

Arcadia Marsh / Bowens Creek Restoration and Fish Passage



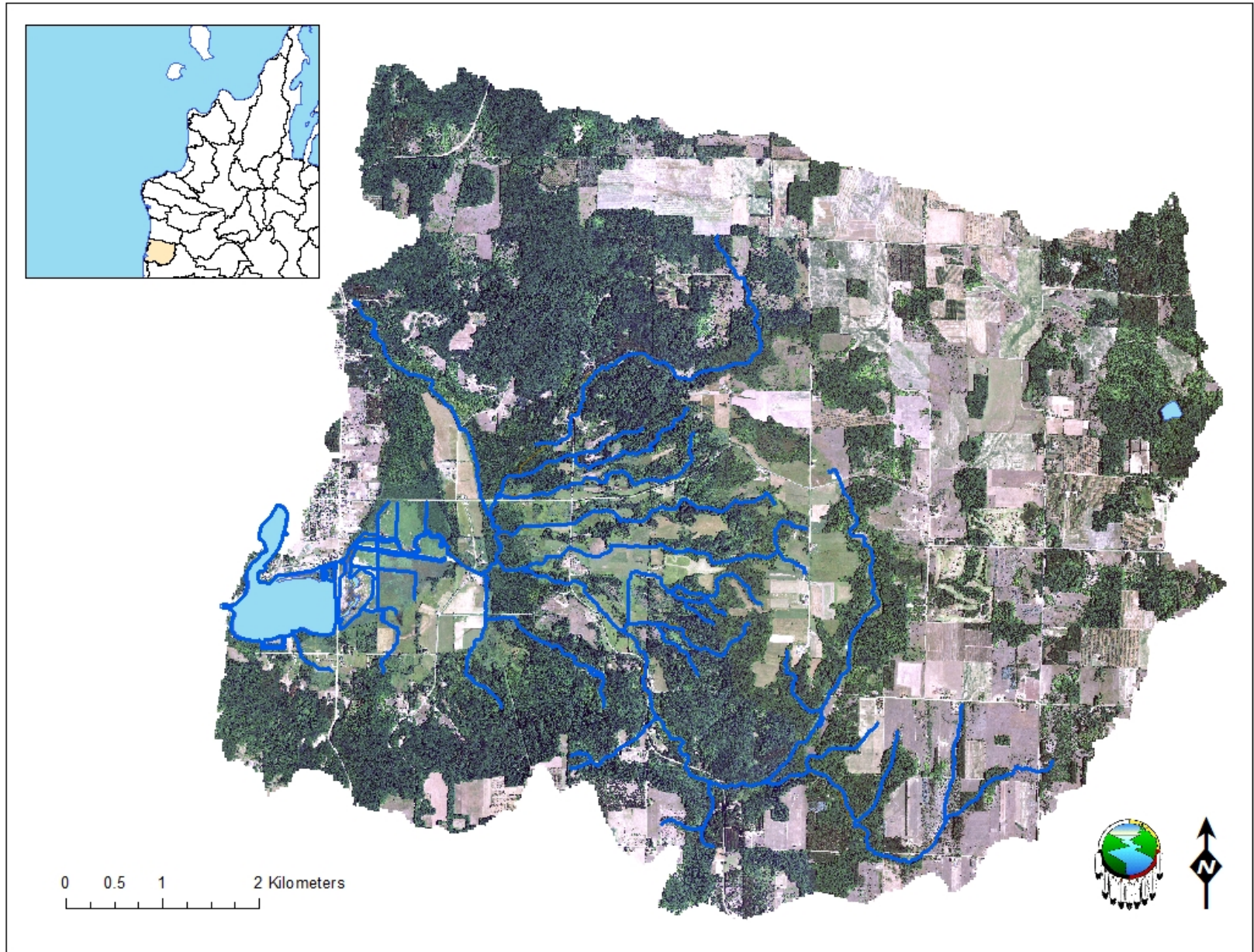
Daniel W. Mays
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Little River Band of Ottawa Indians

Presentation Outline

- **Part 1. Upper Watershed**
 - Restoration Activities/Goals
 - Site Descriptions
 - Methods
 - Results and Conclusion
- **Part 2. Lower Watershed**
 - Restoration Activities/Goals
 - Site Descriptions
 - Methods
 - Results and Conclusion



Bowens Creek Subwatershed



Part 1. Upper Watershed

Restoration Activities

- Replace perched, undersized and /or misaligned culverts at road/stream crossings
- Seven of the most critical were completely replaced (Fall 2011)

Goals

- Reduce streambank scouring
- Reduce erosion
- Improve fish passage

Site Descriptions

Study Streams

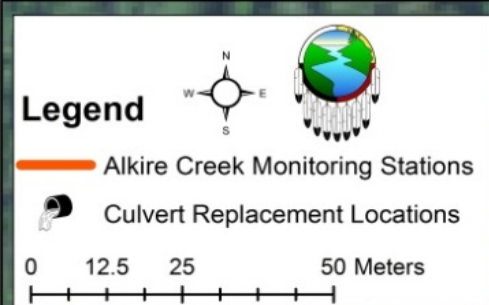
- Alkire Creek - three 100 meter sampling stations
- Ware Creek - three 120 meter sampling stations
- Hull Creek - five 120 meter sampling stations

Control Stream

- Toohey Creek - three 120 meter sampling stations

Alkire Creek





Ware Creek



Legend

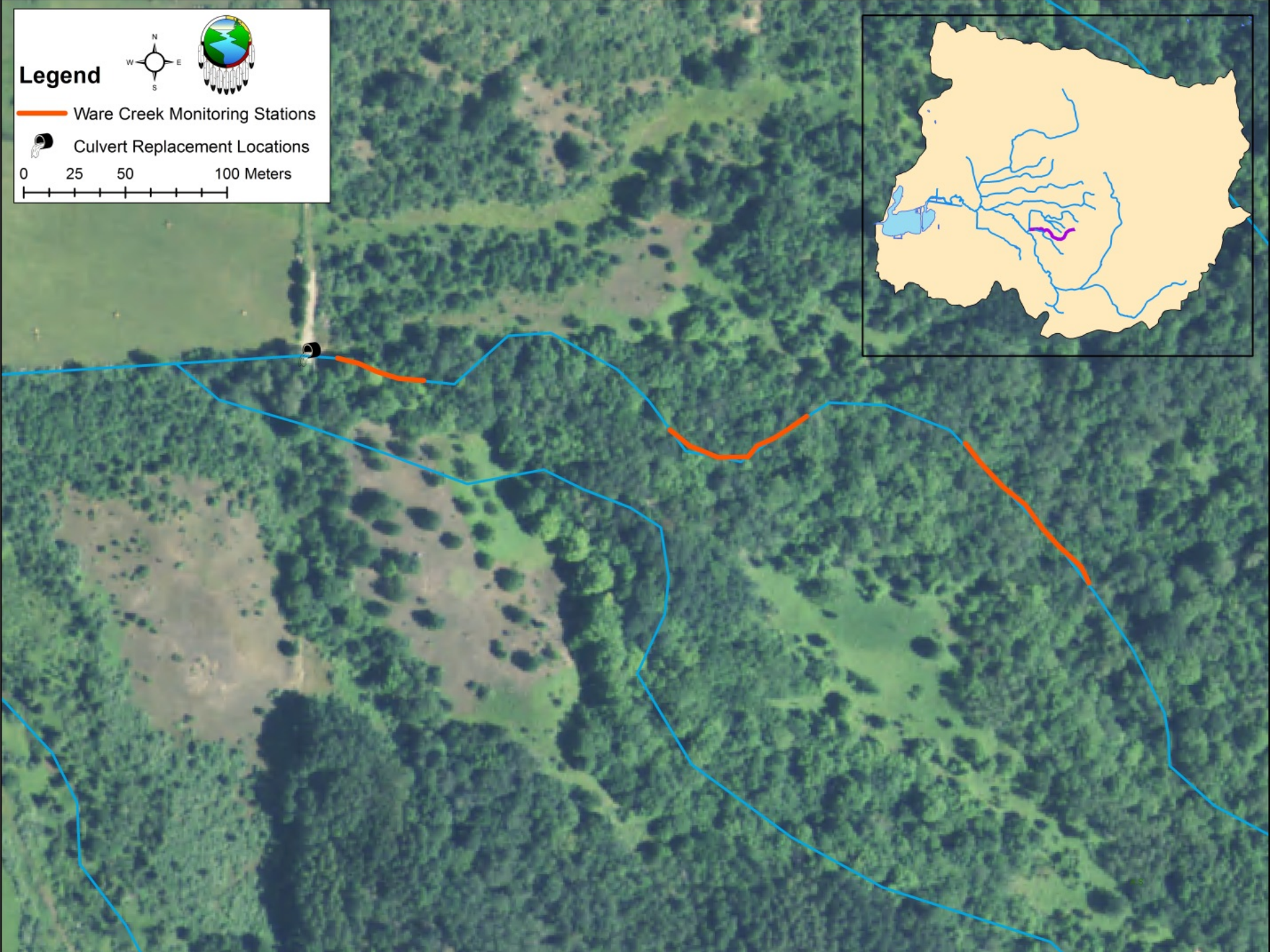
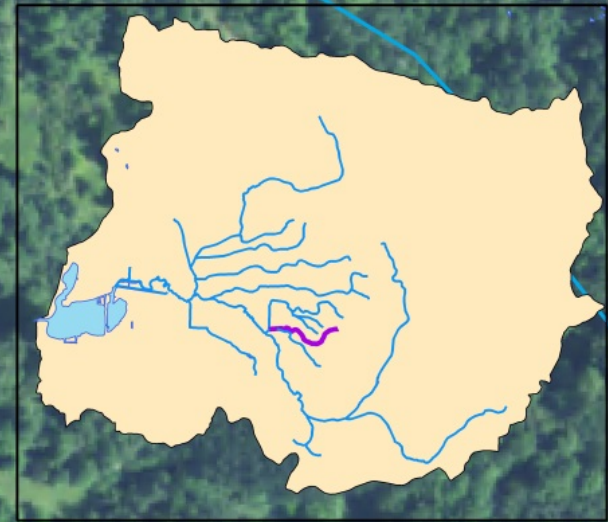


