



2021 OHIO RIVER POOL ASSESSMENTS

DASHIELDS, HANNIBAL, MARKLAND, AND MCALPINE POOLS

ORSANCO Biological Programs
Ohio River Valley Water Sanitation Commission
5735 Kellogg Ave. Cincinnati, OH 45230
www.orsanco.org

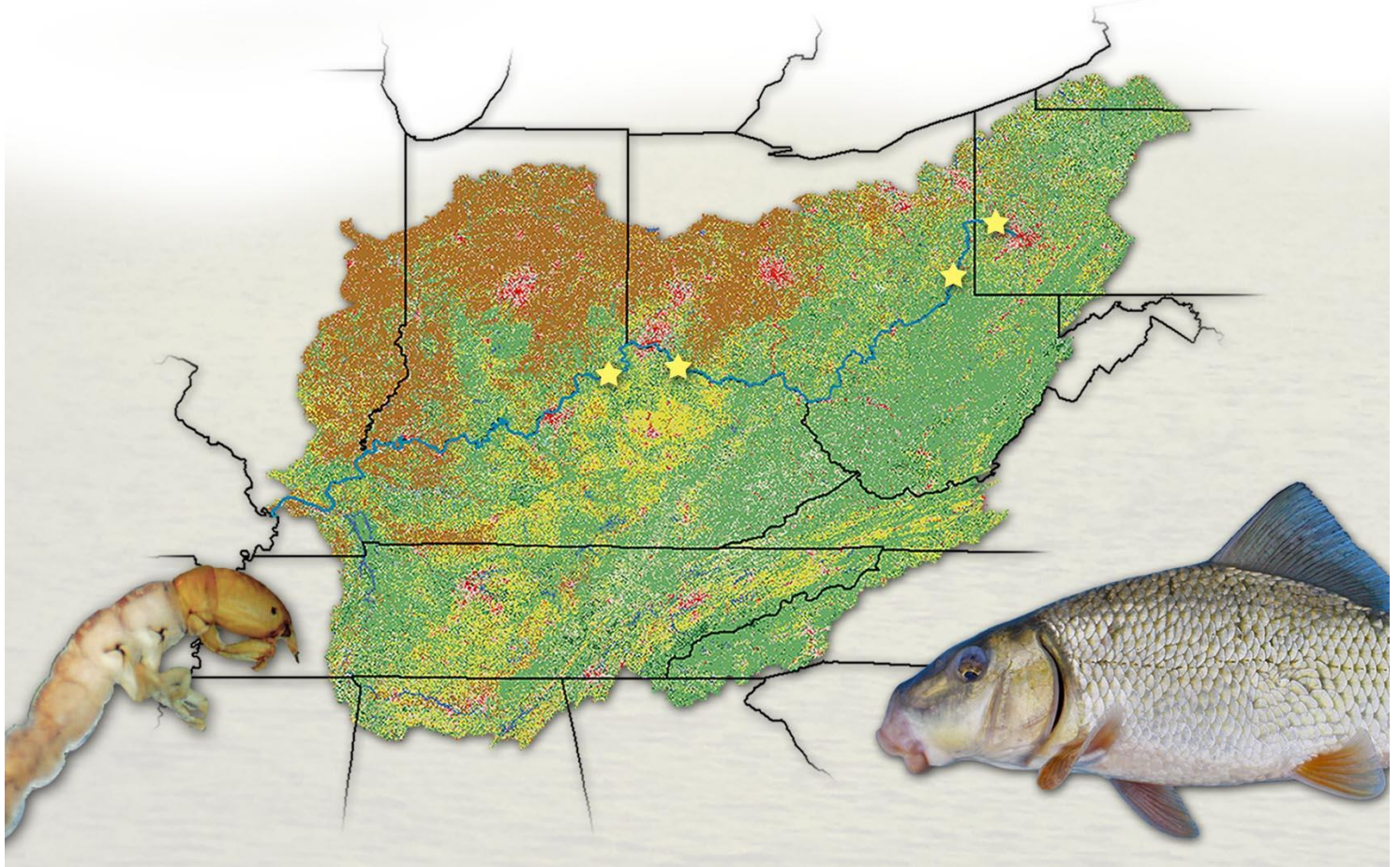


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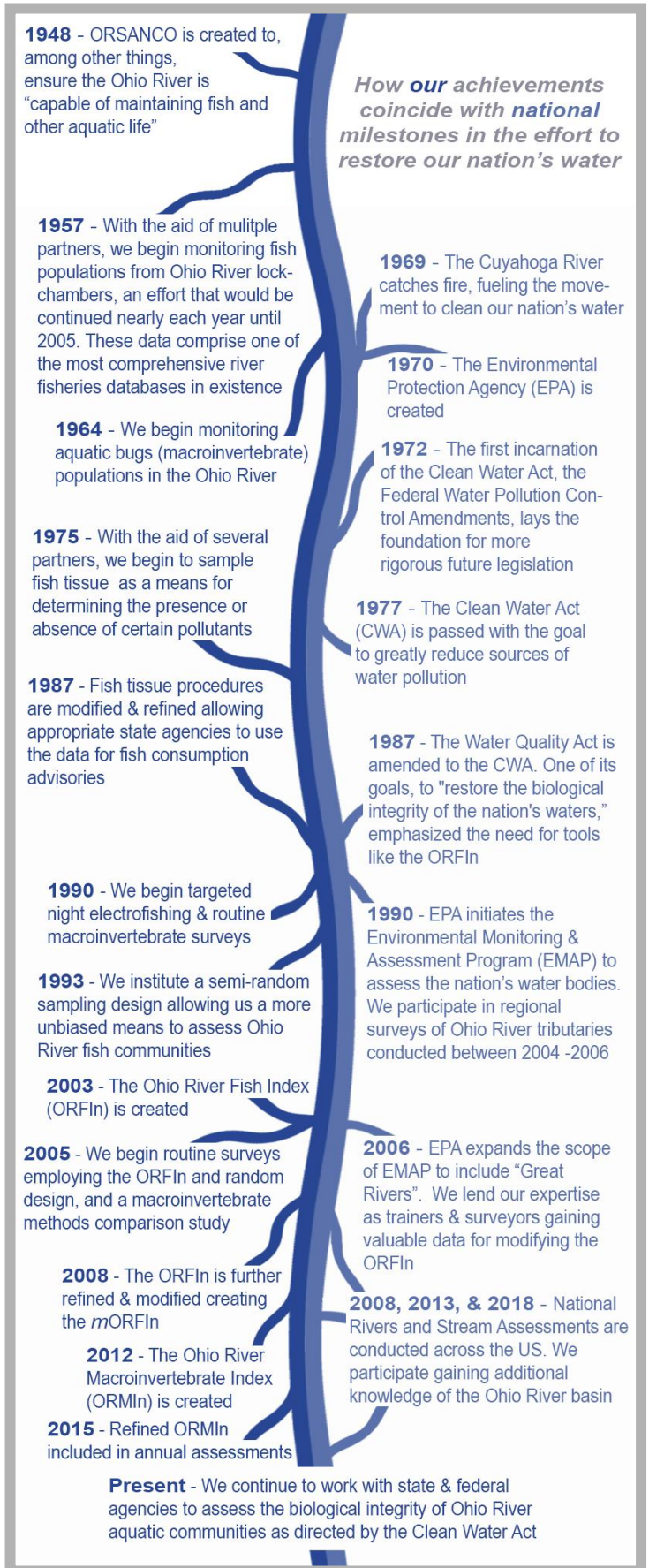
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Introduction

Based in Cincinnati, the Ohio River Valley Water Sanitation Commission (ORSANCO) is an interstate water pollution control agency created in 1948 by an act of Congress to monitor and improve the water quality of the Ohio River. A primary goal of ORSANCO programs is to work with state agencies to develop a set of pollution control standards for the Ohio River. Monitoring programs were established to develop and refine these standards. One of these programs, the ORSANCO biological program, uses fish studies to establish biological criteria (biocriteria) for the Ohio River. These biocriteria are ultimately used to provide insight into the overall health of the river ecosystem.

In 1993, ORSANCO developed and implemented a survey design that used electrofishing methods designed for the Ohio River. After years of collecting fish population data on the Ohio River, we developed the original Ohio River Fish Index (ORFI) which was subsequently modified (*mORFI*). Each year we collect fish and environmental data from various sections of the Ohio River and use these data to calculate *mORFI* scores, which are numerical representations of the relative condition of Ohio River fish communities based on a suite of measurable attributes. The resulting scores allow us to assess the biological condition of each section of the river. The information included in these assessments is further used for regulatory, restorative, and protective efforts within the Ohio River basin.



