Jun 5th, 3:25 PM - 3:45 PM

Session B3 - Assessing Fish Passage through Culverts in Midwest Streams: Identifying Design Parameters that Correlate with Passage Success

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STUDY OF FISH PASSAGE THROUGH CULVERTS IN NORTHEAST OHIO

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Center for Transportation and Materials Engineering
&
Ohio Department of Transportation

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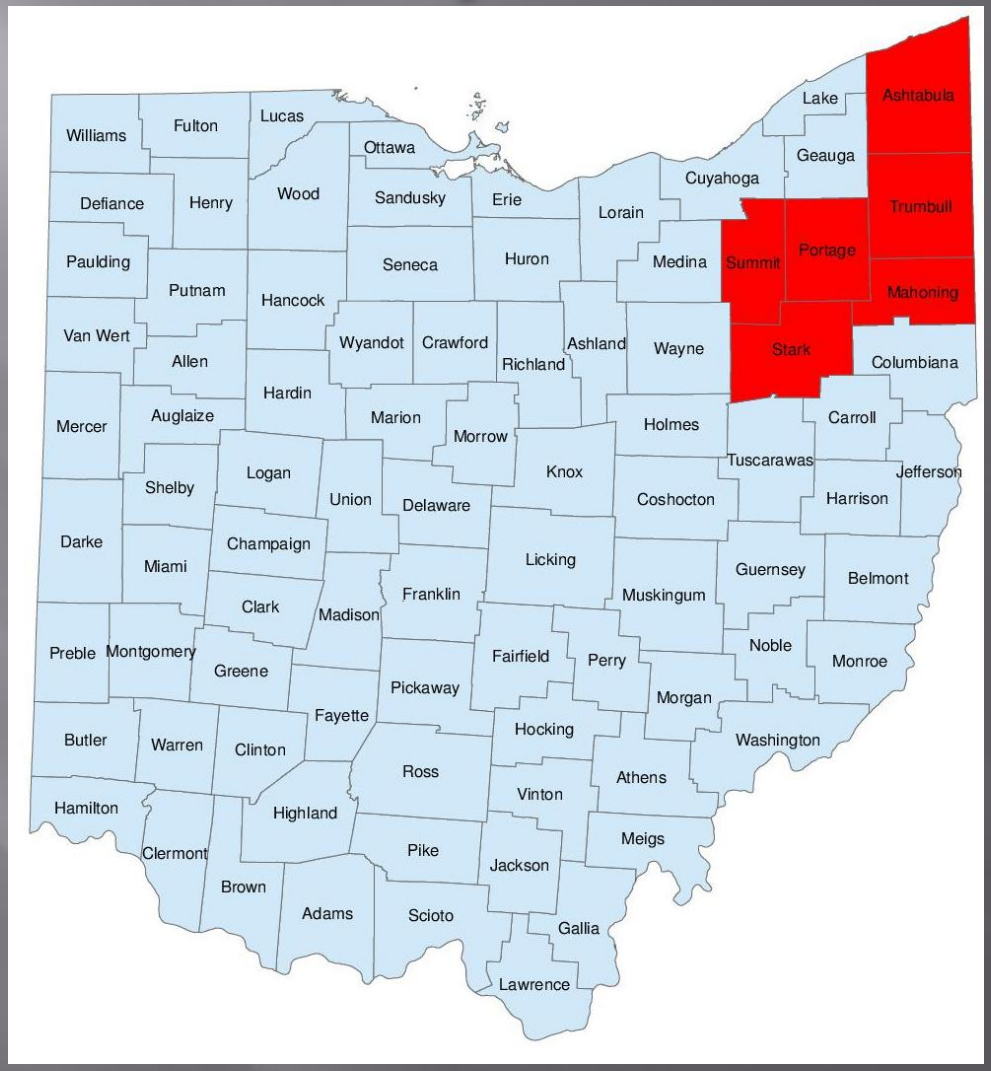
Introduction

- North East Ohio
  - Flat terrain
  - Spring is the wet season
- Study Area
  - District 4 of Ohio
  - Ashtabula, Mahoning, Portage, Stark, Summit, Trumbull