Ware Creek Monitoring Stations



Culvert Replacement Locations

0 25 50 100 Meters



Hull Creek



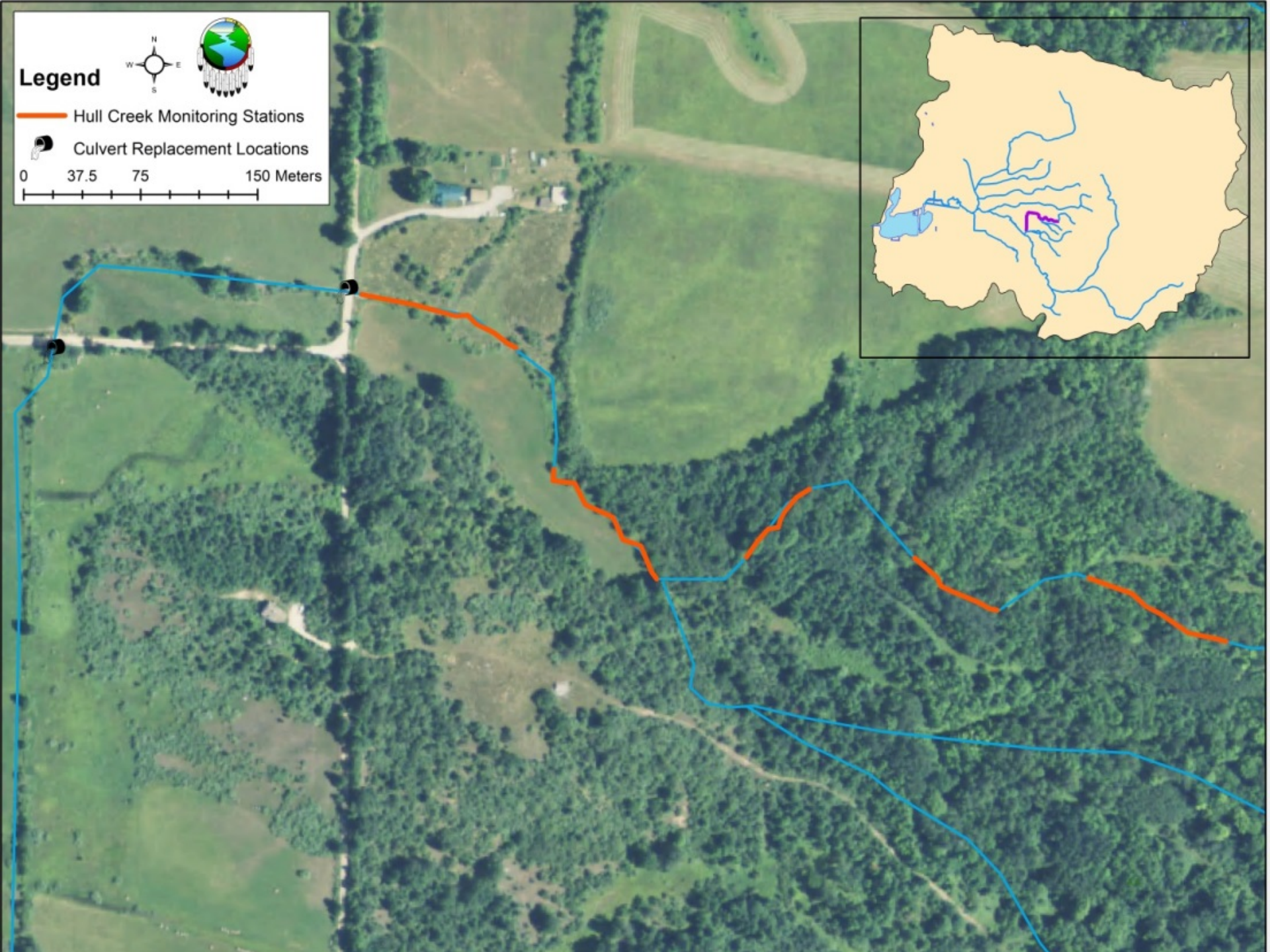
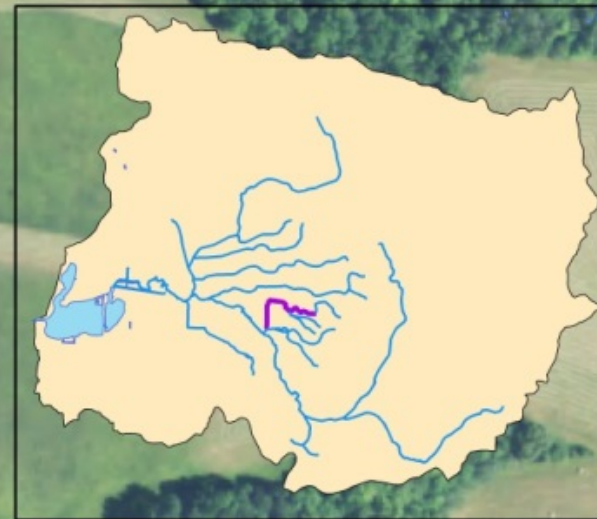
Legend



 Hull Creek Monitoring Stations

 Culvert Replacement Locations

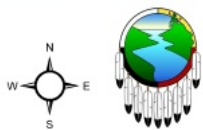
0 37.5 75 150 Meters



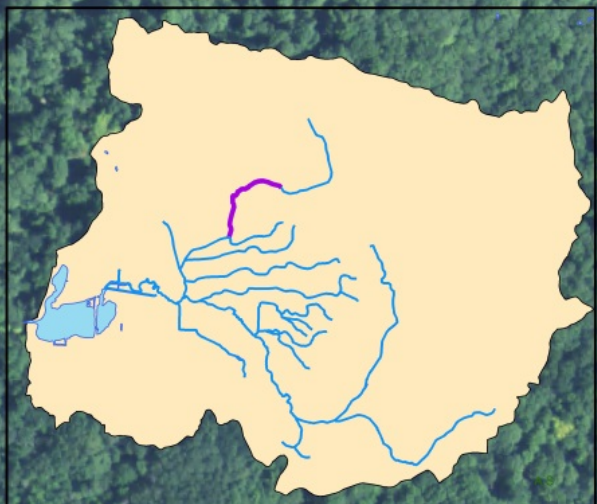
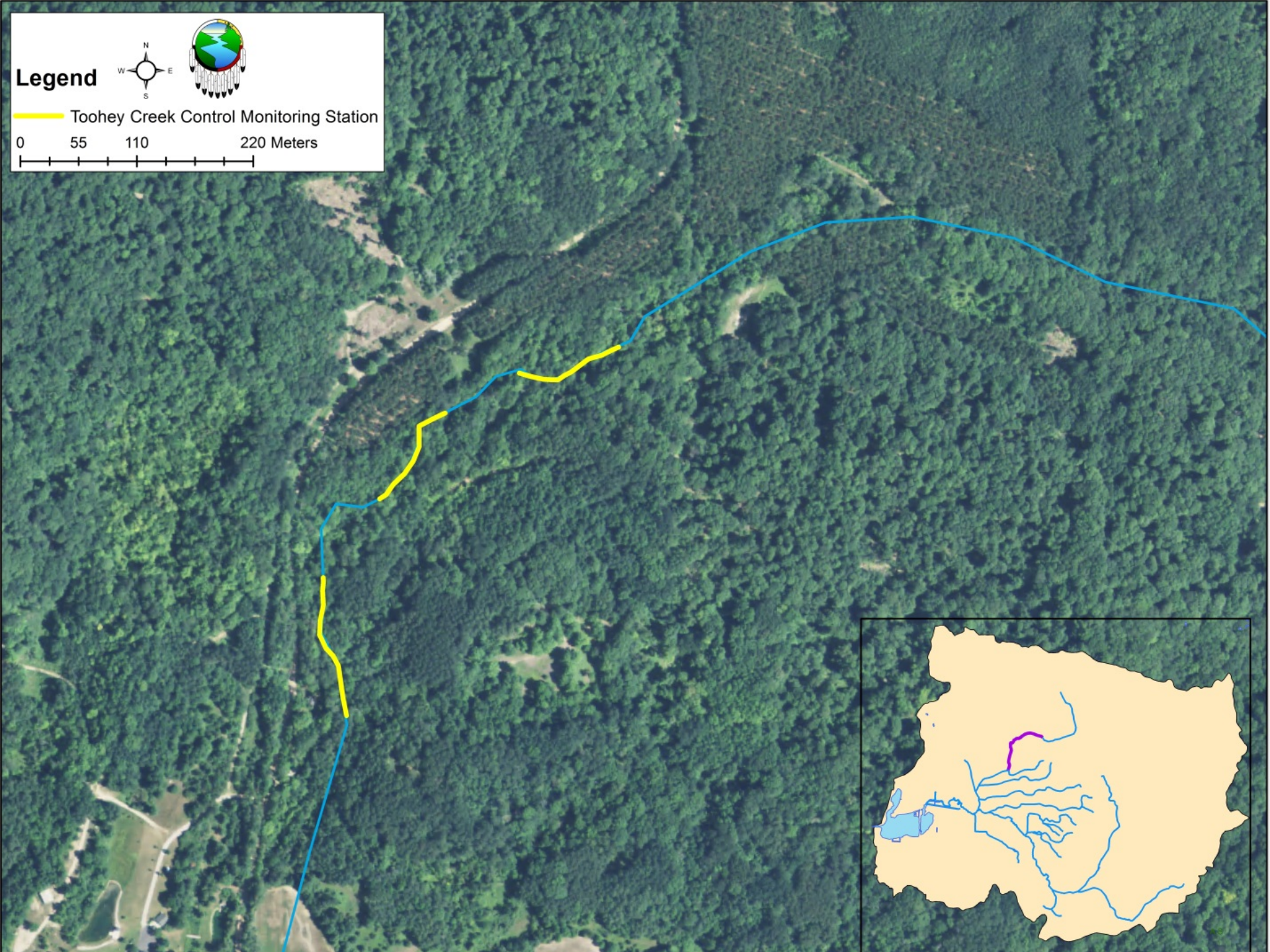
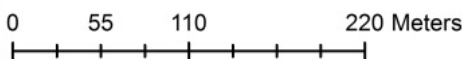
Toohey Creek