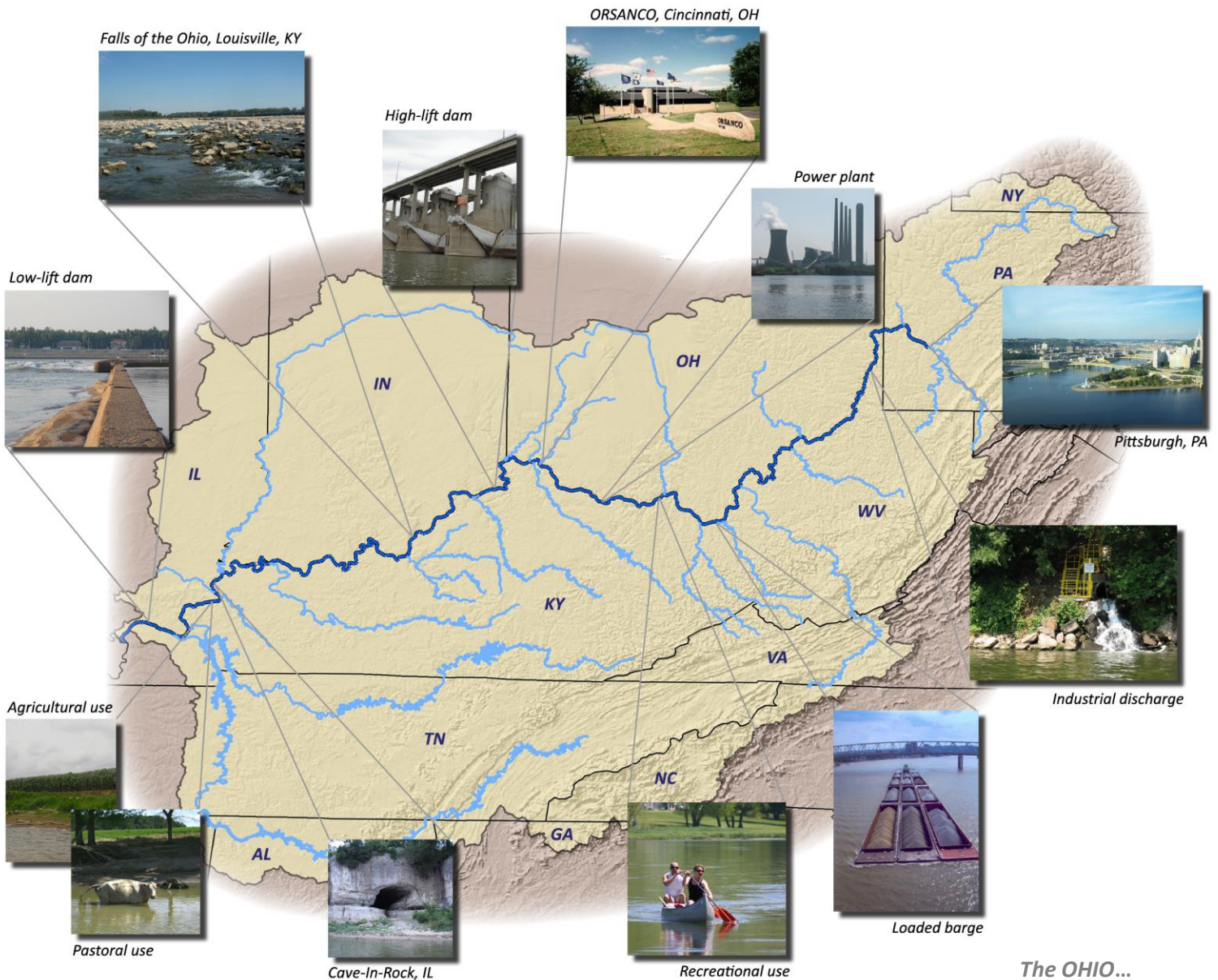
This report summarizes the 2021 Dashields, Hannibal, Markland, and McAlpine pool assessment survey findings.

The River

The Ohio River begins at the confluence of the Monongahela and Allegheny rivers in Pittsburgh, PA and flows 981 miles in a southwesterly direction to its confluence with the Mississippi River near Cairo, IL. The Ohio has several additional large tributaries including the: Muskingum, Scioto, Kanawha, Kentucky, Green, Wabash, Cumberland and Tennessee rivers. The Ohio River itself runs through or borders six states: Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia. The river basin (>200,000 mi²) covers an additional eight states: New York, Maryland, Virginia, North Carolina, Tennessee, Georgia, Alabama, and Mississippi. Nineteen high-lift locks and dams maintain a nine-foot minimum depth for commercial navigation throughout the river.

Facts

- ◆ Average depth 24 ft, max depth exceeding 90 ft
- ◆ Average width ½ mi, 1 mi max (Louisville, KY)
- ◆ ~344 fish species from Ohio River basin (18 exotic) = 40% of known N. American species (800 species)
- ◆ ~178 fish species found in the Ohio River (14 exotic)
- ◆ Deciduous forests continue to dominate the basin
- ◆ Major land uses: pastures, row crops, and urban development
- ◆ Basin holds ~8% of the nation (27 million people)
- ◆ 33 drinking water intakes provide drinking water for over 5 million people along the main stem
- ◆ 589 permitted discharges to the Ohio River
- ◆ 49 power-generating facilities on the main stem
- ◆ Coal and energy products comprise 70% of the 250 million tons of cargo carried by barges each year



The OHIO...
Iroquoian for "great river"

METHODS

Site Selection

A random, probability-based survey design was used to select sampling site locations within each Ohio River navigational pool. The target areas of our surveys are both shorelines of each pool from the upstream dam to the downstream dam. The survey design provides coordinates for 15 sites (500m-long) in each of the selected pools. Biological and environmental data are then collected from these 15 sites and used to assess the biological condition of the pool.

Fish Collection

To maintain consistency across different sampling years, fish surveys are conducted between July 1st and October 31st and when water levels are within two feet of “normal flat pool”. Fish are collected by a non-lethal method called boat electrofishing using an 18ft aluminum johnboat equipped with a generator and an electrofishing unit (standard equipment used by federal and state agencies). Using the electrofishing unit to regulate the output from the generator, a mild current is applied to the water with an effective range of up to 20ft. Because of our limited range, sites are fished at night along the shoreline when species are most active. This allows us to maximize the number of individuals and species captured, thus providing us with an accurate representation of the fish community at each site.

Sampling is conducted in a downstream manner for a minimum of 1800 seconds, during which all available habitats are sampled within 100ft from shore. When the fish encounter the electric field their muscles contract and they rise to the surface. The fish are then netted and placed into a live well where they remain until the entirety of the 500m zone is sampled. Each fish is measured, inspected for anomalies, and identified to lowest possible taxonomic level (e.g. species) before being returned to the water. A subsample of small fishes (i.e. less than 4cm) that cannot be confidently

identified in the field (e.g. minnows) are preserved and identified in the laboratory. All collected information is reviewed and imported into a database from which fish index scores are later generated.

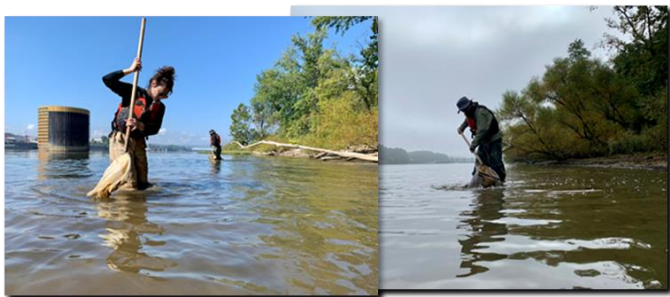


Native Ohio River fishes. Left: Members of the genus *Lepomis*. Bluegill, Redear Sunfish, Orangespotted Sunfish, Warmouth, Longear Sunfish. Right: Members of the genus *Lepisosteus*. Juvenile Shortnose Gar, Longnose Gar, Spotted Gar, Shortnose Gar.

Collecting Macroinvertebrates

Macroinvertebrates (macros) are organisms that lack a true backbone and can be seen with the naked eye. They include aquatic insects, molluscs, arachnids, crustaceans and worms. They can range from large adult forms (e.g. crayfish), to very small larval forms of terrestrial insects (e.g. flies).

Two sampling methods are used to collect macros: Hester-Dendy (HD) samplers and multi-habitat kicks (MH). HD samplers are constructed of tempered masonite cardboard cut into 3-inch square plates and 1-inch square spacers. Eight large plates and 12 spacers are stacked on a metal eyebolt to provide varying degrees of space for macro colonization. Five HDs are attached, in a ring, to a concrete paver. The paver is then placed on the river bottom in 10ft of water at the downstream end of each 500m sampling site and secured to the shore. Similar to the fish, macro sampling is restricted to a defined season within each year. HDs are deployed for six weeks, beginning September 1st allowing adequate time for macro colonization. After the six week colonization period, HDs are retrieved and MH kick surveys are conducted.



A MH kick is performed by actively disturbing the substrate and then sweeping a net through the resulting cloud. This technique allows the sampler to collect macros without compromising the sample with large amounts of sediment. To further exclude sediments, the net heads are “D” shaped (i.e. have flat bottoms), which also eases the scraping of woody debris and boulders. Samplers disturb/scrape 10 linear meters of substrate at each 100m interval of a site in depths 1m or shallower. At each of these intervals, every

attempt is made to sample available habitats (e.g. sand flats, woody debris, boulders, etc.) relative to the proportion of their availability. The kicks conducted at each 100m interval are then combined to represent the community present at the site.

Once the kicks are completed and the HDs have been retrieved, the samples are preserved. The HDs are disassembled in the field. The plates from the HDs and large debris from the MH samples are rinsed and drained through a 500µm sieve. The macros trapped by the sieve are then transferred to a preservative jar with 70% ethanol to be identified in a laboratory. At the lab, macros are identified to species level when possible; in all other cases the highest level of taxonomic resolution is obtained. The macro information is then reviewed and imported into a database from which index scores are generated, keeping HD and MH data separate.



METHODS

Characterizing Instream Habitat

Intensive habitat surveys are conducted which include measures of woody cover, depth, prevalence of substrate types at each electrofishing site. Woody cover (e.g. submerged brush, logs, stumps) is estimated visually. More quantitative measures of depth and substrate proportions are obtained through the use of a 20' copper pole. The pole is used to probe the bottom of the river to determine exact depth and the proportions of substrate types including: boulder, cobble, gravel, sand, fines, and hardpan (clay) that occur at each site.

Because different fish species prefer different habitat types, it is important to classify the instream habitat at each of our sites to better understand *mORFIn* score variability. Using the habitat survey data, we assign each site to one of five statistically derived habitat classes simply named: A, B, C, D and E. The five habitat classes represent a gradient from highly coarse Class A habitats with high amounts of cobble and gravel, to the predominantly sandy/fine substrates of habitat classes "D" and "E" which differ by water depth (see below).

