Aquatic Habitat Restoration Along the Black River Using Fish Shelves

Introduction

- Kate Golden, Storm Water Manager, City of Lorain
- Chip Wendt, Coldwater Consulting, LLC

Lorain, Ohio & The Black River

- Heavily industrialized City with roots in steel, automobile manufacturing, and ship-building
- Formerly "famous" for the tumors & anomalies found on fish species

The *Charles W. Kotcher*, Lorain, Ohio, from Dan Brady; http://danielebrady.blogspot.com/2014/01/a-leiter-real-photo-postcard-sampler.html , circa 1908; Web; 1 April 2019.

Lower Black River Area of Concern Remediation & Restoration Program

- Initiated in 2010 and $31,000,000 in funding
- Addresses legacy steel manufacturing contaminant remediation as well as aquatic habitat, wetland, riparian, and upland restoration
- Address Beneficial Use Impairments (BUI)
  - Degradation of Fish Populations, Degradation of Benthos, Loss of Fish & Wildlife Habitat, among others
- Contribute to potential de-listing as an AOC

Lower Black River Area of Concern (AOC) Projects

Map Number	Project Name	Funding Source	Funded Amount	Description
1	Lakeview Park Beach BUI Assessment	US EPA-GLRI	$ 300,000	Assessment: beach water quality
2 (a,b,c)	Lower Black River Area of Concern (AOC) Remediation and Restoration Program (2017)	US EPA-GLRI	$ 15,095,000	2a: Bulkhead fish habitat shelves 2b: Slag removal, slope stabilization, upland riparian restoration, wetland enhancement 2c: Seep remediation system
3	Black River Landing & Heron Rookery Habitat Restoration Project (2014)	NOAA-GLRI	$ 1,347,644	Bank stabilization, fish shelves, upland riparian restoration
4	Black River Restoration Project (2010)	DEPA-ARRA	$ 6,300,000	Slag removal, 20-acre floodplain wetland restoration, fish shelves, upland riparian restoration, bank stabilization
5	Lower Black River Heron Rookery Restoration Project - Phase I (2012)	ODNR-GLRI	$ 250,000	Slag removal, floodplain wetland restoration
6	Lower Black River Heron Rookery Restoration Project Phase II - Design (2014)	NOAA-GLRI	$ 175,000	Assessment: slag removal & riparian restoration
7	Lower Black River Habitat Restoration Project - Phase II (2011)	NOAA-GLRI	$ 1,089,750	Slag removal, fish shelves, bank stabilization, upland riparian restoration
8	Black River Supplemental Environmental Project (2011)	DEPA-SEP	$ 101,869	Slag removal, upland riparian restoration
9	Lower Black River Habitat Restoration Project - Phase I (2010)	NOAA-GLRI	$ 1,617,800	Bank stabilization, fish shelves, other in-stream habitat
10	Black River Dredge Re-Use Facility	ODNR	$ 4,000,000	Dredgings re-use facility
11	2014 Nearshore Re-Vegetation in the Lower Black River AOC Project (2014)	USFS-GLRI	$ 88,000	Bank stabilization (live cutting plantings)
12	Invasive Vegetation Control in the Lower Black River AOC	NOAA-GLRI	$ 924,825	Invasive species control and native vegetation plantings
13	Disposal of Legacy Steel Mill Contaminants/Riparian Restoration Project (2011)	USFWS-GLRI	$ 339,900	Slag removal, upland and wetland riparian restoration
14	Lower Black River Habitat Restoration Project - Phase III (2011)	NOAA-GLRI	$ 350,000	Design. Bank stabilization, fish shelves, other in-stream habitat, upland riparian restoration
15	Additional Assessment and Characterization at the Former RTI Coke Works Property	DEPA-GLRI	$ 200,000	Assessment: seep remediation
Black River Watershed	Invasive Vegetation Control in the Lower Black River Area of Concern, Phase II	US EPA-GLRI	$ 499,496	Invasive species control and native vegetation plantings
Black River Watershed	Invasive Vegetation Control in the Lower Black River Area of Concern, Phase III	US EPA-GLRI	$ 634,889	Invasive species control and native vegetation plantings
Eaton Township	Black River Area of Concern: Willow Creek Stream Restoration Project	US EPA-GLRI	$ 600,000	Stream and wetland restoration
Eaton Township	Black River Area of Concern: Fortune Ditch Stream Restoration Project	US EPA-GLRI	$ 550,000	Stream and wetland restoration
TOTAL			$ 34,484,173	