Legend



Toohey Creek Control Monitoring Station



Methods

- **Water Quality**

- Temp, DO, pH, conductivity, and turbidity

- **Habitat**

- Stream widths, depths, habitat type, and substrate
- Rapid bioassessments

- **Fish and Macroinvertebrate Community Assessments**

- Summer electro-fishing
- Spring and Fall macroinvertebrate collections



Water Quality (2010-2013)

Waterbody	Temperature (°C)	Dissolved Oxygen (ppm)	pH	Conductivity (mS/cm)	Turbidity (NTU)
Alkire Creek	14.5 (1.2)	8.4 (0.7)	7.7 (0.1)	0.2205 (0.03)	2.9 (4.3)
Hull Creek	11.1 (0.9)	10.5 (0.9)	7.9 (0.2)	0.3297 (0.02)	3.1 (4.0)
Ware Creek	10.3 (0.5)	11.3 (0.6)	7.9 (0.3)	0.3317 (0.02)	9.0 (8.8)
Toohey Creek*	11.1 (1.6)	10.6 (0.9)	7.8 (0.2)	0.3689 (0.01)	2.6 (4.3)

*Numbers in parentheses represent standard deviations among stations and years. * Control Site*



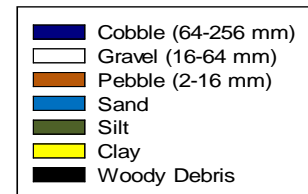
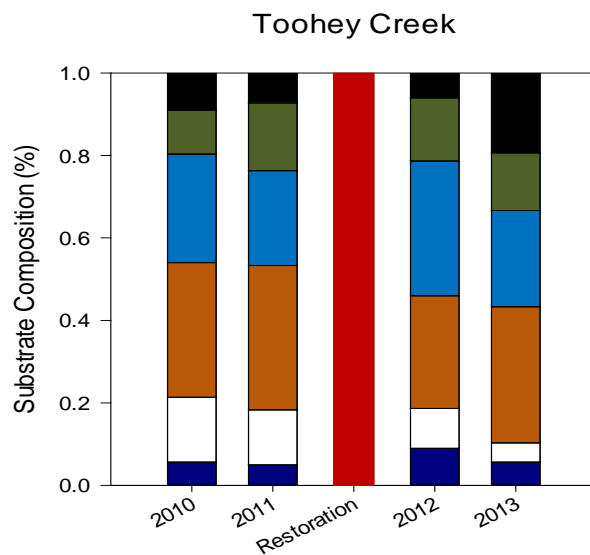
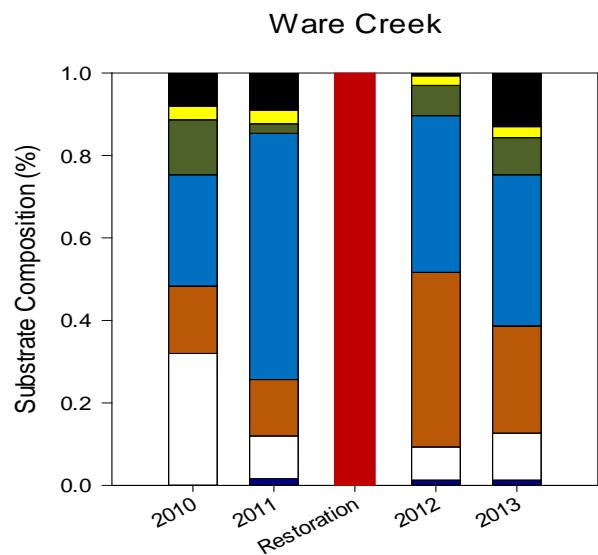
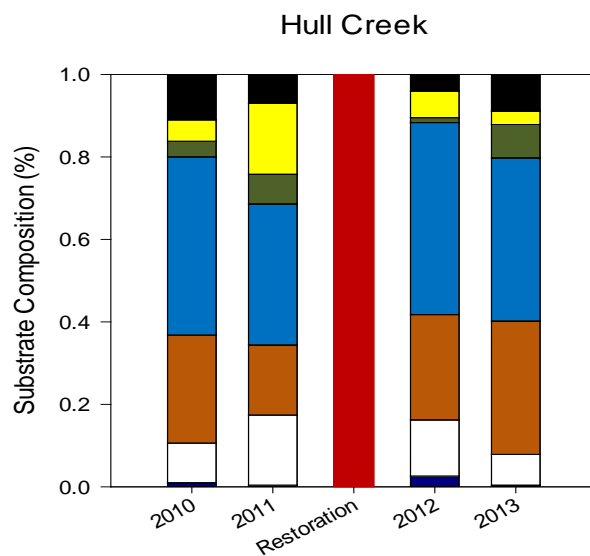
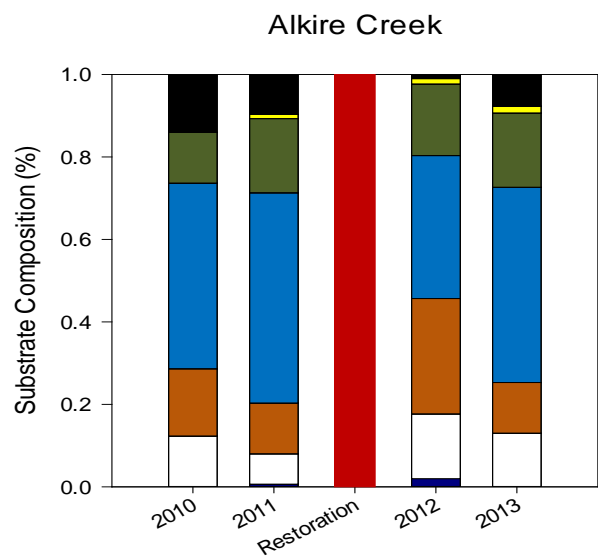
Habitat (2010-2013)

Waterbody	Width (m)	Depth (m)	% Pool	% Riffle	% Run
Alkire Creek	1.0 (0.4)	0.11 (0.06)	0.09 (0.10)	0.08 (0.12)	0.84 (0.12)
Hull Creek	1.4 (0.5)	0.10 (0.06)	0.13 (0.09)	0.34 (0.24)	0.53 (0.22)
Ware Creek	2.1 (0.5)	0.10 (0.06)	0.16 (0.08)	0.21 (0.16)	0.62 (0.17)
Toohey Creek*	3.1 (1.2)	0.06 (0.04)	0.06 (0.06)	0.53 (0.18)	0.41 (0.22)

Numbers in parentheses represent standard deviations among stations and years. Control Site*