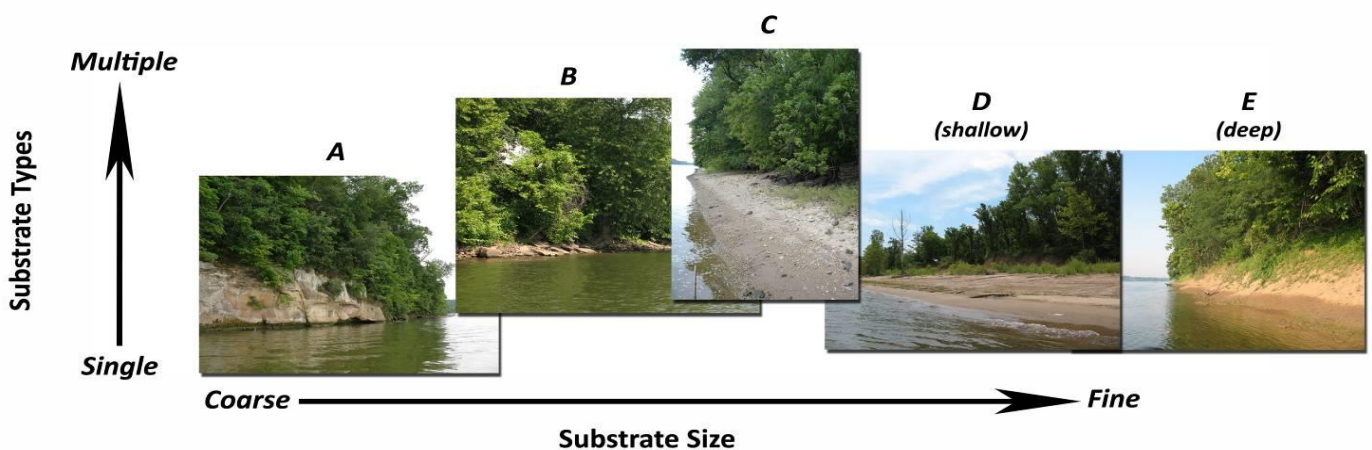


Water Quality and Hydrology

Basic measures of water quality such as water temperature, clarity, pH, DO, and conductivity are measured at each site prior to electrofishing. Water samples may also be collected at the downstream end of each 500m zone approximately 100ft from shore to determine various water quality parameters (e.g. nutrient levels and hardness). River stage is monitored using data obtained from the U.S. Army Corps of Engineers, who also provide measures of predicted daily average flow volumes and velocities from the nearest-upstream sampling station to any particular site. These data are compiled to aid in the interpretation of the fish index results.



A look at our five habitat classes



Assessing Biological Condition

ORSANCO uses two biological indices to assess the condition of the Ohio River. The modified Ohio River Fish Index (*mORFI*n) and the Ohio River Macroinvertebrate Index (ORMI)n using HD data only) were established in 2003 and 2012, respectively. Both indices include various measures (metrics) of the fish and macro communities such as: diversity, abundance, feeding and reproductive guilds, pollution tolerance, habits, health.

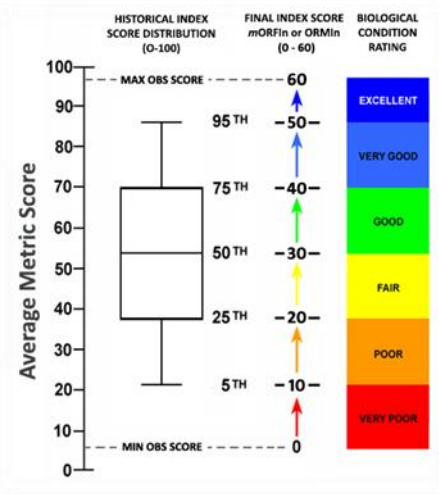
13 metrics used to generate *mORFI*n scores

Fish Metric	Definition
Native Species	Number (No.) of species native to the Ohio River
Intolerant Species	No. of species intolerant to pollution and habitat degradation
Sucker Species	No. of sucker species (e.g. redhorse and buffalo)
Centrarchid Species	No. of black bass, sunfish, crappie species
Great River Species	No. of species primarily found in large rivers
% Piscivores	% of individuals (ind.) that consume other fish
% Invertivores	% of ind. that consume invertebrates
% Detritivores	% of ind. that consume detritus (dead plant material)
% Tolerants	% of ind. tolerant to pollution and habitat degradation
% Lithophils	% of ind. belonging to breeding groups that require clean substrates for spawning
% Non-natives	% of ind. not native to the Ohio River, including both exotics and hybrids
No. <i>DELT</i> anomalies	No. of ind. with <i>Deformities, Erosions, Lesions, Tumors</i> present
Catch per unit effort (CPUE)	Total abundance of ind. (minus exotics, hybrids, tolerants)

8 metrics used to generate ORMI)n scores

Macro Metric	Definition
No. Taxa	Number (No.) of unique taxa
EPT Taxa	No. of taxa that belong to are either the Ephemeroptera, Plecoptera, or Trichoptera orders
Predator Taxa	No. of taxa that are predators
% Collector-Gatherer Taxa	% of taxa that feed on fine particulate organic matter
% Caenids	% of individuals (ind.) that belong to the pollution tolerant <i>Caenidae</i> family of Ephemeropterans
% Odonates	% of ind. that belong to the Odonata order
% Intolerants	% of ind. intolerant to pollution and habitat degradation
% Clingers	% of ind. that cling to instream habitat

Each navigational pool is separately assessed with each index based upon the biological and environmental data collected from its 15 randomly selected sites. This involves a multi-step approach (depicted top right) that converts average metric scores (0-100) of each individual site into final index scores (0-60), based on varying expectations of the five different habitat classes. Index scores of the 15 sites are then averaged to provide an overall score and rating for the navigational pool specific to each index.



The presence of five distinct habitat classes A, B, C, D, and E, coupled with the range of habitat preferences exhibited by individual fish and macro taxa required the translation of metric scores into relative index scores. By removing the effect of habitat, index scores can then be averaged within a pool to represent the overall condition of the biological community in question.

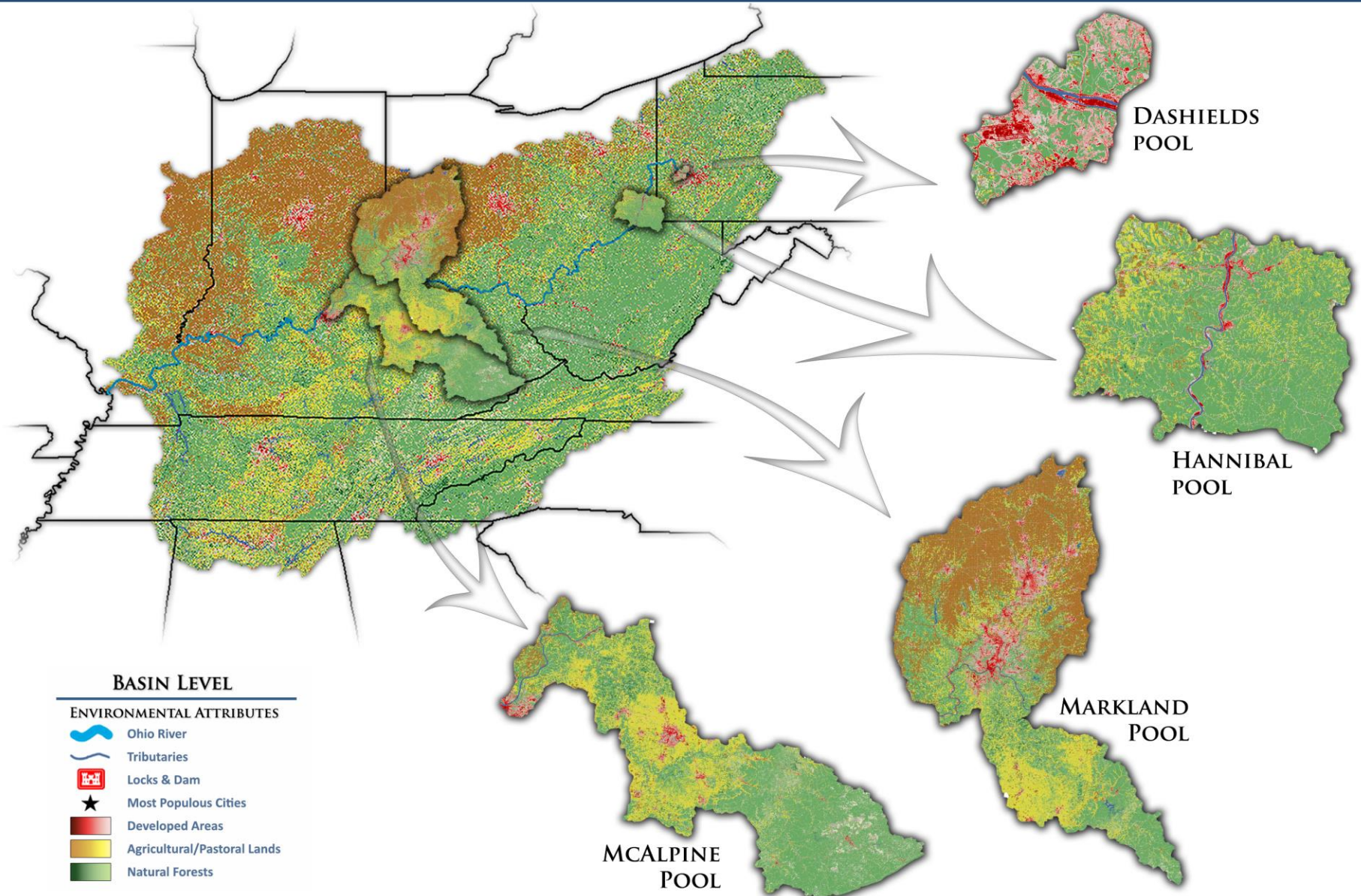
The averaged scores for both the *mORFI*n and ORMI)n are then compared to a biocriterion. The 25th percentile is the statistical threshold commonly used by regulatory agencies for establishing biocriteria. Using this threshold, our established biocriterion (i.e. a representation of healthy Ohio River fish communities) is set at an average index score of 20.0.

A pool is assessed to be in **full support** of its aquatic life-use (ALU) designation (i.e. possessing intact biological communities) if both the *mORFI*n and ORMI)n scores are greater than or equal to 20.0 (i.e. a biological rating “Fair”, “Good”, “Very Good”, or “Excellent”). A pool is in **partial support** of its ALU designation if only one of the indices’ scores greater than or equal to 20.0, while the other index score falls within 10.0 - 19.9 (i.e. a “Poor” rating). Any pool in which both indices score below a 20.0, or in which at least one index scores below 10.0 (i.e. a “Very Poor” rating), would be considered in **non-support** of its ALU designation.