Study Area


Williams
Fulton
Lucas
Ottawa
Lake
Ashtabula
Geauga
Cuyahoga
Defiance
Henry
Wood
Sandusky
Erie
Lorain
Trumbull
Paulding
Seneca
Huron
Medina
Summit
Portage
Putnam
Hancock
Mahoning
Van Wert
Wyandot
Crawford
Richland
Ashland
Wayne
Stark
Columbiana
Allen
Hardin
Mercer
Auglaize
Marion
Morrow
Holmes
Carroll
Shelby
Logan
Union
Knox
Tuscarawas
Jefferson
Delaware
Coshocton
Harrison
Darke
Champaign
Licking
Miami
Guernsey
Belmont
Clark
Madison
Franklin
Muskingum
Preble
Montgomery
Greene
Fairfield
Perry
Noble
Monroe
Pickaway
Morgan
Fayette
Hocking
Butler
Warren
Clinton
Ross
Washington
Athens
Hamilton
Highland
Vinton
Meigs
Clermont
Pike
Jackson
Brown
Adams
Scioto
Gallia
Lawrence

Goals

- Identify
  - Percentage of culverts acting as barriers to fish passage in Northeast Ohio
  - Elements that may be affecting passage success

Data Sources

- Ohio Department of Transportation
  - 5837 culverts
- Ohio Gap Analysis
  - Fish distribution information
- USGS Seamless Data Warehouse
  - Digital Elevation Model (1/9 NED)
- Ohio Streamstats
  - Discharge data
- FishXing Helpfile
  - Fish dimensions and swimming speed

Fish Species

S.N.	Fish Name	Fish Length (ft)	Fish Height (ft)	Fish Velocity (ft/s)
1	Central stoneroller	0.2	0.05	1.31
2	White sucker	1.25	0.22	2.52
3	Northern pike	2.08	0.3	1.58
4	Greenside darter	0.17	0.02	1.02
5	Pumpkinseed	0.42	0.18	1.22
6	Longear sunfish	0.29	0.11	1.28
7	Smallmouth bass	1.13	0.3	2.68
8	Largemouth bass	1.38	0.39	3.44
9	Golden shiner	0.46	0.14	2.43
10	Blacknose dace	0.14	0.02	1.26