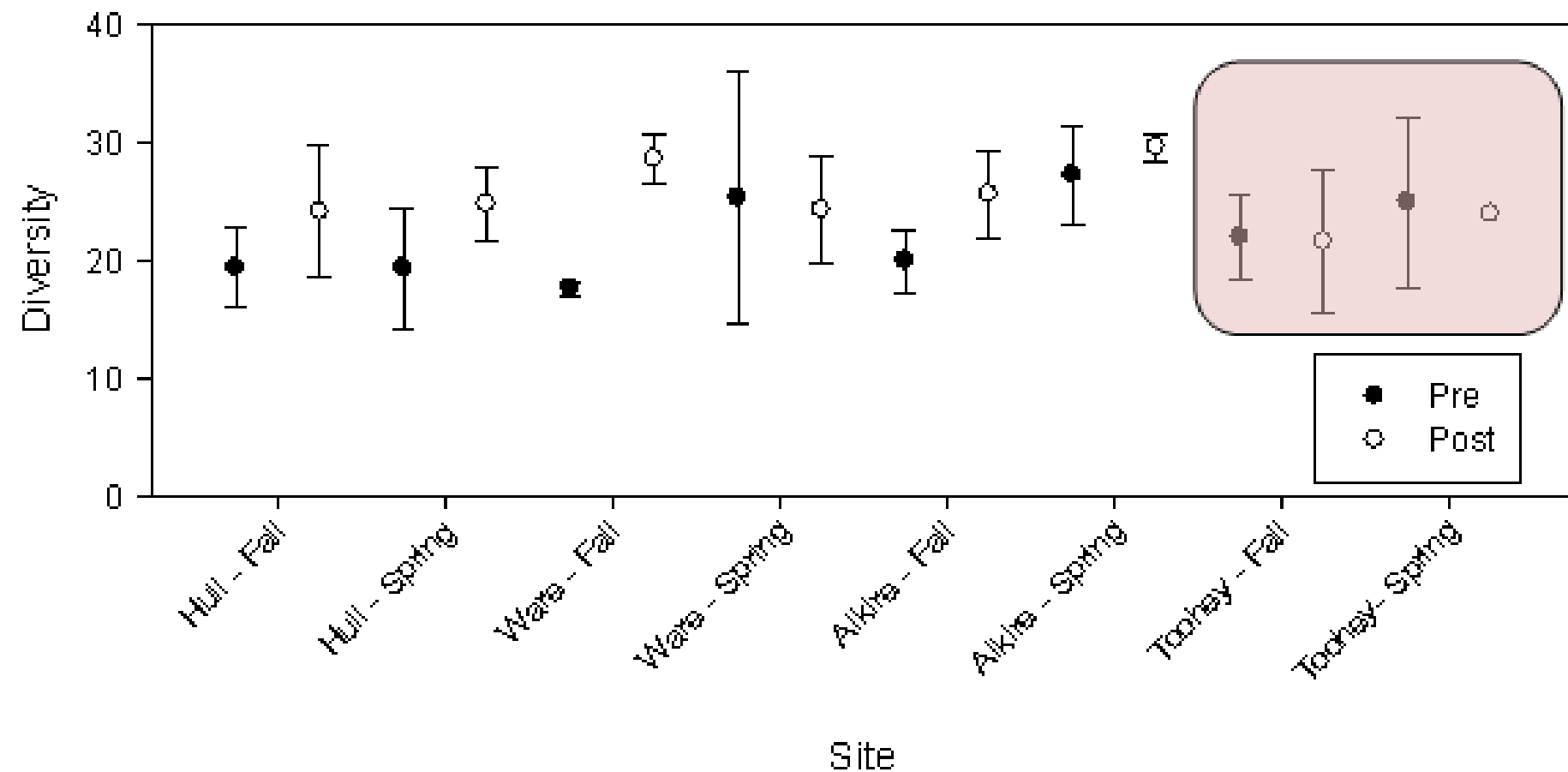


Substrate





Macroinvertebrates



Macroinvertebrate Indices

		<i>Pre</i>		<i>Post</i>		
		2010	2011	2011	2012	2012
		Fall	Spring	Fall	Spring	Fall
Alkire						
HBI	3.999	5.062	4.719	4.870	4.114	
GLEAS	5.3	3.3	4.0	4.3	2.7	
BCI	32.7	30.7	34.7	30.0	30.7	
Hull						
HBI	4.373	4.321	4.846	3.870	5.180	
GLEAS	2.4	1.6	2.8	2.4	3.4	
BCI	26.0	26.0	24.8	25.6	26.4	
Ware						
HBI	4.547	4.478	4.916	4.244	5.617	
GLEAS	2.3	1.0	2.0	2.3	2.0	
BCI	26.7	28.0	28.0	28.0	27.3	
Toohey						
HBI	4.117	4.040	3.477	3.648	4.546	
GLEAS	1.7	1.3	1.0	0.3	-1.3	
BCI	28.7	28.7	28.0	29.3	27.3	



HBI = Hilsenhoff Biotic Index

0-3.50 Excellent
3.51-4.50 Very good
4.51-5.50 Good
5.51-6.50 Fair

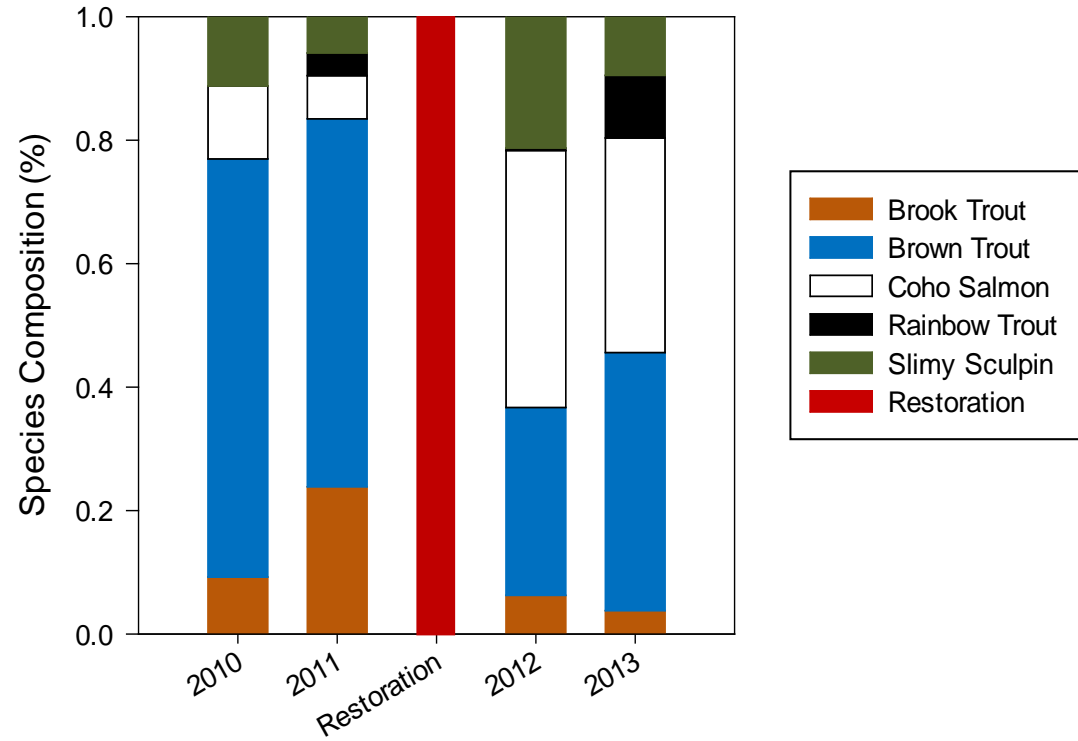
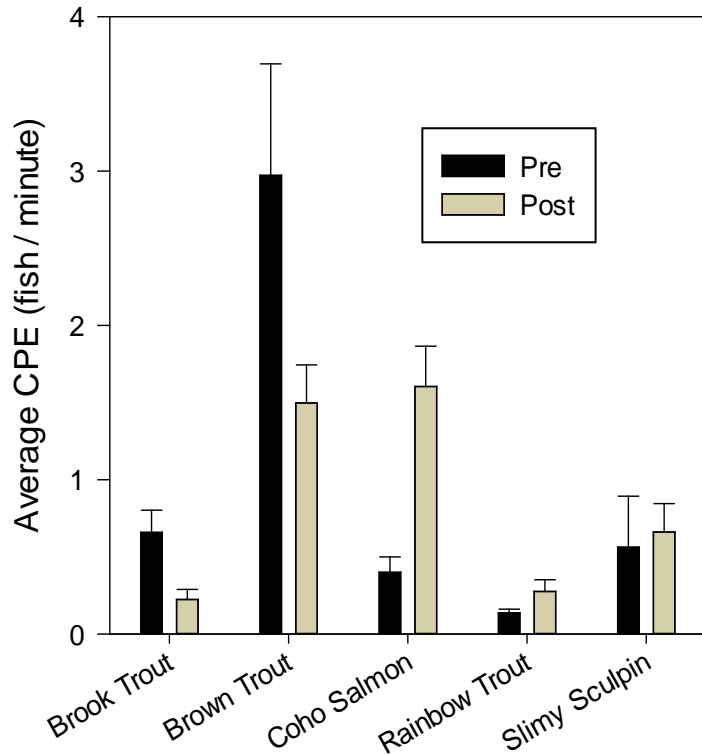
GLEAS = Great Lakes Environmental Assessment Section, Procedure 51.