City of Lorain Reclamation Site Restoration

Program Partners

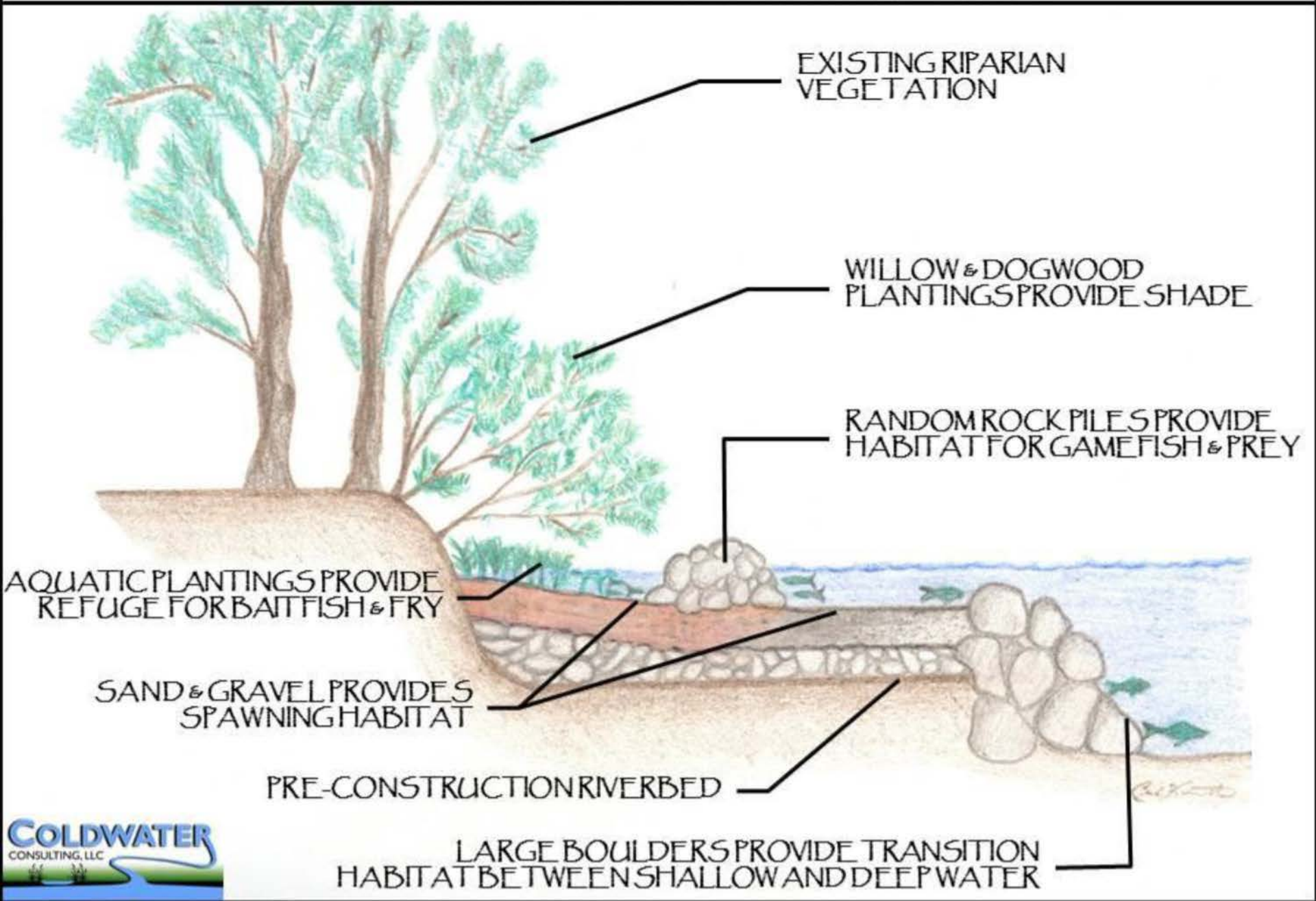
- Thank you to our partners for making program this possible!
  - City of Lorain, Black River AOC Advisory Committee, LoCo 'Yaks Lorain County, Lorain County Public Health, Lorain Port Authority, Lorain County Metro Parks, Coldwater Consulting, Midwest Biodiversity Institute, Wood, Brown and Caldwell
  - NOAA, US EPA – GLNPO, Ohio EPA, ODNR, USFWS, USFS