For more detailed information pertaining to our programs including survey design, field methods, past & present assessment results, or biological data contact one of our staff or visit: www.orsanco.org/biological-programs

2021 POOL SURVEY RESULTS

The results of the 2021 biological surveys are detailed in the following pages (relative pool locations shown below). Included are brief descriptions of the land use & hydrology, site level mORFIn & ORMIn ratings, summaries of notable catches & instream habitat, and the overall biological condition of each pool.



For more detailed catch, metric, and index scores visit www.orsanco.org/programs/biological-programs

DASHIELDS POOL (2021) - HEALTHY CONDITION

DOMINANT MACRO GROUPS

MAYFLIES 19.38%



Stenacron sp.

MIDGES 13.68%



Caelotanytus sp.

SCUDS 13.62%



Echinogammarus ischnus

SNAILS 8.43%



Hydrobiidae sp.

MUSSELS 7.91%



Dreissena polymorpha

BOULDER 5.6%



COBBLE 15.5%



GRAVEL 26.7%



SAND 28.5%



FINES 18.2%



HARDPAN 2.8%



OTHER 2.7%

The Dashields Pool is 7.1 miles long, extending from Emsworth Locks and Dam (ORM 6.2) to Dashields Locks and Dam (ORM 13.3). The pool has a gradient drop of 0.7 feet per mile and averages 1,467 feet wide and 14 feet deep (ORSANCO 1994). The entirety of the pool lies in Pennsylvania. This pool lies in a portion of the Ohio River heavily influenced by industry with a large amount of barge activity. The pool receives little water from tributaries. The shorelines of this pool support a moderate degree of aquatic vegetation, and where aquatic vegetation was observed, the dominant species was invasive (*Hydrilla* sp.). The watershed is primarily forested (60.7%), and is also comprised of pasture lands (12.0%) and row crops (5.2%). The Ohio Park, a reclaimed Superfund site, lies on the western tip of Neville Island.

DOMINANT FISH FAMILIES

MINNOWS 62.9%



Channel Shiner

SUCKERS 19.4%



Smallmouth Redhorse

SUNFISHES & BASS 16%



Smallmouth Bass

PERCHES 5.8%

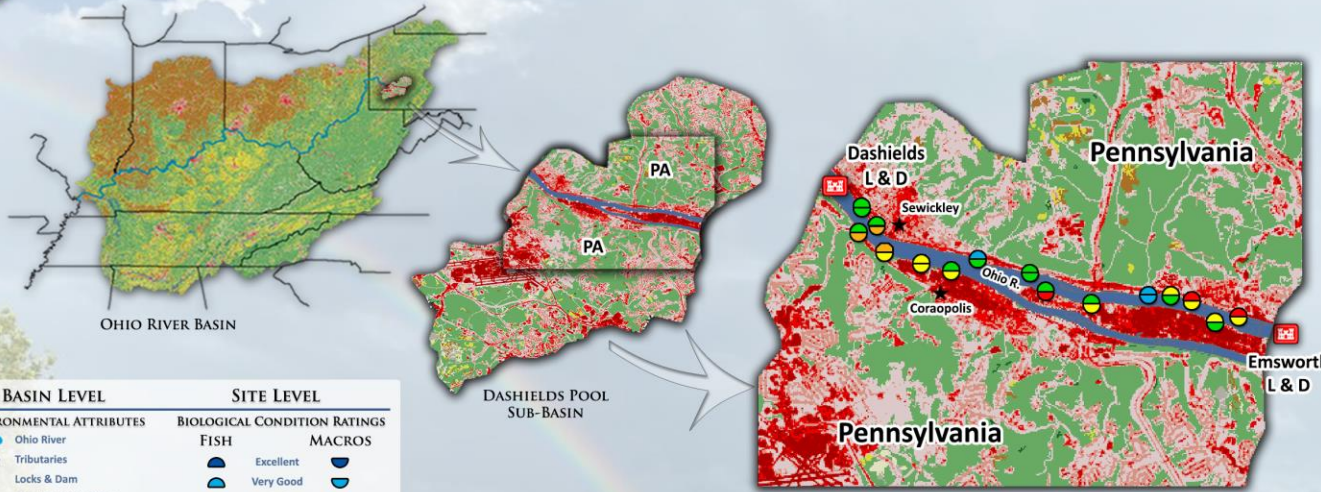


Logperch

CATFISH 0.62%



Channel Catfish



BASIN LEVEL		SITE LEVEL	
ENVIRONMENTAL ATTRIBUTES		BIOLOGICAL CONDITION RATINGS	
	Ohio River		FISH
	Tributaries		MACROS
	Locks & Dam		Excellent
	Most Populous Cities		Very Good
	Developed Areas		Good
	Agricultural/Pastoral Lands		Fair
	Natural Forests		Poor
			Very Poor

AQUATIC INVASIVES WATCH



SURVEY SUMMARY

Electrofishing sampling took place over one week in early July, at the beginning of the index period (July-Oct). Sampling conditions were favorable marked by low flows and high Secchi readings. Three species of redhorse were observed in large abundance (Smallmouth Redhorse, *Moxostoma breviceps*, n=216; Silver Redhorse, *Moxostoma anisurum*, n=189; and Golden Redhorse, *Moxostoma erythrum*, n=177), and River Redhorse (*Moxostoma carinatum*) were also observed with lower frequency (n=10). Notable catches include Longhead Darters (*Percina macrocephala*, n=4) and Streamline Chubs (*Erimystax disimilis*, n=4), both of which require habitat with clean, coarse substrate. Notable macroinvertebrate collections from Dashields Pool include large numbers of aquatic worms (*Oligochaeta* sp.), two species of Common Burrowing Mayflies (*Hexagenia limbata* and *Stenacron* sp.), Prosobranch Snails (*Amnicola* sp.), and the highly tolerant caddisfly (*Cyrenellus fraternus*). Of the 2021 macroinvertebrate assessments, the most species diversity was observed in the Dashields Pool. Independent biological indices were used to apply numeric values to important components of fish and macroinvertebrate assemblages and assess their relative status. The results (see above map) show that, on average, fish populations in Dashields Pool were in 'Good' condition and macroinvertebrates were in 'Fair' condition.

POOL SUBSTRATE COMPOSITION

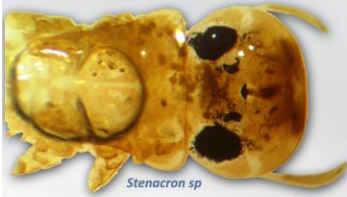


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HANNIBAL POOL (2021) - HEALTHY CONDITION

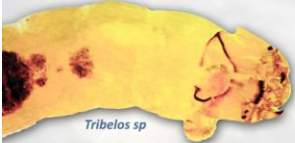
DOMINANT MACRO GROUPS

MAYFLIES 24.3%



Stenacron sp.

MIDGES 17.20%



Tribelos sp.

MUSSELS 13.37%



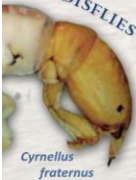
Dreissena polymorpha

SCUDS 13.30%



Gammarus sp.

CADDISFLIES 7.43%



Cynnellus fraternus

BOULDER 1.1%

COBBLE 1.7%

GRAVEL 13.5%

SAND 27.5%

FINES 32.7%

HARDPAN 20%

OTHER 3.6%



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The Hannibal Pool is 42.2 miles long, extending from Pike Island Locks and Dam (ORM 84.2) to Hannibal Locks and Dam (ORM 126.4). The pool has a gradient drop of 0.5 feet per mile and averages 1,133 feet wide and 21 feet deep (ORSANCO 1994). The pool is bordered by the states of West Virginia and Ohio and lies in a portion of the Ohio River heavily influenced by industry with a large amount of barge activity. The Hannibal pool directly receives water from numerous smaller tributaries draining approx. 1,120 square miles of the larger Ohio River basin: Wheeling Creeks (OH & WV), McMahon Creek, Grave Creek, Captina Creek, Fish Creek, and Sunfish Creek. Shorelines support a large amount of aquatic vegetation, and where observed, littoral zones were dominated by invasive species (*Hydrilla* sp.). The combined watershed is primarily forested (64.6%) and also contains pasture lands (12.7%) and row crops (7.0%).



OHIO RIVER BASIN



HANNIBAL POOL SUB-BASIN



BASIN LEVEL	SITE LEVEL	
ENVIRONMENTAL ATTRIBUTES	FISH	MACROS
Ohio River	Excellent	Excellent
Tributaries	Very Good	Very Good
Locks & Dam	Good	Good
Most Populous Cities	Fair	Fair
Developed Areas	Poor	Poor
Agricultural/Pastoral Lands	Very Poor	Very Poor
Natural Forests		

DOMINANT FISH FAMILIES

MINNOWS 60.5%



Channel Shiner

DRUM 14.2%



Freshwater Drum

SUNFISH & BASS 6.0%



Smallmouth Bass

CATFISH 4.9%



Channel Catfish

SUCKERS 4.9%



River Carpsucker

AQUATIC INVASIVES WATCH



SURVEY SUMMARY

The pool was sampled at normal conditions during the beginning of the defined index period (July-Oct). The past three fish assessments show that Sauger (*Sander canadensis*) numbers are continuing to decline (n=317, n=147, n=76, respectively), while the relative abundance of two species of Cyprinids have each increased by roughly 15% (Channel Shiner, *Notropis wickliffi*; and Emerald Shiner, *Notropis atherinoides*). Notable macroinvertebrate collections from Hannibal Pool include large numbers of Burrowing Mayflies (*Stenacron* sp. and *Hexagenia limbata*), invasive mussels (*Dreissena polymorpha*), and tolerant species (Midges-Tribelos sp. and Scuds-Gammarus sp.) Rare, intolerant species of Riffle Beetles were observed in low numbers (*Stenelmis* sp., *Macronychus glabratus*, and *Dubiraphia* sp.). Independent biological indices were used to apply numeric values to important components of fish and macroinvertebrate assemblages and to assess their relative status. The results (see above map) show that, on average, fish populations in Hannibal Pool were in 'Good' condition and macroinvertebrate communities were in 'Good' condition. Overall, these results indicate that Hannibal Pool supports its aquatic life use.