5 to 9 Excellent
-4.9 to 4.9 Acceptable
-5 to -9 Poor

BCI = Biotic Condition Gradient (Northern Lakes and Forests)

36 to 50 Good
24 to 34 Fair
10 to 22 Poor

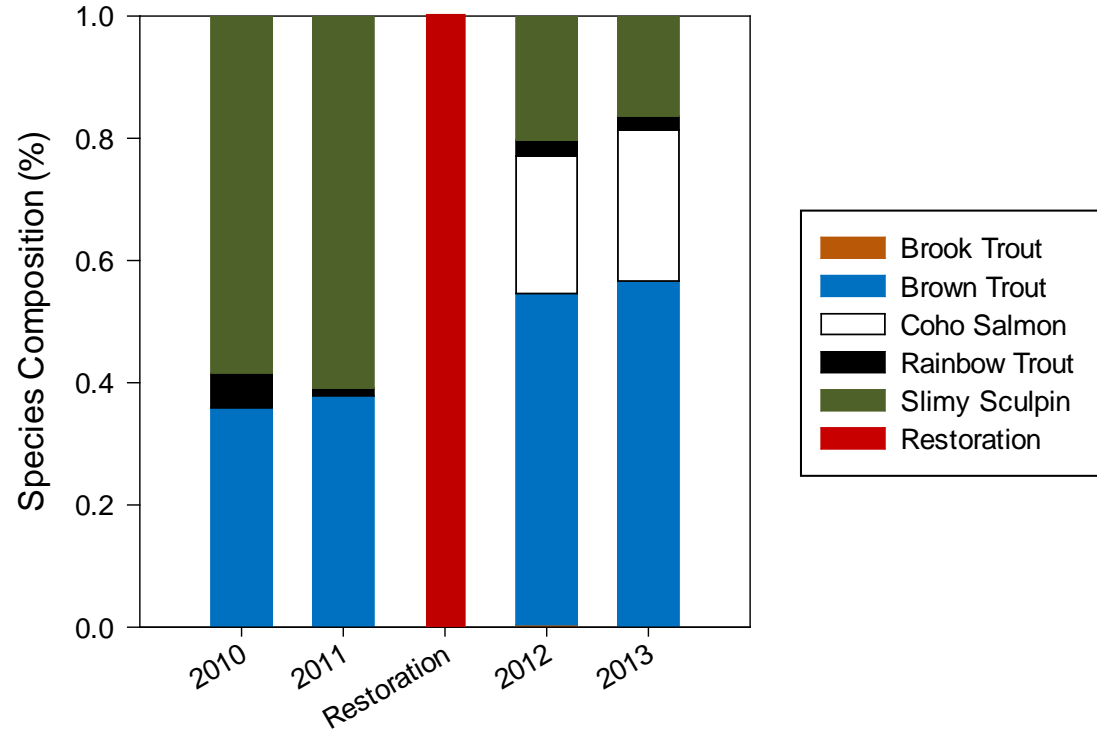
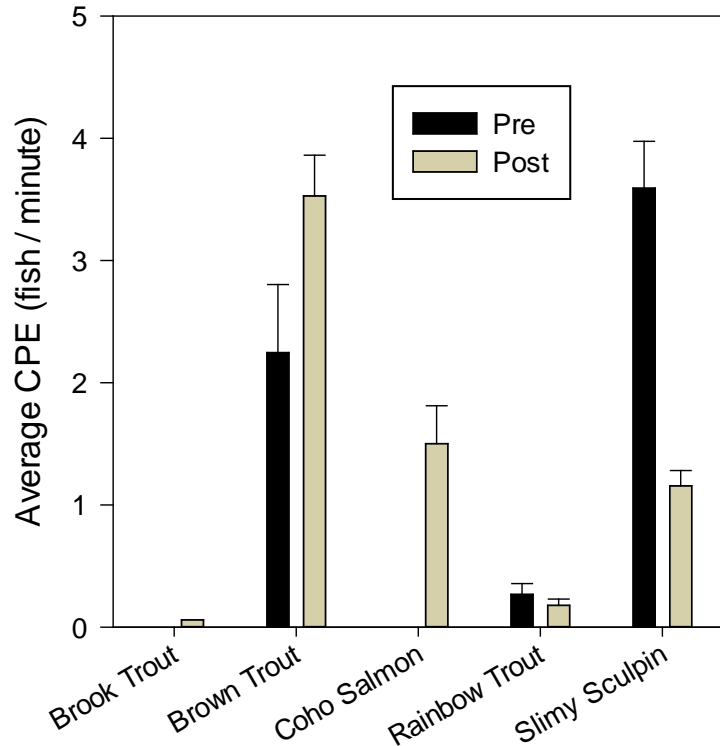
Alkire Creek Fish Community



Alkire Creek - Tiger Trout



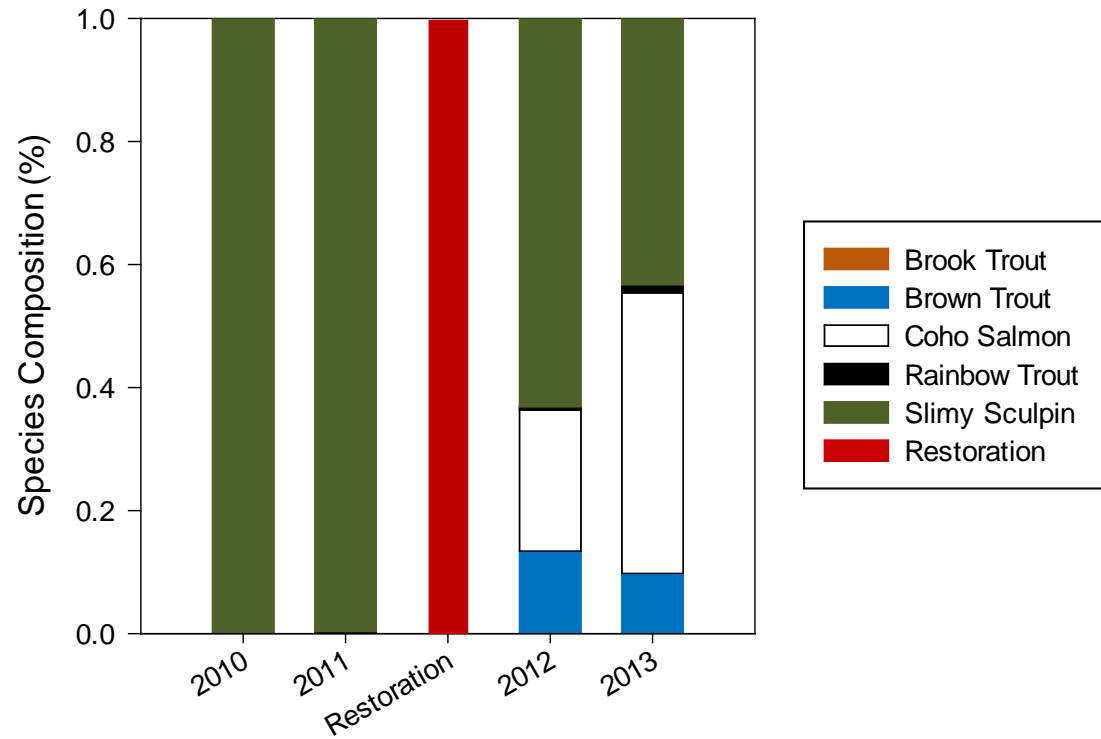
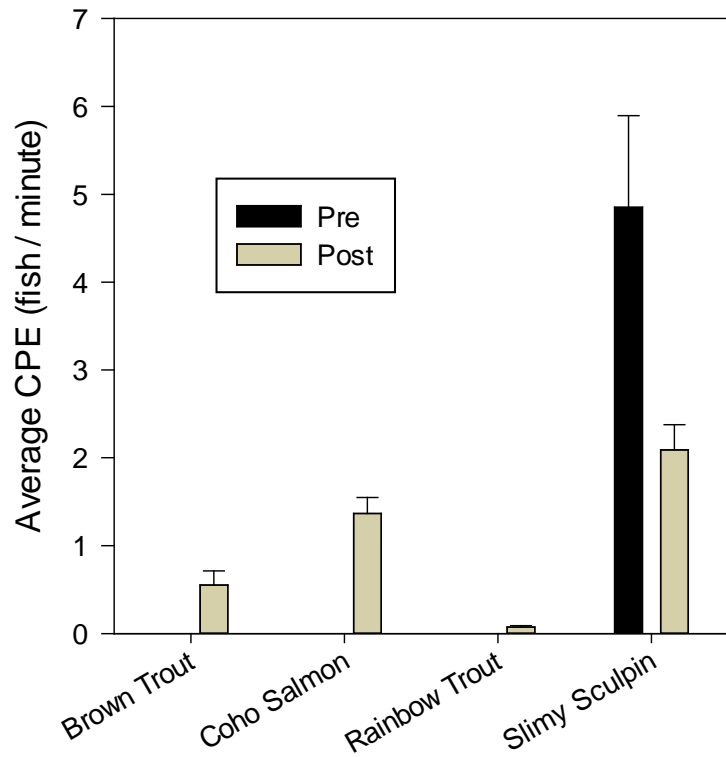
Ware Creek Fish Community