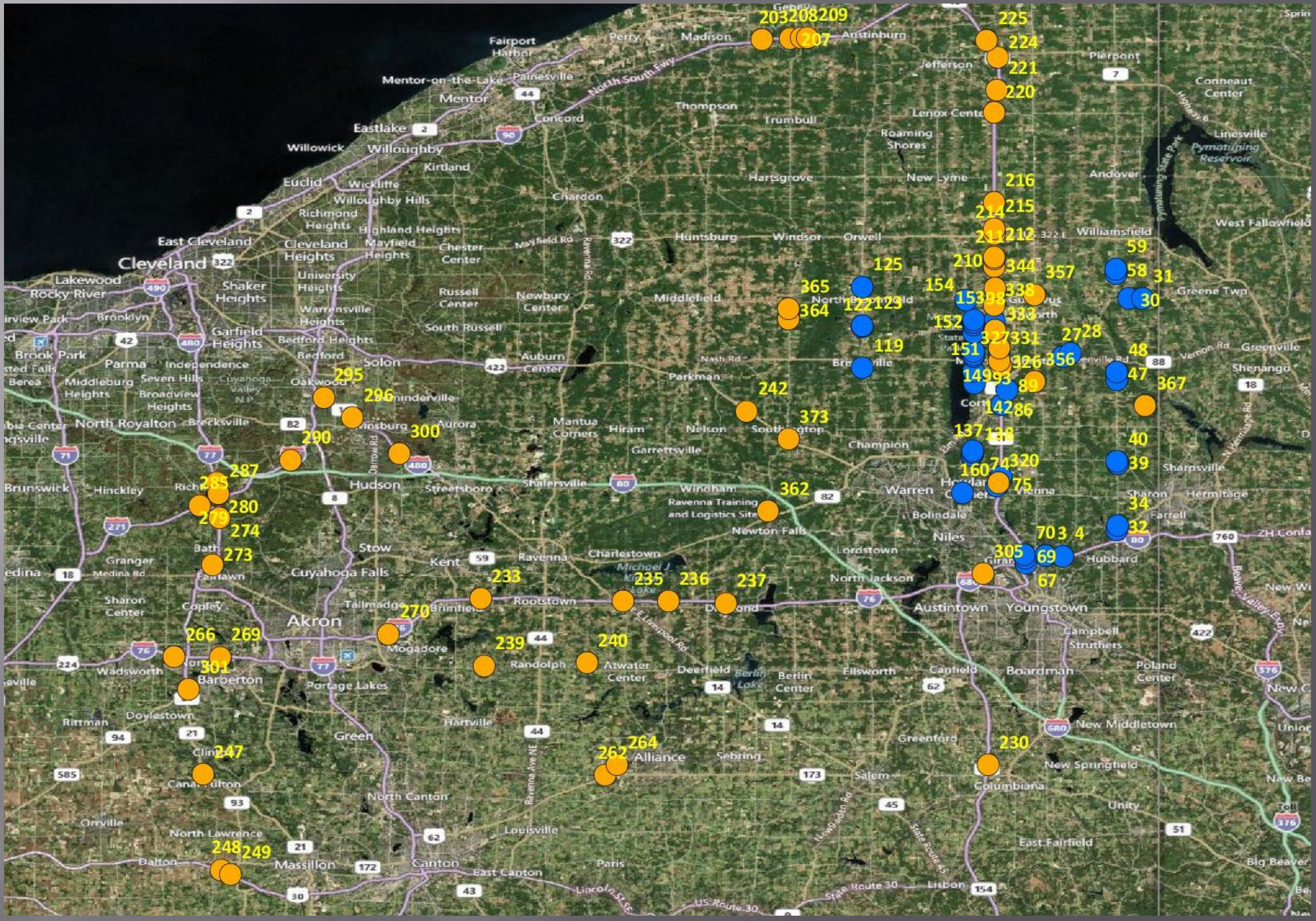
Methods

- Identify fish presence
  - Overlay of GIS layers
- Determine discharge
  - StreamStats Ohio
- Extract stream Cross section and slope
  - From NED 1/9 DEM

Methods

- Selection of culverts for analysis
  - One celled circular culverts
  - Diameter greater than 24 inches
  - Having slope and length data
  - Having tributaries
  - Presence of Fish Species
  - Possibility to extract cross section and slope
  - 101 out of 5,837 culverts selected
  - 42 analyzed