POOL SUBSTRATE COMPOSITION

MARKLAND POOL (2021) - HEALTHY CONDITION

DOMINANT MACRO GROUPS

MIDGES 32.74%



Dicrotendipes sp.

CADDISFLIES 22.32%



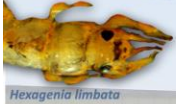
Cyrnellus fraternus

MUSSELS 20.88%



Dreissena polymorpha

MAYFLIES 15.91%



Hexagenia limbata

SCUDS 2.93%



Gammarus sp.

BOULDER 14.2%



COBBLE 6.9%



GRAVEL 24.1%



SAND 28.6%



FINES 22.1%



OTHER 2.6%

HARDPAN 1.5%

POOL SUBSTRATE COMPOSITION

The Markland Pool is 95.3 miles long, extending from Captain Anthony Meldahl Locks and Dam (ORM 3436.2) to Markland Locks and Dam (ORM 531.5). The pool has a gradient drop of 0.4 feet per mile, averages 1,594 feet wide and 31 feet deep. The pool flows adjacent to the states of Ohio, Indiana, and Kentucky. This pool lies in a portion of the Ohio River heavily influenced by industry with a large amount of barge activity. Markland pool receives water from three major tributaries. The Little and Great Miami rivers drain 1,750 and 5,400 square miles, respectively. The Licking River drains 3,670 square miles and empties into the Ohio River just downstream of the Little Miami River. The pool's watershed is primarily forested (54.7%) but also has a considerable amount of row crops (14.0%) and pasture lands (13.2%).

DOMINANT FISH FAMILIES

SUNFISH & BASS 24.3%



MINNOWS 23.9%



Channel Shiner

SHAD 20%



Gizzard Shad

SUCKERS 11.2%

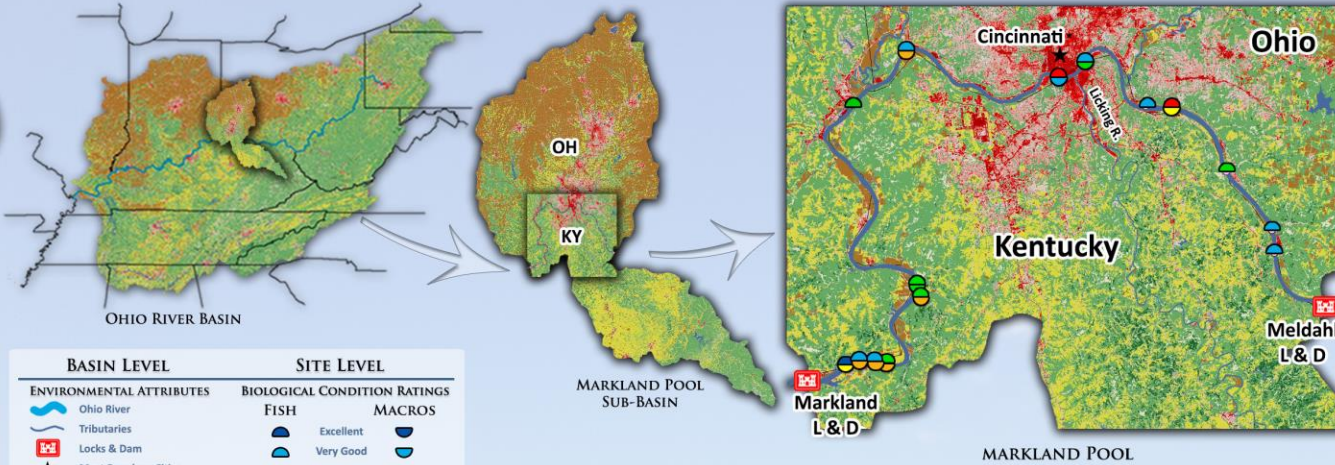


River Carpsucker

TEMPERATE BASSES 6.6%



White bass



BASIN LEVEL		SITE LEVEL	
ENVIRONMENTAL ATTRIBUTES		BIOLOGICAL CONDITION RATINGS	
	Ohio River		FISH
	Tributaries		Excellent
	Locks & Dam		Very Good
	Most Populous Cities		Good
	Developed Areas		Fair
	Agricultural/Pastoral Lands		Poor
	Natural Forests		Very Poor
			MACROS

AQUATIC INVASIVES WATCH



SURVEY SUMMARY

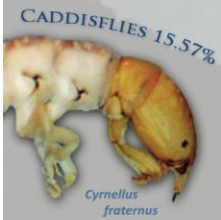
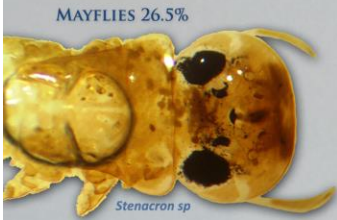
Electrofishing sampling occurred during normal sampling conditions at the beginning of August. Notable observations over the last three assessment cycles include an increased occurrence of Bluegill (*Lepomis macrochirus*), Gizzard Shad (*Dorosoma cepedianum*), and White Bass (*Morone chrysops*). Declines in Sauger (*Sander canadensis*), Silver Chub (*Macrhybopsis storeriana*), and Smallmouth Buffalo (*Ictiobus bubalus*) populations were observed. Notable macroinvertebrate collections include a high percentage of tolerant Caddisflies (*Cyrnellus fraternus*), invasive mussels (*Dreissena polymorpha*), and two species of Non-biting Midges (*Dicrotendipes sp.* and *Tribelos sp.*). One observation of Stoneflies (*Acroneria sp.*, n=1) occurred during the 2021 surveys, which was observed in the Markland Pool. Independent biological indices were used to apply numeric values to important components of fish and macroinvertebrate assemblages and assess their relative status. The results (see above map) show that, on average, fish in Markland Pool were in 'Good' condition and the macroinvertebrates were in 'Fair' condition. Overall, these results indicate that Markland Pool harbored healthy aquatic communities.



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MCALPINE POOL (2021) - HEALTHY CONDITION

DOMINANT MACRO GROUPS



BOULDER 1.1%

COBBLE 1.7%

GRAVEL 13.5%

SAND 27.5%

FINES 32.7%

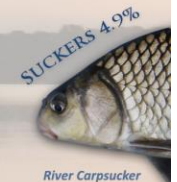
HARDPAN 20%

OTHER 3.6%

McAlpine Pool is 75.3 miles long, extending from Markland Locks and Dam (ORM 531.5) to McAlpine Locks and Dam (ORM 606.8). The pool has a gradient drop of 0.3 feet per mile and averages 2,040 feet wide and 25 feet deep (ORSANCO 1994). The pool is bordered by Indiana and Kentucky. This pool lies in a moderately developed portion of the basin. Though the pool is heavily influenced by industry and associated barge activity, portions of rocky forested shorelines still remain. The city of Louisville, one of the largest cities on the river, is located just upstream of McAlpine Locks and Dam and the naturally occurring Falls of the Ohio (ORM 605). The majority of the pool's shorelines are relatively shallow with a mix of fines and sand. The McAlpine Pool receives water from one of the larger tributaries in the basin, the Kentucky River, which has a drainage areas of nearly 7,000 square miles.



DOMINANT FISH FAMILIES



AQUATIC INVASIVES WATCH



SURVEY SUMMARY

The pool was sampled at normal conditions towards the end of the defined index period (July-Oct). Notable catches include the rise in abundance of Eastern Banded Killifish (*Fundulus diaphanus*) and Orangespotted Sunfish (*Lepomis humilis*), which have increased steadily over the three assessments. This observed increase is likely due to the increasing presence of the invasive vegetation, *Hydrilla verticillata*, which provides refugia for these fishes. Notable macroinvertebrate collections from McAlpine Pool include large numbers of several tolerant species (Non-biting Midges-*Tribelos sp.*, Mayflies-*Stenacron sp.* and *Hexagenia limbata*, and Caddisflies-*Cynellus fraternus*) and invasive mussels (*Dreissena polymorpha*). Rare, intolerant species were observed in low numbers (Riffle Beetles- *Macronychus glabratus* and Dragonflies- *Neurocordulia molesta*). Independent biological indices were used to apply numeric values to important components of fish and macroinvertebrate assemblages and to assess their relative status. The results (see above map) show that, on average, fish populations in McAlpine Pool were in 'Good' condition and macroinvertebrate communities were in 'Fair' condition. Overall, these results indicate that McAlpine Pool supports its aquatic life use.

POOL SUBSTRATE COMPOSITION



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CONCLUSIONS

Pool Surveys

The fish assessment portion of the 2021 pool surveys was successfully completed during the normal sampling timeframe. Fish sampling took place from July 5th-16th (Hannibal), July 12th-15th (Dashields), July 26th-30th (McAlpine), and Aug. 2nd-6th (Markland). Electrofishing surveys took place under normal stage and flow conditions. Conditions allowed for adequate sampling of fish and macroinvertebrates during the respective index periods. The macroinvertebrate sampling for all four pools was completed between September 23rd-Oct. 27th. Dashields, Hannibal, Markland, and McAlpine Pools were assessed as *meeting* their aquatic life-use designations for both fish and macroinvertebrates (i.e. containing healthy fish and macroinvertebrate communities).