BLACK RIVER

Fish Habitat Design Approach

- Replicate natural riverine features (interface, substrate, wood) that withstand the elements
- Sought guidance from NOAA and Roger Thoma (MBI) to determine suitable materials and placement of structures

THE LOWER BLACK RIVER FISH HABITAT RESTORATION PROJECT
FISH HABITAT SHELF CONSTRUCTION CONCEPT



COLDWATER CONSULTING, LLC

Traditional Fish Shelf

- Fish Shelves and In-Stream Structures
  - Substrate Diversity
  - Shallows
  - Cover and Structure
  - Spawning and Refuge
- Bank Restoration
  - Erosion Reduction
  - Native Vegetation

Traditional Fish Shelf Monitoring Approach

- Prior to creation of AOC de-listing guidance, Ohio WQS for bio-criteria used to demonstrate improvements to water quality
  - LIBI, MIwb, LICI, LQHEI
- AOC de-listing guidance utilizes same indices and similar targets for BUI removal in the Black River

Traditional Fish Shelf Fish Assemblage Monitoring and Results

- Utilize LIBI & MIwb to demonstrate improvements towards delisting targets
- Monitoring performed 1982, 1992, 1997 (OEPA) and 2010-2013, 2015, 2017 (MBI)
- Progressive improvement of fish assemblages from 1997-2019
  - 1982 – Poor
  - 1992 – Poor to Fair
  - 1997 – Poor to Good
  - 2010-2013 – Poor to Good
  - 2015, 2017 – Fair to Good

Traditional Fish Shelf Fish Assemblage Monitoring and Results

RIVER MILE	LIBI (Target: 42)							
	1997	2010		2011	2012	2013	2015	2017
4.4	-	-		27*	38^{ns}	34*	34	39^{ns}
4.3	-	46	40^{ns}	42	42	39^{ns}	41^{ns}	36.5*
3.91	-	-		34*	41^{ns}	28*	35*	34*
3.9	-	34*		33*	39^{ns}	39^{ns}	36.7*	42
3.8	-	-		-	44	35*	39^{ns}	40^{ns}
3.6	-	32*	31*	34*	44	41^{ns}	39^{ns}	43
3.01	-	-		-	-	-	40.7^{ns}	38^{ns}
0.6	45	40^{ns}		39^{ns}	42	45	39^{ns}	34*

Traditional Fish Shelf Fish Assemblage Monitoring and Results

RIVER MILE	MIwb (Target: 8.6)						
	1997	2010	2011	2012	2013	2015	2017
4.4	-	-	6.4*	8.1^{ns}	8.2^{ns}	7.6*	8.2^{ns}
4.3	-	9.4	9.5	9.0	8.9	8.9	8.2^{ns}
3.91	-	-	7.8*	9.0	8.2^{ns}	8.0*	7.8*
3.9	-	8.5^{ns}	8.1^{ns}	8.5^{ns}	8.7	8.6	8.4^{ns}
3.8	-	-	-	8.5^{ns}		9.1	8.6
3.6	-	8.2^{ns}	8.3^{ns}	8.7	9.0	8.6	8.9
3.01	-	-	-	-	-	9.0	8.9
0.6	8.5	7.9*	7.8*	8.2^{ns}	9.3	8.2	7.5*

