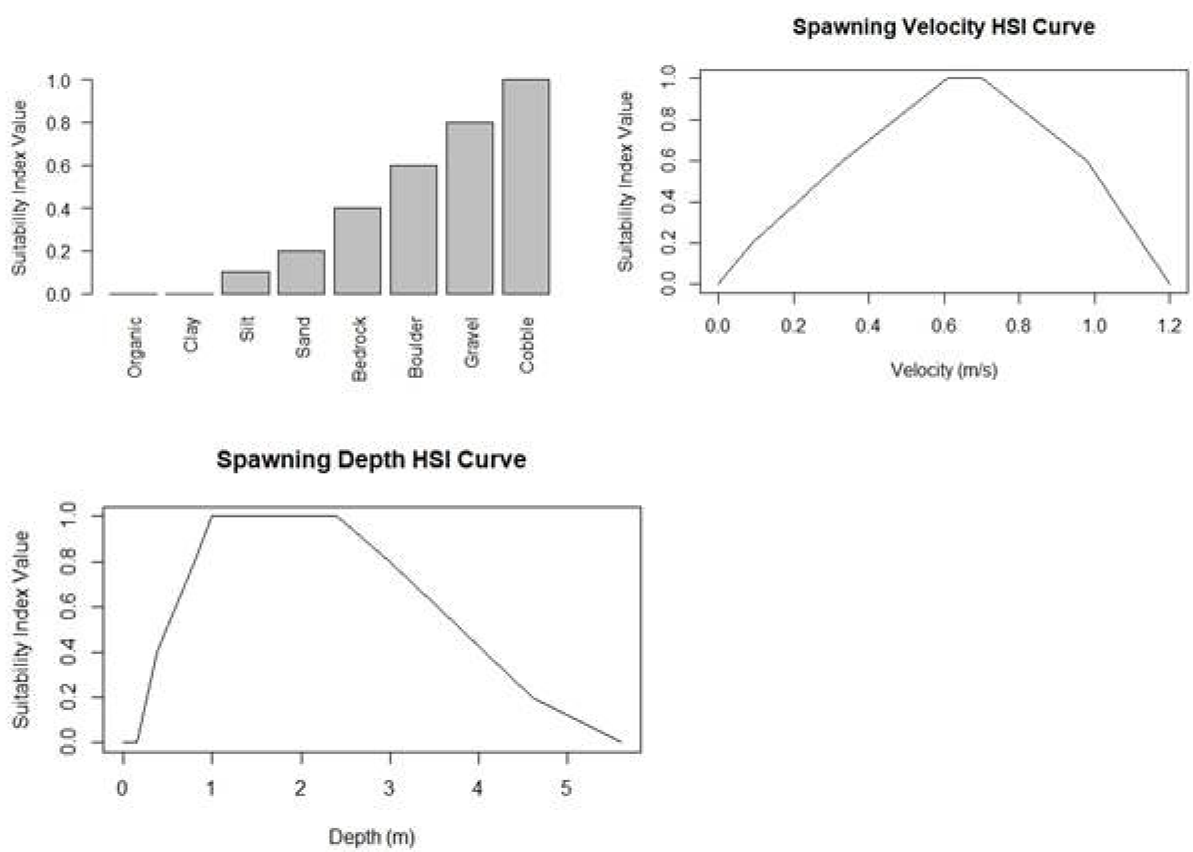


Figure A.3. Sauger Habitat Component HSI Curves. Suitability index values range from least suitable (0), to most suitable (1) (Anderson 2025).

References used by Anderson (2025) to develop a Sauger Habitat Suitability Index (HSI) model (see Table A4):

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