Assessment Comparisons

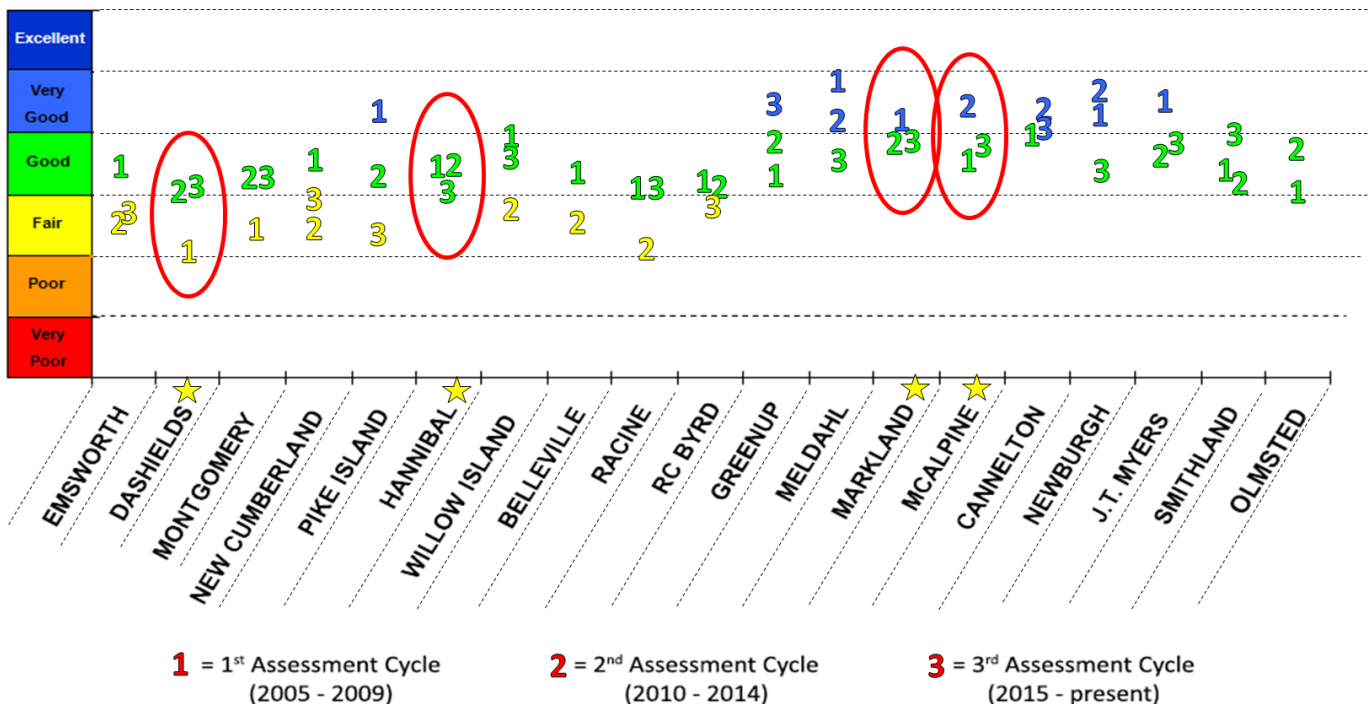
Between 2005 and 2014, all 19 Ohio River navigational pools were surveyed and assessed twice. Both cycles revealed the majority of the river to be in 'Good' condition, even though some pools changed in condition rating between surveys. The 2021 surveys continued the third cycle, which enhances our ability to detect riverwide patterns. Some of the index and species variability observed across pools may be due in part to variations in natural distributions, instream habitat, invasive species distributions, annual variations in flow, weather conditions, and water quality.

Present vs. Past Assessments

The focus of ORSANCO's biological assessments is to determine whether each pool is in full support, partial support or non support of its ALU. To aid in interpretation, we assign one of six ratings (e.g. from "Very Poor" to "Excellent") to the pools based on the relative condition of their fish communities. Shifts between years in these condition ratings may be due to variations in environmental factors other than water quality. By examining these factors (e.g. invasive species, flows, etc.) and their effects on *mORFIN* metrics, we attempt to provide defensible explanations for the differences in final condition ratings observed between assessments.



Blue Sucker (*Cycoreptus elongatus*) caught in the Markland Pool.



CONCLUSIONS

Dashields

(Fish = **GOOD**, Macros = **FAIR**)

Variable	2008	2013	2021
Environmental Factors			
Avg. seasonal flow (cfs)	Low	Low	Low
Avg. Conductivity	366.6	260.3	337.5
Avg. Secchi Depth	29.8	20.0	31.3
Avg. CPUE Score	1.9	9.5	25.8
Channel Shiner	1	108	1423
Emerald Shiner	5	46	748
All Fish	1231	2177	3697
Avg. % Invert Score	23.7	30.6	86.1
Bluegill	32	34	105
Golden Redhorse	33	155	177
Avg. % Piscivore Score	61.4	58.6	15.5
Flathead Catfish	11	6	7
Sauger	23	17	12
Avg. Great River Species Score	40	4.4	0
Silver Chub	26	0	0
Mooneye	11	1	0
Assessment Result			
Avg. mORFIn Score	22.2	30.8	32.4
Fish Condition Rating	Fair	Good	Good

Dashields Pool was assessed to be in “Good” condition in 2021, and the condition rating has exhibited an increasing trend over the past three assessments. The 15 randomly drawn sites were distributed evenly throughout the 7.1 mile long pool. Conductivity and average Secchi depth did not appear to have a significant effect on assessment outcomes. The overall fish abundance has grown over the past three assessments, which is reflected in the increased CPUE metric. The resurancance of pollution intolerant species has also been observed, with a relative abundance of 30.1%, 27.7%, and 52.1% of the total population, respectively. While this is a positive reflection of water quality improvement, other metrics reflective of fish habitat quality have decreased, specifically the Average Great River Species Score and Average Percent Simple Lithophil Score. Despite the increased populations of certain simple lithophils, such as round-bodied suckers (Golden Redhorse and Smallmouth Redhorse), there has been a decline in all Percidae species (Logperch, Sauger, Walleye). The overall relative abundance of simple lithophils was roughly 46% of the catch in 2008 and 2013, and has dropped to ~22% in 2021. This unsurprisingly coincides with shifts in substrate composition. Average cobble cover has decreased from 20.32% to 15.5%, while fine substrates have increased throughout the pool.

Hannibal Pool

(Fish = **GOOD**, Macros = **GOOD**)

Variable	2009	2014	2021
Environmental Factors			
Avg. seasonal flow (cfs)	Low	Low	Low
Avg. Conductivity	422.5	396.3	489.4
Avg. Secchi Depth	30.4	31.1	41.1
Avg. CPUE Score	23.1	18.1	13.9
Gizzard Shad	1461	43	24
All Fish	3229	2819	2406
Avg. of Sucker Score	69.4	69.8	38.3
Deep-Bodied Suckers	170	99	38
River Redhorse	35	12	0
Avg. of Non-Native Score	82.6	79.3	76.2
Avg. % Invertivore Score	25.6	55.8	82.8
Avg. % Piscivore Score	62.7	44.9	17.8
Sauger	317	147	76
All Piscivores	656	743	282
Avg. Great River Species Score	26.7	8.9	2.2
Silver Chub	20	0	0
Mooneye	10	2	0
Assessment Result			
Avg. mORFIn Score	34.8	34.1	30.4
Fish Condition Rating	Good	Good	Good

Hannibal Pool was assessed to be in “Good” condition in 2021. While the condition rating has remained the same over the last three assessments, the lowest score was observed in 2021, less than one point shy of being downgraded to “Fair”. In 2021, the mORFIn Score decreased by about four points from the last two assessments. Metric performance revealed decreasing scores in several metrics shown in the figure above. One driving factor behind these declines is more than likely the proliferation of invasive submerged aquatic vegetation, primarily *Hydrilla sp.* One of the only metrics that has been consistently increasing over the last two cycles is the Percent Invertivore Score. This is consistent with what has been observed in Hydrilla dominated shoreline communities. The dense beds of invasive plant material create an environment for small fish and macroinvertebrates to thrive. However, these communities are not consistent with native species distributions and tend to have more individuals of tolerant species than would be seen in a healthy aquatic ecosystem. Of the round-bodied suckers, Golden and Silver Redhorse are the most tolerant species in the Ohio River. Over the last two assessment cycles, they are the only round-bodied suckers that more individuals were collected in 2021. Also worth mentioning is a large increase in Bluntnose Minnows, a tolerant species, beginning in 2013. By that time,

CONCLUSIONS

Hydrilla sp. had dominated most of the shoreline habitat in Hannibal Pool. A drastic decline in great river species was observed in Silver Chubs and Mooneye. Fish health appears to be slightly declining in Hannibal Pool, Average DELT Score dropped 10 points from the 2008 assessment to 2021 assessment. Average DELT Score reflects the number of deformities, erosions, lesions, and tumors observed while identifying and measuring fish at the 15 sites throughout the pool. Habitat observations in Hannibal Pool consisted of a heterogenous mix of coarse and fine substrate with sand and fine substrates being the most abundant substrate type observed.

Markland Pool

(Fish = **GOOD**, Macros = **FAIR**)

Variable	2009	2014	2021
Environmental Factors			
Avg. seasonal flow (cfs)	Low	Low	Low
Avg. Conductivity	470.5	304.6	430.4
Avg. Secchi Depth	27.2	26.9	26.4
Avg. Sucker Score	63.2	73.4	76.4
Black Buffalo	1	5	21
Silver Redhorse	3	19	26
River Redhorse	0	0	6
Avg. Species Score	66.8	66.6	75.1
# native OH River species	42	42	45
Avg. Great River Score	64.4	55.6	46.7
Mooneye	9	5	2
River Shiner	12	156	47
Avg. % Simple Lithophil	72.4	30.1	23.3
Golden Redhorse	219	26	65
Sauger	378	116	58
Silver Chub	372	33	44
Assessment Result			
Avg. mORFIn Score	43.36	37.71	38.13
Fish Condition Rating	Very Good	Good	Good

Markland pool was assessed to be in “Good” condition in 2021. This is condition rating is the same as the 2014 assessment, both of which are lower than the 2009 assessment. The 15 randomly drawn sites were fairly evenly distributed throughout the pool with the exception of four sites clustered just above the Markland dam; there were six sites above and nine sites below the confluence of the Licking River. The only site that scored “Poor” was located in the only highly urbanized portion of the pool in Cincinnati, OH. Environmental factors such as flow and Secchi depth were comparable over the last three assessments, while there was some variation in conductivity. The primary factor responsible for the decline of the

biological condition rating from the first assessment compared to the following two was the Average Percent Simple Lithophil Score. This score was most drastically affected by fewer observations of Golden Redhorse, Sauger, and Silver Chub. There has been an increasing trend in the Average Sucker Score over the past three assessments, mostly attributed to a higher occurrence of round-bodied suckers. The River Redhorse, which is an Ohio species of concern, was documented six times in 2021, which was not observed in neither the 2009 nor 2014 assessments.