Traditional Fish Shelf Macroinvertebrate Monitoring and Results

- Utilize LICI to demonstrate improvements towards delisting targets
- Little improvement of macroinvertebrate assemblage
  - Consistently Very Poor to Poor
- Lack of improvement suggests multiple stressors influence
  - Legacy pollutants
  - WWTP, HSTS
  - Nonpoint Source Pollution
  - Sediment

Traditional Fish Shelf Monitoring and Results

RIVER MILE	LICI (Target: 34)									
	1997	2010	2011	2012	2013 Bank	2013 Mid	2015 Bank	2015 Mid	2017 Bank	2017 Mid
4.4	-	-	16*	6*	20*	22*	12*	6*	8*	8*
4.3	-	4*	-	10*	20*	32^{ns}	14*	14*	10*	12*
3.91	-	-	10*	-	14*	20*	16*	18*	12*	6*
3.9	-	8*	6*	12*	14*	-	-	-	10*	10*
3.8	-	-	-	14*	12*	14*	10*	10*	10*	6*
3.6	-	12*	12*	14* 16	12*	14*	12*	6*	14*	10*
3.01	-	-	-	-	-	-	12*	-	12*	14*
0.6	18*	24*	10*	18* 14	14*	-	22*	-	16*	-

Traditional Fish Shelf Habitat Monitoring and Results

RIVER MILE	LQHEI (Target: 55)								
	2008	2010		2011	2012		2013	2015	2017
4.4	-	-		43.5	45		48	49	45.5
4.3	-	52		51	51.3		57.5	53.5	54
3.91	-	-		46.5	44		56.2	62	52.5
3.9	-	54.5		50.5	53.8		53.5	56.5	59
3.8	-	-		-	62		56	55.5	58.5
3.6	47	49	45.8	60.8	59		62	60	49.5
3.01	-	-		-	-		-	46	44.5
0.6	57	49	55	55	48	40	52.5	52.3	54.5

BLACK RIVER FISH HABITAT SHELVES

Specifically sized openings are fabricated to permit access by juvenile fish species, baitfish, and macroinvertebrates.

Horizontally oriented shelves filled with gravel allow fish to deposit eggs.

Walleye

Yellow Perch

Largemouth Bass

Bluegill

Gizzard Shad

Emerald Shiner

Macroinvertebrates

Industrialized rivers such as the Black River have historically been managed for shipping and commerce. Riverbanks are hardened with steel and concrete sheet piling and bulkheads designed to protect against damages caused by wind, water, ice flows, storm surge, and commercial boat traffic.

Prior to Lorain's settlement, lower reaches of the Black River had back-water areas and coastal marshland which provided critical habitat for the survival of juvenile fish. Today, these areas are framed by steel bulkheads, a deeply dredged channel, and lack the refuge habitat needed by juvenile fish to thrive.

Restoring fish habitat, while preserving commercial shipping, requires an innovative approach to design and construction. This fish shelf is an excellent example that effectively stabilizes the river bank while restoring valuable fish habitat.

The semi-cylindrical structures on the bulkhead are filled with large stones and pieces of oak in order to create many different sized spaces that provide refuge for passing fish, aquatic bugs, and macroinvertebrates. Habitat space is maximized through the use of both concave and convex surfaces.

Designing and constructing structures that provide diverse habitat encourages utilization by multiple species of fish and aquatic life.