Ware Creek - Coho Salmon



Hull Creek Fish Community



Hull Creek

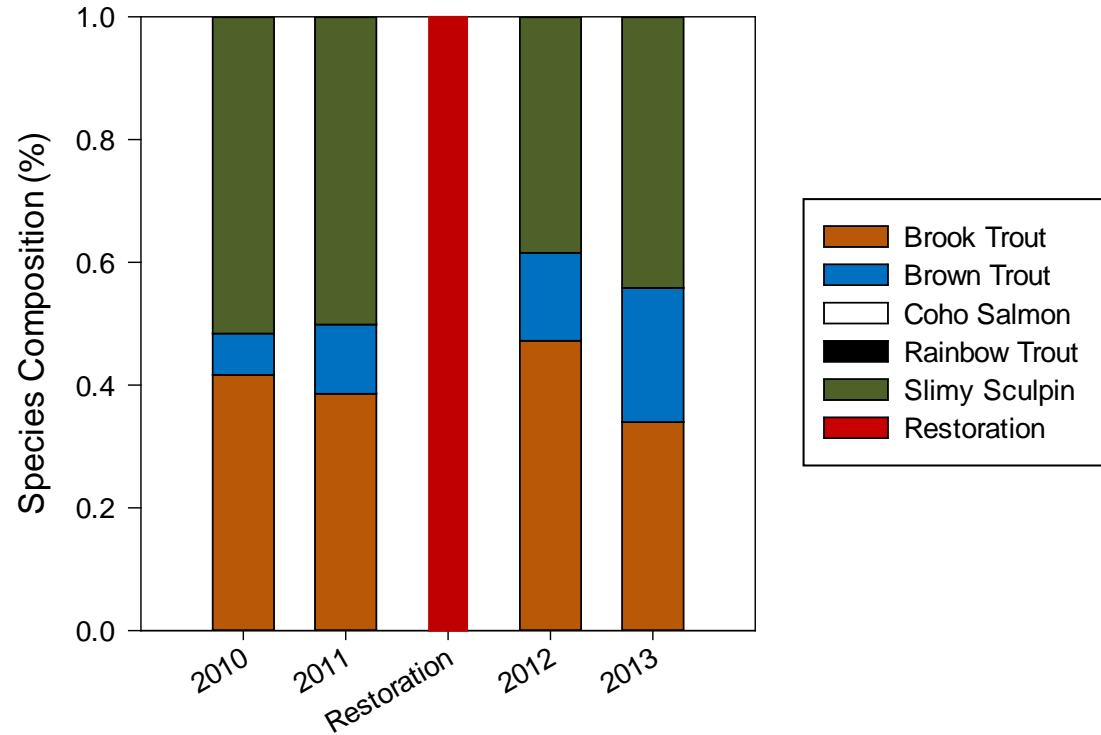
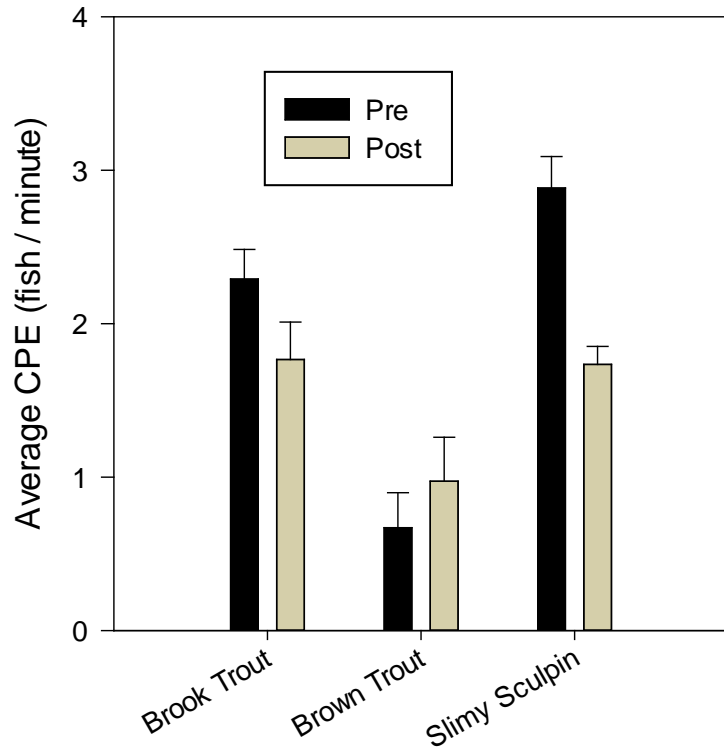


Slimy Sculpin



Brown Trout

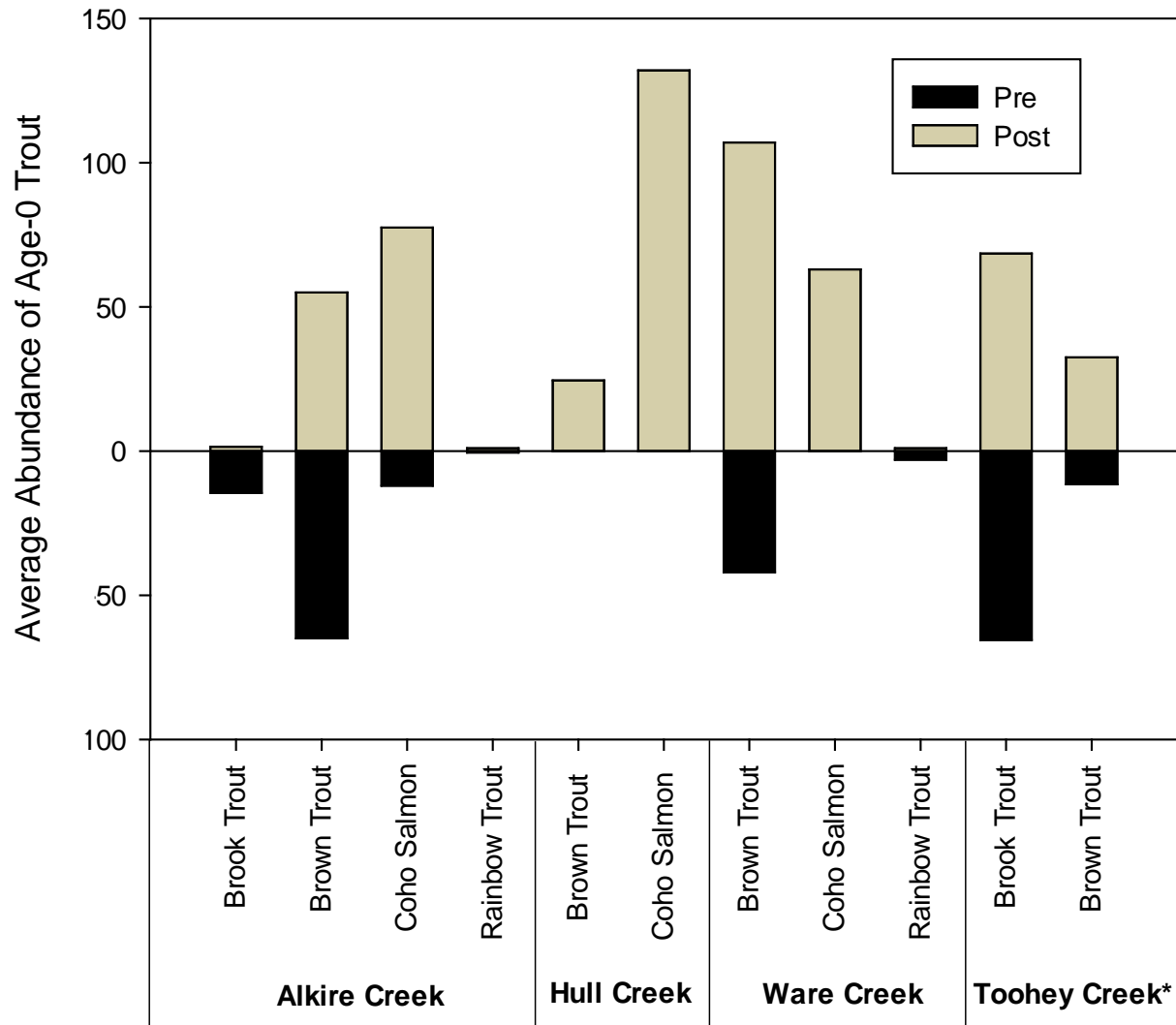
Toohey Creek Fish Community



Toohey Creek – Brook Trout



Age-0 Trout



Conclusions: Upper Watershed

- Immediate shift in fish communities
 - Substantial increase in Coho salmon
 - Brown and Rainbow trout are now present in streams where they were not previously sampled
 - Overall higher percent dominance of trout and salmon
- Macroinvertebrate taxa richness improved although community index scores did not
- Water quality and habitat remained similar before and after restoration

Part 2. Lower Watershed

Restoration Activities

- Re-route the channelized section of Bowens Creek back into its natural channel
- Addition of large woody debris into streams

Goal

- Improve habitat for fish and aquatic organisms
- Return natural hydrologic processes to Arcadia Marsh

Site Descriptions

Bowens Creek Study Sites

- Historical Channel - Lower (200 meters)
- Historical Channel - Middle (200 meters)
- Historical Channel - Upper (120 meters)
- Channelized Segment (265 meters)

Control Site

- Below St.Pierre Rd. (120 meters)

Bowens Creek Study Sites

Historical Channel - Lower



Historical Channel - Middle



Bowens Creek Study Sites

Historical Channel - Upper



Below St. Pierre Rd. (Control)