McAlpine Pool

(Fish = **GOOD**, Macros = **FAIR**)

Variable	2009	2014	2021
Environmental Factors			
Avg. seasonal flow (cfs)	Low	Low	Low
Avg. Conductivity	42.47	396.27	489.4
Avg. Secchi Depth	30.4	31.06	41.13
Avg. % Invertivore Score	54.19	67.0	68.21
Bluegill	105	89	154
River Shiner	10	30	94
Avg. % Non-Native Score	86.86	91.78	27.12
Common Carp	12	4	3
Avg. Great River Species Score	44.44	51.11	64.44
Mooneye	10	1	12
River Shiner	10	30	94
Silver Chub	43	51	55
Assessment Result			
Avg. mORFIn Score	35.92	43.95	37.48
Fish Condition Rating	Good	Very Good	Good

McAlpine Pool was assessed to be in “Good” condition in 2021. Although this is a condition rating lower than what was observed in the previous assessment (2014), the mORFIn score is slightly higher than what was observed in 2009 indicating not much has changed over the previous two assessment cycles. The 15 randomly drawn sites were distributed fairly evenly throughout the pool; one site was upstream of the Kentucky River, five sites immediately upstream of Louisville dam, and the remaining nine sites scattered inbetween. Environmental factors such as flow, temperature, conductivity, and Secchi depth were all comparable over the last three assessments. In 2021, the Average Percent Invertivore Score, Average Percent Piscivore Score, and Average

CONCLUSIONS

Great River Score were the highest scores observed for those metrics over the previous two assessment cycles. Two of these increased metrics have been driven up by the increased abundance of River Shiners. These results indicate stable fish and macroinvertebrate populations. The trends of shifting fish communities observed in Hydrilla dominated pools in the upper river have not been observed in the fish community of McAlpine pool. Vegetation surveys conducted during the assessment showed no presence of *Hydrilla sp.* in McAlpine Pool.

Macroinvertebrates

As per ORSANCO's Biological Assessment protocol, a minimum of 15 fish samples and / or 10 macro samples are required to be collected in each pool in order to derive a viable assessment. The ten macro samples must be comprised of deep Hester-Dendy samples (HDD) or multihabitat kick samples (MH). Multihabitat kick samples will only be used when deep Hester-Dendy samples are lost, unrecoverable or otherwise disturbed, provided the multihabitat kick samples contain at least 200 individuals. Minimum sample number criteria (15 fish and 10 macro respectively) are standardized and necessary to ensure comparability between assessments.

Dashiels Pool

Macroinvertebrate collections in the Dashiels Pool met the minimum number of samples in 2021. All 15 HDD samplers were recovered at the end of the colonization period. The Ohio River Macroinvertebrate Index (ORMIn) indicates that the macro community in Dashiels Pool is in "Fair" condition, with the average ORMIn score of 28.03.

The most abundant macroinvertebrates present in the Dashiels pool aside from Oligochaetes, were two different families of moderately tolerant mayflies--*Heptageniidae* commonly known as Flathead Mayflies (*Stenacron sp.*), and *Ephemeridae*, or Common Burrowing Mayflies (*Hexagenia limbata*). There was also a high abundance of Prosobranch Snails (*Amnicola sp.*) and highly tolerant Tube-making/trumpet-net Caddisflies (*Cyrnellus fraternus*).

The greatest species diversity was observed in the Dashiels Pool, with the presence of 70 unique taxa, rendering the highest score for the Number of Taxa metric. Dashiels also scored the highest in the Percent Collector-Gatherer Taxa score, which was mostly driven by the high relative abundance of nine species of midges from the family *Chironomidae*, as well as five different species of mayflies.

Hannibal Pool

Fourteen of the HDD samplers were retrieved at the end of the colonization period. The ORMIn score for the 2021 season was 35.62, which rates the Hannibal pool to be in "Good" condition for macroinvertebrates.

Mayflies (*Ephemeroptera*) comprised 24% of the population present in Hannibal pool--*Stenacron sp.* was the most abundant genus sampled, which is a species of Flathead Mayfly. There were also high abundances of invasive Zebra Mussels (*Dreissena polymorpha*), Burrowing Mayflies (*Hexagenia limbata*), and tolerant Non-biting Midges (*Tribelos sp.*).

The Hannibal Pool scored the highest on average compared to other 2021 pools in the following ORMIn metrics: Percent Odonata Score and Percent Intolerant Score. Hannibal's macroinvertebrate composition contained the highest diversity and abundance of Riffle Beetle (*Elmidae*) species, and the highest density of snails from the order *Neotaenigioglossa*, all of which require highly oxygenated environments. These aforementioned observations could be attributed to the high density of *Hydrilla verticillata* present throughout the pool which has the ability to cause large swings in dissolved oxygen and also provides ideal habitat to predacious Dragonflies, Damselflies, and Riffle Beetles.

CONCLUSIONS

Markland Pool

Ten HDDs were retrieved from the Markland Pool, which is the minimum number required to accurately compute ORMI_n scores. The 2021 assessment score of 25.09 classifies the Markland Pool to be in “Fair” condition for macroinvertebrates.

The most abundant species present in this assessment was a highly tolerant caddisfly, *Cyrnellus fraternus*, comprising 20.62% of the individuals sampled. There was also a high abundance of Zebra Mussels (*Dreissena polymorpha*), and two species of Non-biting Midges (*Dicrotendipes sp.* and *Tribelos sp.*). Markland pool was the only pool of the 2021 assessments to contain any stonefly specimens (*Acroneturia sp.*) and also contained the highest abundance of caddisflies (22.32% of individuals), which resulted in Markland scoring the highest in the EPT Taxa Score metric.

McAlpine Pool

Fourteen HDDs were retrieved from Hannibal Pool, yielding an ORMI_n score of 25.54 which classifies the pool in “Fair” condition based on the observed macroinvertebrate population.

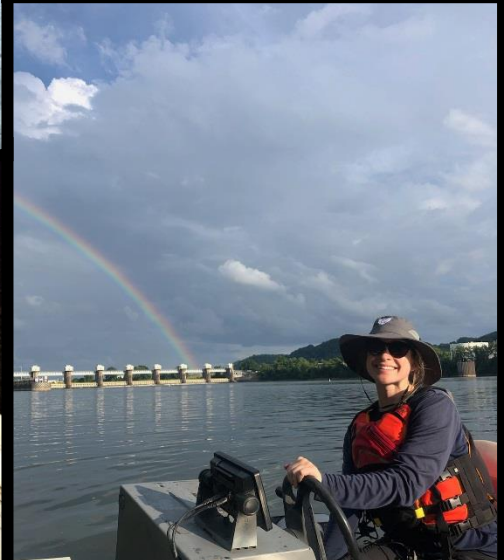
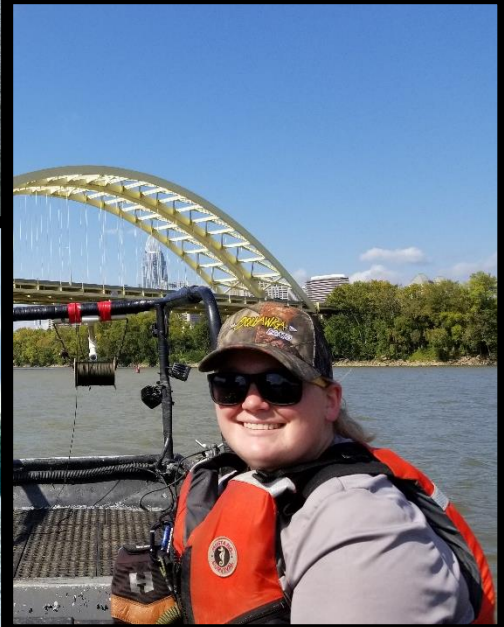
Zebra Mussels (*Dreissena polymorpha*) were the most prevalent species sampled throughout the pool, comprising 14% of the total catch. The other most abundant species include Non-biting Midges (*Tribelos sp.*), two species of mayflies (*Stenacron sp.* and *Hexagenia limbata*) and the caddisfly, *Cyrnellus fraternus*.

McAlpine contained the highest abundance of *Diptera* and *Ephemeroptera* (24.58% and 26.59% of the sampled population, respectively), both orders are represented by species that are predominantly classified as moderately to highly tolerant to pollution.