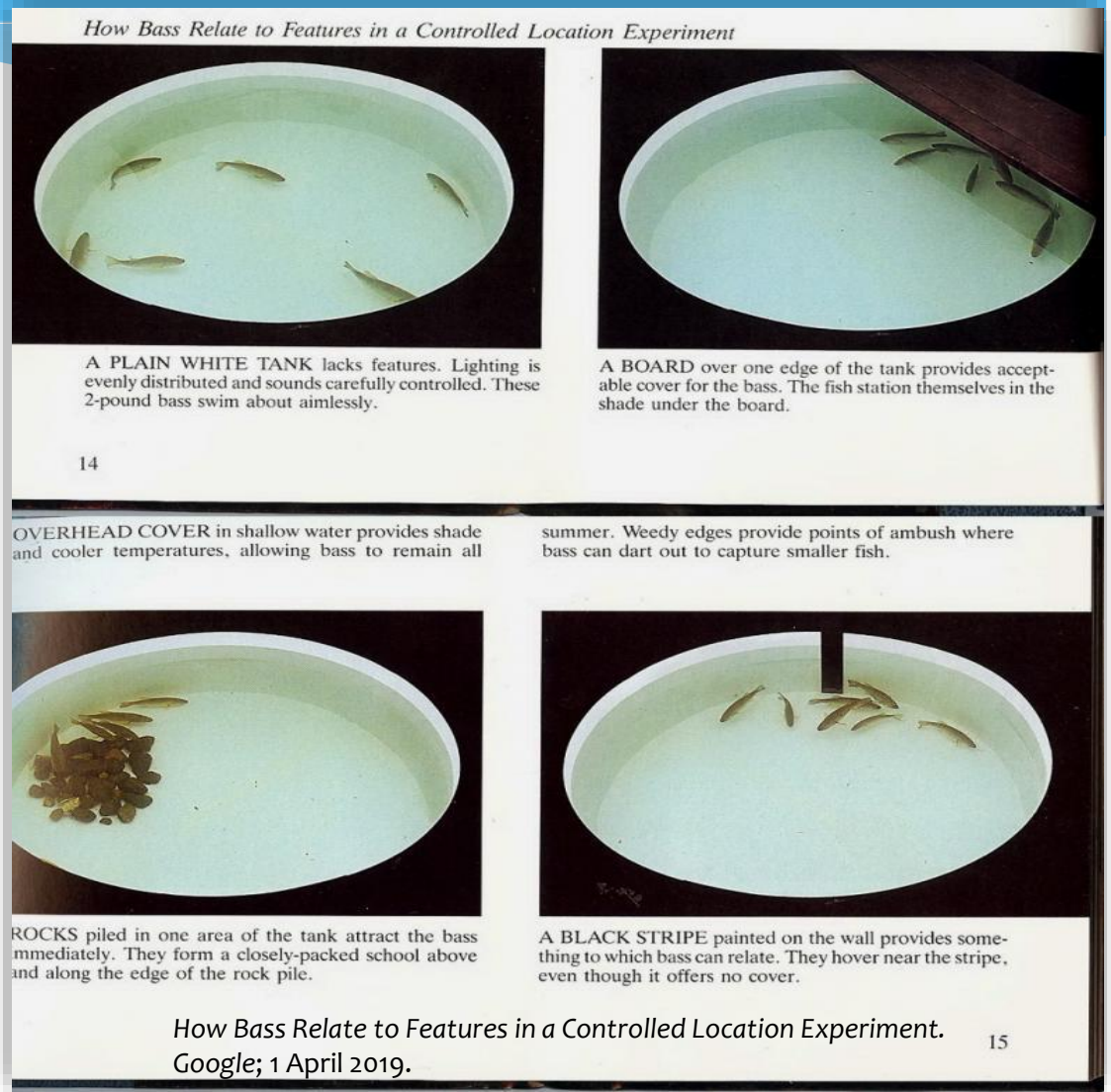
Funding Provided By:

Great Lakes RESTORATION

COLDWATER CONSULTING, LLC

"If you build it, he will come." – Field of Dreams

- Limited habitat components are better than no habitat at all
- Multi-species, multi-size use
- Robust enough to withstand barge traffic, ice, waves
- 75-year bulkhead lifespan



How Bass Relate to Features in a Controlled Location Experiment

A PLAIN WHITE TANK lacks features. Lighting is evenly distributed and sounds carefully controlled. These 2-pound bass swim about aimlessly.

A BOARD over one edge of the tank provides acceptable cover for the bass. The fish station themselves in the shade under the board.