Methods



Cleveland
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Youngstown
Warren
Canton
Alliance
Kent
Hudson
Mentor
Painesville
Chardon
Middlefield
Niles
Boardman
Barberton
Massillon
Columbiana
Sharon
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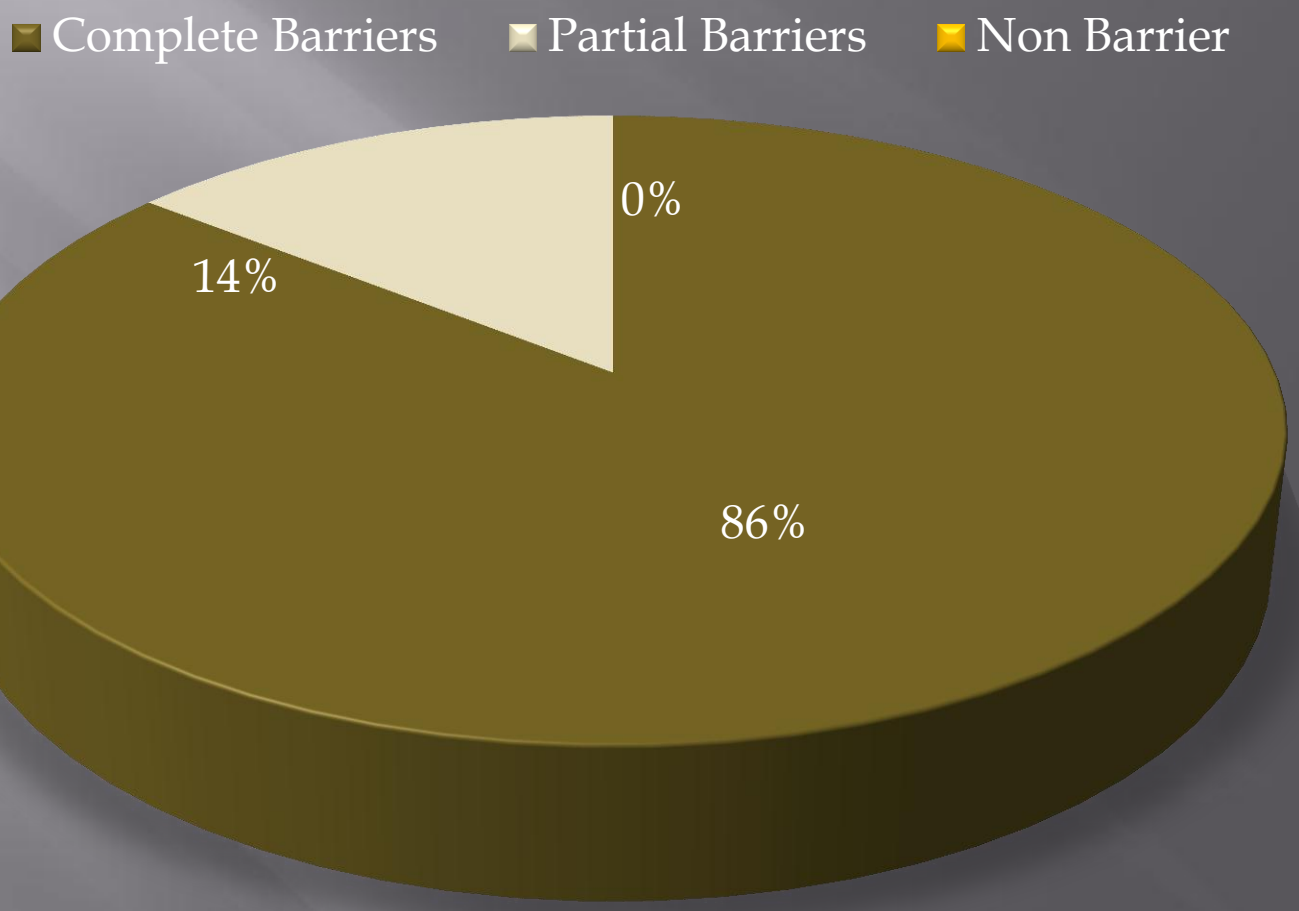
249