Bowens Creek Channelized Section



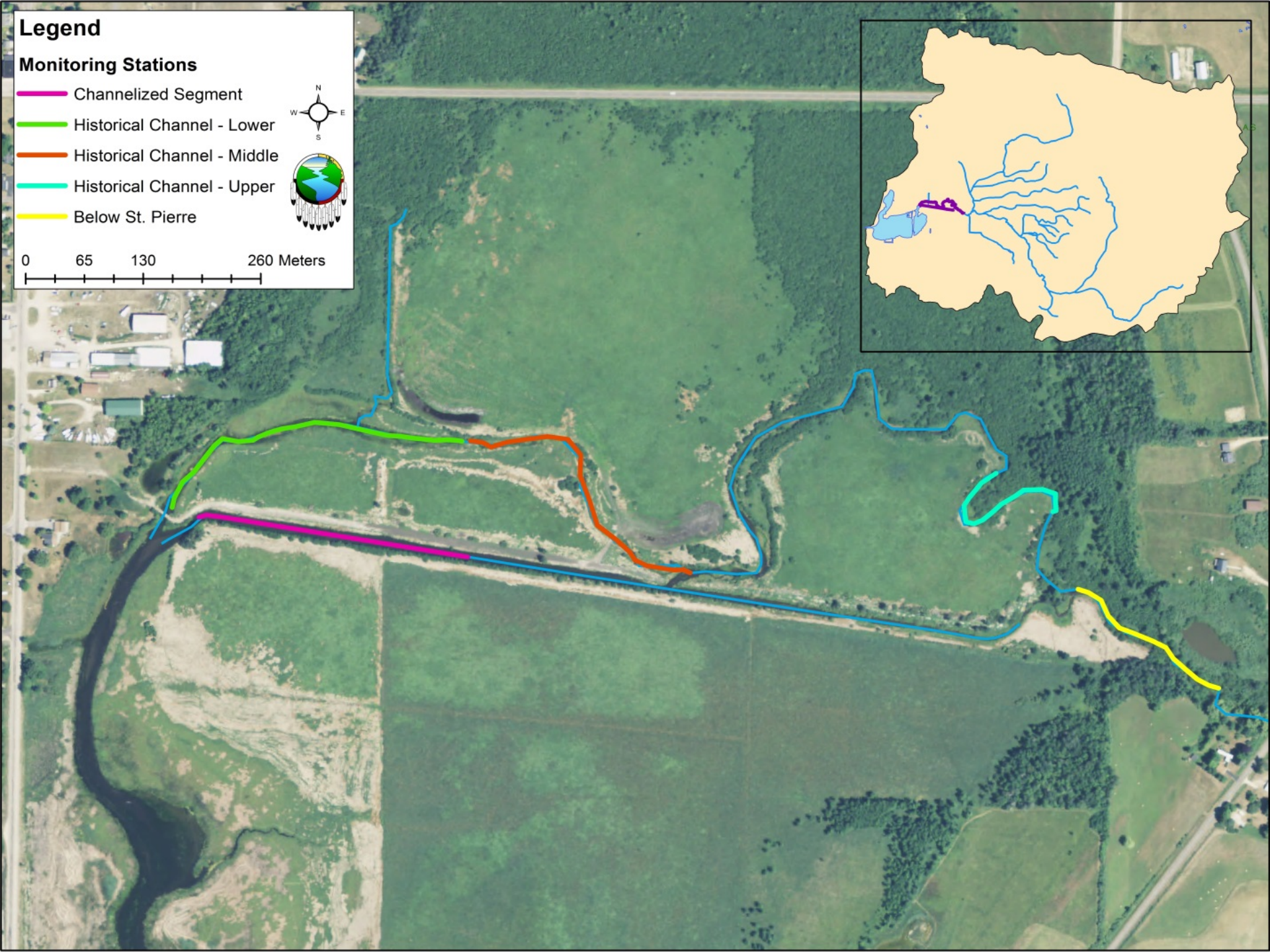
Legend

Monitoring Stations

- Channelized Segment
- Historical Channel - Lower
- Historical Channel - Middle
- Historical Channel - Upper
- Below St. Pierre



0 65 130 260 Meters



Methods

- **Water Quality**

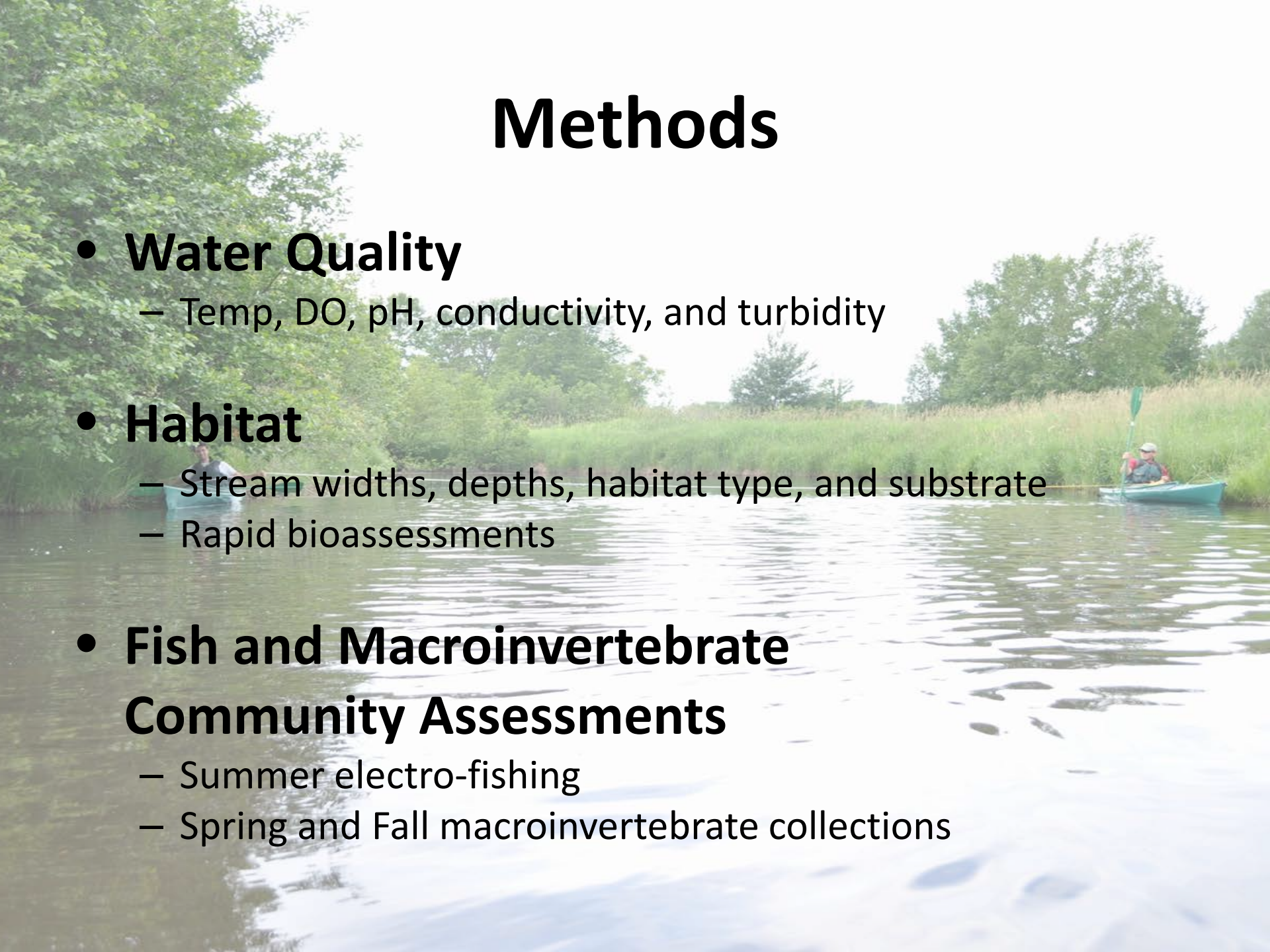
- Temp, DO, pH, conductivity, and turbidity

- **Habitat**

- Stream widths, depths, habitat type, and substrate
- Rapid bioassessments

- **Fish and Macroinvertebrate
Community Assessments**

- Summer electro-fishing
- Spring and Fall macroinvertebrate collections



Electrofishing in Lower Bowens Creek



Water Quality (2010-2013)

Station	Temperature (°C)		Dissolved Oxygen (ppm)		pH		Conductivity (mS/cm)		Turbidity (NTU)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Channel	14.7 (1.7)	NA	11.5 (1.4)	NA	8.3 (0.2)	NA	0.3324 (0.00)	NA	9.8 (0.2)	NA
Lower	19.8 (3.8)	13.7	7.8 (6.6)	5.9	7.8 (0.5)	7.3	0.2752 (0.04)	0.3556	2.9 (0.9)	3.1
Middle	18.7 (3.7)	13.4	8.1 (6.5)	7.0	8.1 (0.3)	7.4	0.2892 (0.05)	0.3518	26.6 (26.4)	3.2
Upper	13.7 (0.8)	11.6	11.0 (0.8)	9.1	8.1 (0.1)	7.8	0.3250 (0.02)	0.3484	6.7 (8.2)	3.0
St. Pierre*	13.4 (0.4)	12.4	11.1 (0.7)	10.8	8.1 (0.1)	7.9	0.3216 (0.02)	0.3477	7.4 (2.6)	2.5

*Pre-restoration values were averaged from 2010, 2011 and 2012 mid-summer samplings. Numbers in parentheses represent standard deviations among years. * Control Site*

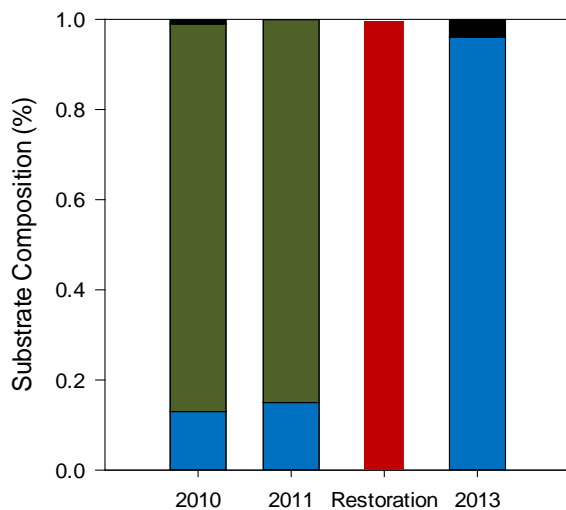
Habitat (2010-2013)