14

OVERHEAD COVER in shallow water provides shade and cooler temperatures, allowing bass to remain all summer. Weedy edges provide points of ambush where bass can dart out to capture smaller fish.

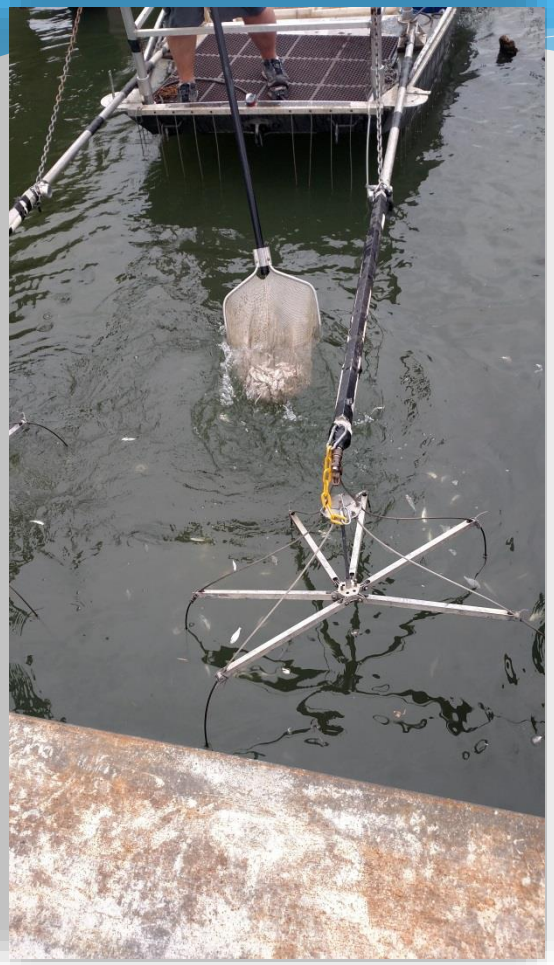
ROCKS piled in one area of the tank attract the bass immediately. They form a closely-packed school above and along the edge of the rock pile.

A BLACK STRIPE painted on the wall provides something to which bass can relate. They hover near the stripe, even though it offers no cover.

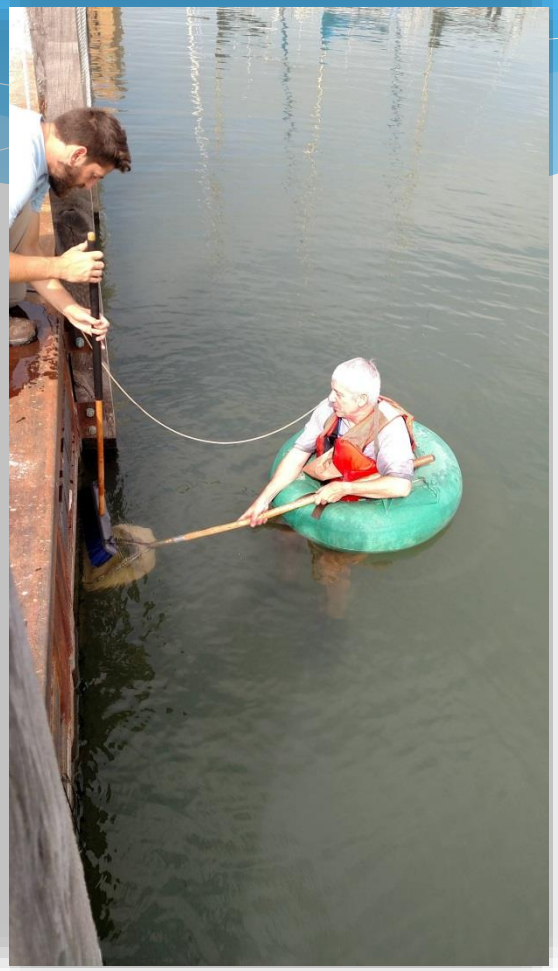
15

How Bass Relate to Features in a Controlled Location Experiment. *Google*; 1 April 2019.