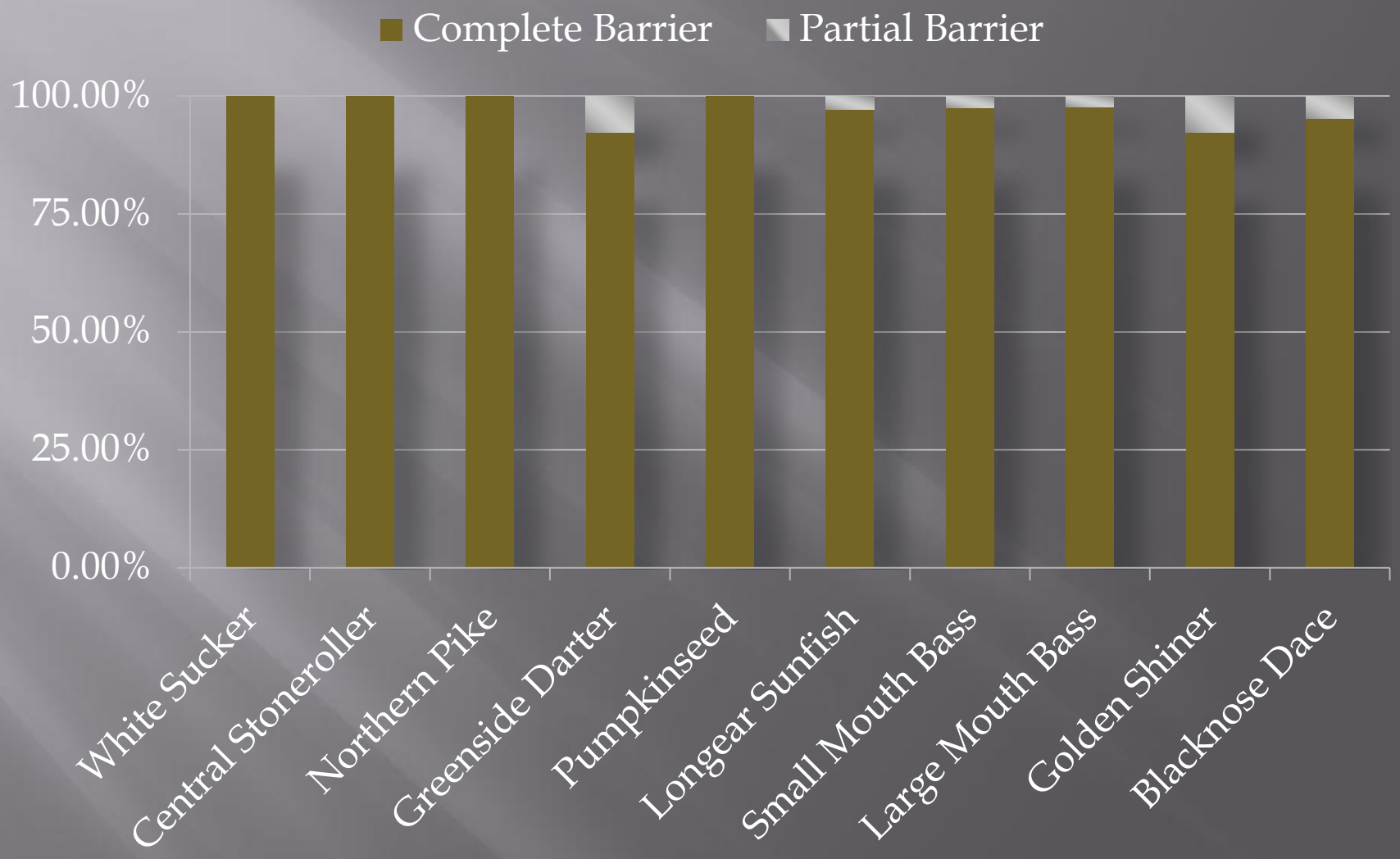
Methods

- Plug into FishXing
  - For four flow conditions
    - Minimum average monthly flow (usually September)
    - Maximum average monthly flow (usually March)
    - 2 year high flow
    - 25% low flow