Select Ohio River Macroinvertebrates

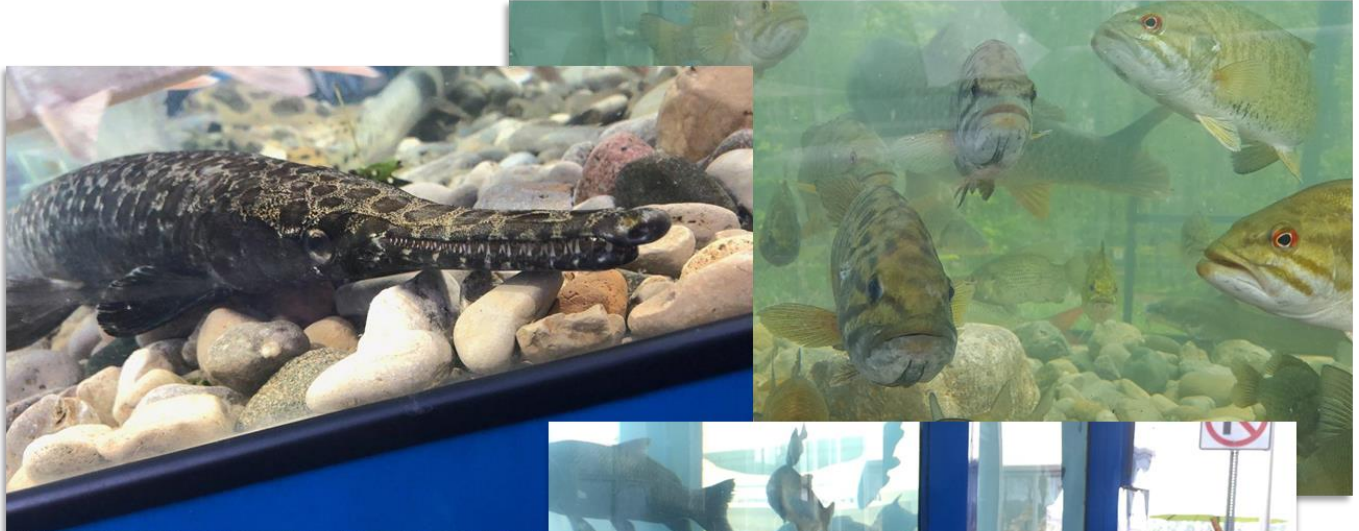
Left: non-biting midge (*Tribelos fuscicorne*), Top Middle: long-horned caddisflies (*Oecetis sp.*), Top Right: scud (*Gammarus fasciatus*)
Bottom Middle: burrowing mayfly (*Hexagenia limbata*), Bottom Right: black-shouldered spinyleg dragonfly (*Dromogomphus spinosus*)



Our assessments would not be possible without the guidance of our committee and hard work of our Seasonal Biologists. For information on seasonal employment opportunities available to recent graduates, contact Rob Tewes (rtewes@orsanco.org).

Look for our mobile 2,200 gallon educational aquarium displays at festivals and events along the Ohio River filled with fishes from local areas.

To request a "Life Below the Waterline" display at your event, contact Rob Tewes (rtewes@orsanco.org) for pricing and scheduling



River-wide Catch Comparison (data from most recent survey year shown)

Group	Species (common name)	Emsworth '18	Dashields '21	Montgomery '15	New Cumberland '17	Pike Island '18	Hannibal '21	Willow Island '16	Belleville '14	Racine '15	Robert C. Byrd '13	Greenup '16	Meldahl '17	Markland '21	McAlpine '21	Cannelton '16	Newburgh '17	John T. Myers '15	Smithland '13	Open Water '14
GAR	Longnose Gar	18	16	11	31	54	54	34	28	64	25	42	59	31	21	50	30	16	11	61
	Spotted Gar															1			2	
	Shortnose Gar												1				12	12	28	101
SHAD	Skipjack Herring							2			1			1	2	3	5	2	1	
	Gizzard Shad	6	11	26	83	37	24	154	117	147	176	158	591	616	312	378	216	650	557	278
	Threadfin Shad																		14	74
CARP	Common Carp	12	25	45	75	16	11	11	26	3	32	7	13	15	3	3	4	8	7	2
	Grass Carp								1					1	1		2			1
	Silver Carp														1	3		15	17	25
	Bighead Carp																			
	Goldfish								1									1		
	Carp x Goldfish																			
MINNOW	Cyprinidae sp.																			
	Golden Shiner								1					1	1					1
	Striped Shiner				2		1						11							
	Spottail Shiner			4				11	2	4	1	2								
	Spotfin Shiner	76	81	68	165	61	60	295	58	127	19	52	19	8	18	73	8	112	218	14
	Notropis sp.																			
	Emerald Shiner	238	748	216	357	75	376	1085	240	1208	172	221	423	133	185	407	195	102	86	20
	Silverband Shiner																			
	Sand Shiner					70														
	Channel Shiner	1071	1423	323	845	484	391	1173	410	733	684	2017	872	685	145	1822	426	255	102	47
	River Shiner	1			42		1		5			16	69	47	94	145	47	104	8	15
	Shoal Chub																			
	Silver Chub	1							1		1	11	38	44	55	32	10	10	12	10
	Streamline Chub	6	4			5														
	River Chub																			
	Gravel Chub																			
	Creek Chub											1								
	Central Stoneroller					2		9					1							
	Mississippi Silvery																			15
	Suckermouth Minnow																			
	Bluntnose Minnow	10	47	30	224	33	61	227	8	12		2	3	4			12	9		2
	Bullhead Minnow				0		3	12	5		1	17	14	11	1	11	13	24	1	6
Silverjaw Minnow																				
SU CK ER	Ictiobinae sp.																			

River-wide Catch Comparison (data from most recent survey year shown)

	Ictiobus sp.																1			
	Smallmouth Buffalo	22	43	82	37	42	14	26	38	33	32	19	45	24	9	17	11	32	106	32
	Bigmouth Buffalo											1			1		1	4	4	5
	Black Buffalo	5	20	18	13	13	1	3	7			3	14	21	9	2		2		10
	Carpoides sp.						2		1							1				1
	Quillback	2	11	6	13	3	10	9	7	3	12	3	28	41	10	3	3	7	31	5
	River Carpsucker	4	43	47	15	5	8	18	33	20	26	38	151	181	92	19	48	187	263	139
	Highfin Carpsucker		1	12			3		3	8	1	6	6	8	1			3	91	3
	Northern Hog Sucker	7	8	6	16	4	1	8	1	5	2	1		1	5					
	Moxostoma sp.				22						1									
	Shorthead Redhorse																			10
	Smallmouth Redhorse	48	216	27	3	27	62	41	61	11	22	38	114	46	17	40	13			
	Silver Redhorse	131	189	215	122	26	118	42	31	16	22	39	31	26	7	5	2			
	River Redhorse	12	10	23	6	5		1		2	6	25	4	6	1	4				
	Black Redhorse	5		25	27	4		6												
	Golden Redhorse	34	177	156	442	116	439	219	64	56	56	124	112	65	31	17	25	8		1
	Spotted Sucker							13	8	1		2	1	1						
	White Sucker					2														
CATFISH	Yellow Bullhead																			
	Brown Bullhead																			
	Northern Madtom																			
	Blue Catfish															4		1	5	
	Channel Catfish	9	16	83	59	45	59	35	177	52	114	61	98	107	58	46	68	106	478	65
Flathead Catfish	8	7	8	9	10	12	22	36	24	40	29	26	39	24	10	19	20	30	12	
SUNFISH	Lepomis sp.																			5
	Warmouth												1							
	Rock Bass	31	28	22	238	35	14	11	2											
	Bluegill	20	105	88	215	138	129	540	391	220	254	205	73	490	154	65	32	65	270	41
	Green Sunfish	3	2	1	3	2	3	1	1	4	4	2	2	9	6	2	2	1		4
	Pumpkinseed		1	3	54	6	1	14		2	6									
	Orangespotted Sunfish		1				17	197		5		5	13	76		2	2	6	1	
Longear Sunfish				1	20	173	18	24	13	56	15	17	134	88	31	32	137	207	16	
SUNFISH	Redear Sunfish							2	7	2	3	4	2	13	3	20	8	1	32	
	Lepomis Hybrid				3	1			1		2				1				2	
	Bluegill X Longear																			
	Bluegill X Green									1										
	Longear X Green																			
TEMPERATE BASS	Morone sp.			3		1		49	79	8	15	35	25	140	36	28	37	72	86	733
	White Perch																2			
	Striped Bass								1		1		3				4			
	White Bass	3	10	7	3		27	4	16	1	71	16	59	95	41	20	43	13	83	34
	Yellow Bass															1			15	25

River-wide Catch Comparison (data from most recent survey year shown)

BLACK BASS	Hybrid Striped Bass			2			6		3	1	2	6	16	13	7	13	6	2	6	10	
	Micropterus sp.	2			4	3		5			9		21	2		12	3	14		16	
	Smallmouth Bass	229	177	184	241	169	58	198	27	41	38	24	55	65	20	13	11	2	2	7	
	Largemouth Bass	3		12	16	17		20	10	19	18	18	6	19	20	4		2	10	6	
	Spotted Bass	7	17	6	28	25	18	46	26	17	60	59	46	120	74	48	50	133	48	26	
DARTER	Johnny Darter			1																	
	Greenside Darter					1								1							
	Variagate Darter																				
	Rainbow Darter		1	2					1						1						
	Fantail Darter																				
	Bluebreast Darter																				
	Banded Darter																				
	Dusky Darter																				
	Channel Darter				1				1	1				1							
	Blackside Darter																				
	Slenderhead Darter																				
		River Darter																			
	Logperch	59	91	26	15	35	85	73	5	9	5	16	4	14	1	2		2		2	
PERCH	Yellow Perch	1		44	15	9	1	7	3					1							
	Walleye	26	19	68	29	9	5	1	13	1			1		12		7	5			
	Saugeye		16	42	1	1	12		25	25			14	78	152	2	23	4	4	6	
	Sauger	13	85	110	110	31	76	73	89	15	128	194	58	58	8	94	52	225	23	46	
MISC.	Silver Lamprey	1	1										1								
	Ohio Lamprey								1												
MISCELLANEOUS	Goldeye																	10	1		
	Mooneye	2		26	11	3		2			3	2		2	12	5	4	1		1	
	Paddlefish													1			1				
	Northern Pike	1																			
	Muskellunge	4																			
	White Crappie				2			1	4	2	1	6	2	3	1	3	3	7	2	1	
	Black Crappie	1		9	8		1	4	6	6		6	10	1	2		2	7	5		
	Inland Silverside																		16	14	
	Brook Silverside		1		4			1									2	1	1		
	Atlantic Needlefish																				
	Trout-Perch	9	22	137	21	14	3		2												
	Banded Killifish				10	1	16	14	1												
	Western Mosquitofish																		1		
	Bowfin																				
	Freshwater Drum	17	20	36	34	8	44	16	82	36	89	116	158	151	86	47	157	114	328	746	
Total No. of Individuals		2158	3693	2260	3675	1666	2402	4755	2190	2957	2211	3666	3329	3650	1827	3507	1652	2518	3230	2680	
Total No. of Species		41	37	42	48	43	42	49	52	40	41	45	45	49	45	43	45	47	43	46	