Hybridized Fish Shelf Monitoring and Results



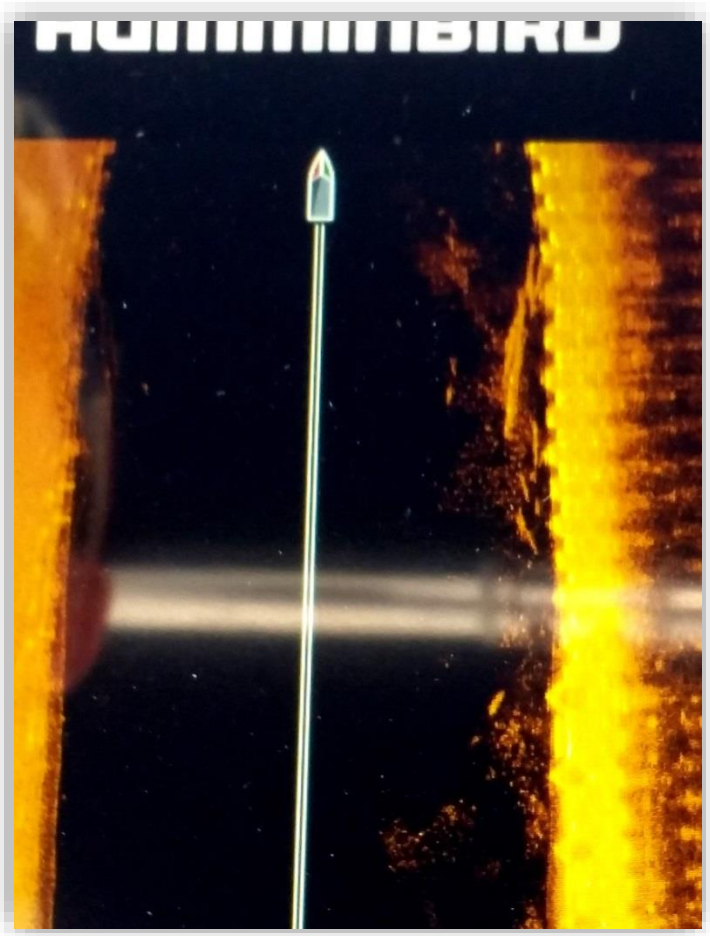
Electro-fishing and macroinvertebrate sampling conducted in 2017 (baseline), 2018, 2019



Hybridized Fish Shelf Monitoring and Results

RIVER MILE	LIBI (Target: 42)		MIwb (Target: 8.6)		LICI (Target: 34)		LQHEI (Target: 55)	
	2017	2018	2017	2018	2017	2018	2017	2018
0.6 - Traditional Fish Shelf Control Site	34*	47	7.5*	9.1	16*	14*	54.5	50.5
0.4 - No Habitat Control Site	30.5*	40^{ns}	6.4*	7.8*	12*	20*	32	35.5
0.2 - Hybridized Fish Shelf Site	26*	31*	5.8*	6.9*	22*	21*	19	31

Hybridized Fish Shelf Monitoring and Results



Hybridized Fish Shelf Monitoring and Results

- 84% increase in Largemouth Bass density
- 80% increase in Centrarchidae species richness (Bluegill, LMB, rock bass, etc.)
- 25% increase in total fish species richness
- 100% increase in EPT taxa abundance and species richness
- Rapid colonization/utilization by organisms only 4-6 months following construction
- Follow-up assessments planned for 2019, 2020

Cost and Funding

- Grant funded projects through ARRA, GLRI
- Traditional fish shelf construction
  - $136/linear foot
- Hybridized fish shelf construction
  - Bulkhead replacement and fish habitat components = $2,720/linear foot
  - Fish habitat components only = $453/linear foot

Questions

- Kate Golden, Storm Water Manager, City of Lorain
  - kathryn_golden@cityoflorain.org
- Chip Wendt, Coldwater Consulting, LLC
  - cwendt@coldwaterconsultants.com