Results



Results

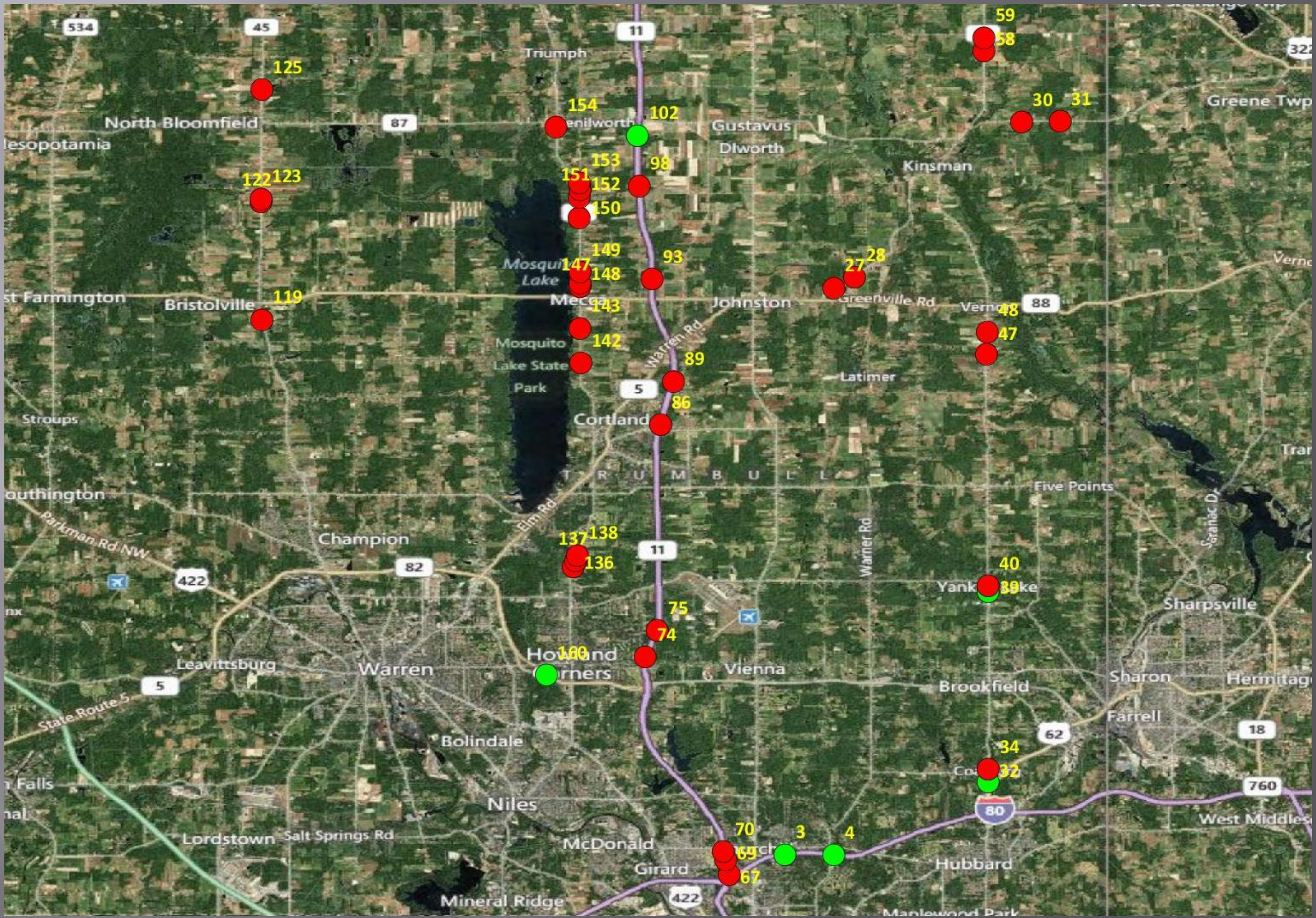

Complete Barrier
Partial Barrier
100.00%
75.00%
50.00%
25.00%
0.00%
White Sucker
Central Stoneroller
Northern Pike
Greenside Darter
Pumpkinseed
Longear Sunfish
Small Mouth Bass
Large Mouth Bass
Golden Shiner
Blacknose Dace

Results

Parameter	Barrier Type	Nos	Mean	Std. Deviation	Std. Error Mean
Slope	Partial Barrier	6	1.1	1.2	0.5
	Complete Barrier	36	1.4	0.8	0.1
Diameter	Partial Barrier	6	47	23	10
	Complete Barrier	36	38	17	3
Length	Partial Barrier	6	129	59	24
	Complete Barrier	36	165	89	15

- Student's t-test ($p < 0.05$) showed no significant relationship.

Results



125
154
102
59
58
30
31
North Bloomfield
Gustavus
Greene Twp
Kinsman
122
123
153
151
152
150
98
149
147
148
93
27
28
Mosquito Lake
Bristolville
119
Johnston
Greenville Rd
143
142
48
47
Mosquito Lake State Park
Warren Rd
89
Latimer
86
Cortland
T R U M B U L L
Five Points
Champion
137
138
136
Warner Rd
Parkman Rd NW
Elm Rd
40
39
Sharpsville
75
74
100
Howland Corners
Vienna
Leavittsburg
Warren
Brookfield
Sharon
Hermitage
Farrell
State Route 5
Bolindale
34
32
Niles
Lordstown
Salt Springs Rd
McDonald
70
69
67
3
4
Girard
Hubbard
Mineral Ridge
West Middlesex
Maplewood Park

Sources of Error

- Limitations of FishXing
  - Considers one-dimensional flow
  - Insufficient fish swimming speed data
- Temporal inconsistency in data
- Limiting precision of initial data

Conclusion

- 42 culverts were analyzed for fish passage in four flow conditions
- Barrier
  - 14% partial barriers
  - 86% complete barriers
- Design Parameters
  - Slope
  - Diameter
  - Length

Future Work

- More culverts
- Broader geographic area
- More design parameters
- Analysis using HEC-RAS add-on

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THANK YOU!