Station	Width		Depth		% Pool		% Riffle		% Run	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Channel	12.5 (0.9)	NA	0.49 (0.01)	NA	0.04 (0.05)	NA	0	NA	0.96 (0.05)	NA
Lower	14.2 (0.6)	6.4	0.32 (0.11)	0.49	0 (0)	0	0	0	1.0 (0)	1.0
Middle	4.4 (1.0)	5.1	0.25 (0.06)	0.55	0.04 (0.05)	0	0	0	0.96 (0.05)	1.0
Upper	4.7 (0.5)	4.1	0.31 (0.11)	0.85	0.15 (0)	0.08	0	0	0.85 (0)	0.92
St. Pierre*	5.7 (0.2)	5.8	0.45 (0.05)	0.74	0.12 (0.16)	0	0	0	0.88 (0.16)	1.0

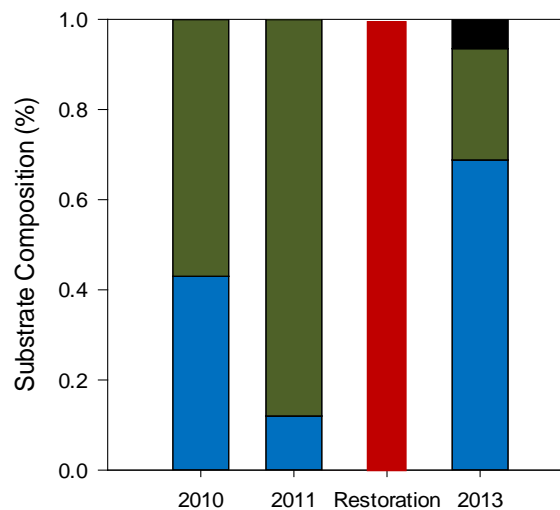
*Pre-restoration values were averaged from 2010, 2011 and 2012 mid-summer samplings. Numbers in parentheses represent standard deviations among years. * Control Site*

Substrate

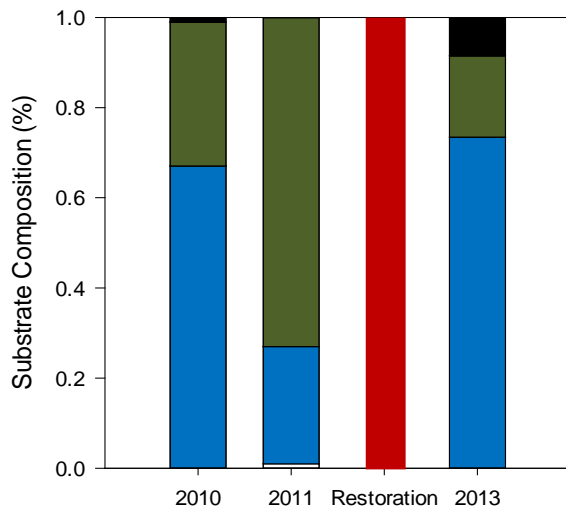
Bowens Creek - Lower



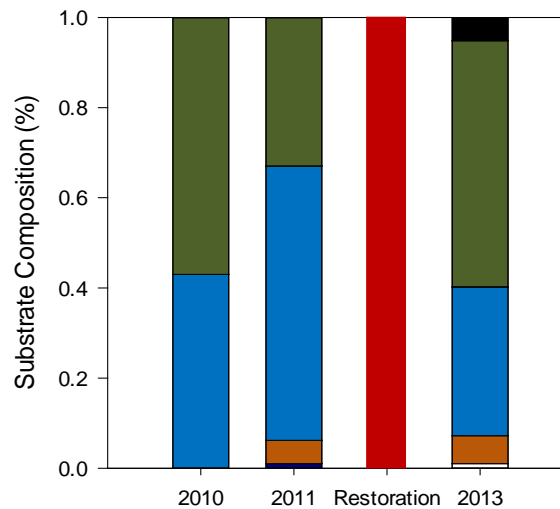
Bowens Creek - Middle



Bowens Creek - Upper



Bowens Creek - St. Pierre



Macroinvertebrates

	Pre	Post
<i>Channel</i>		
HBI	5.910	n/a
GLEAS	-4	n/a
BCI	18	n/a
<i>Restored</i>		
HBI	5.966	6.811
GLEAS	-3	-5
BCI	20	17
<i>Control</i>		
HBI	4.59	4.66
GLEAS	-2	-5
BCI	26	24

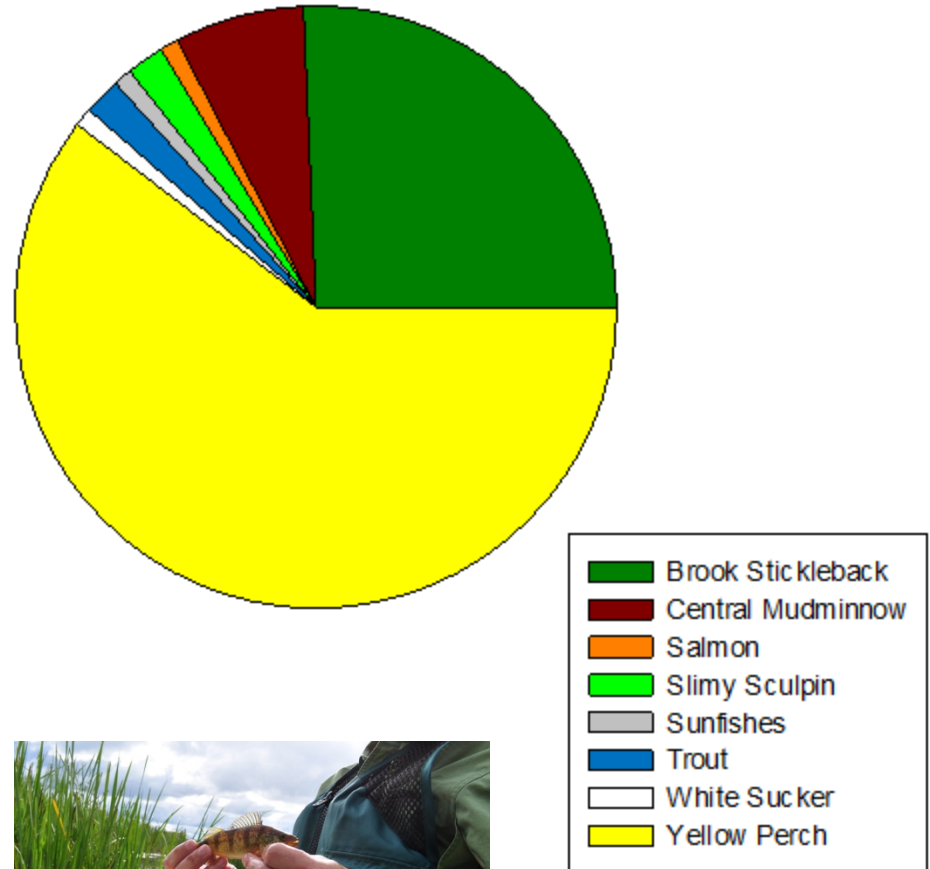
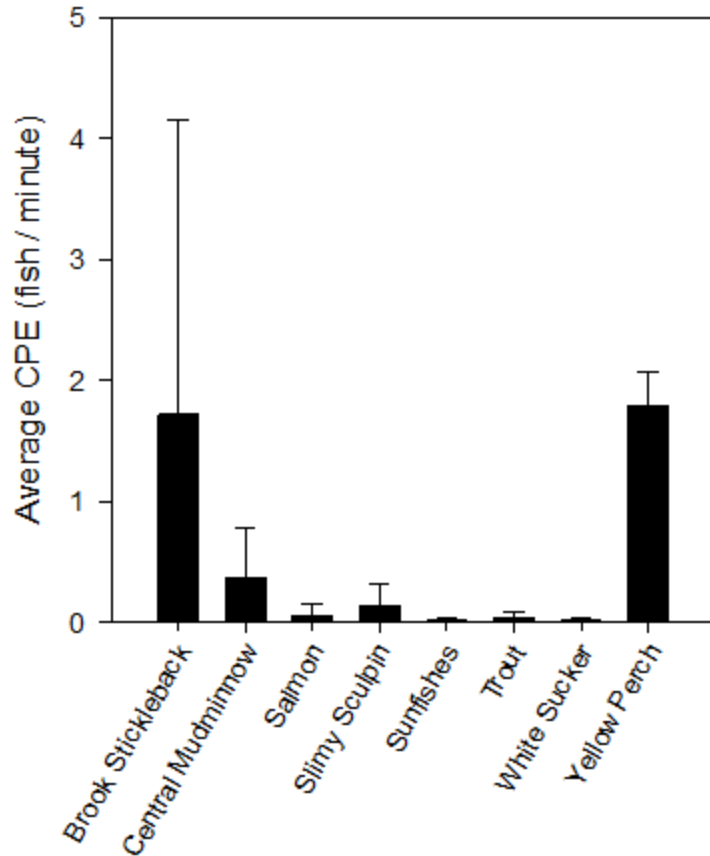


**HBI = Hilsenhoff
Biotic Index**
 0-3.50 Excellent
 3.51-4.50 Very good
 4.51-5.50 Good
 5.51-6.50 Fair

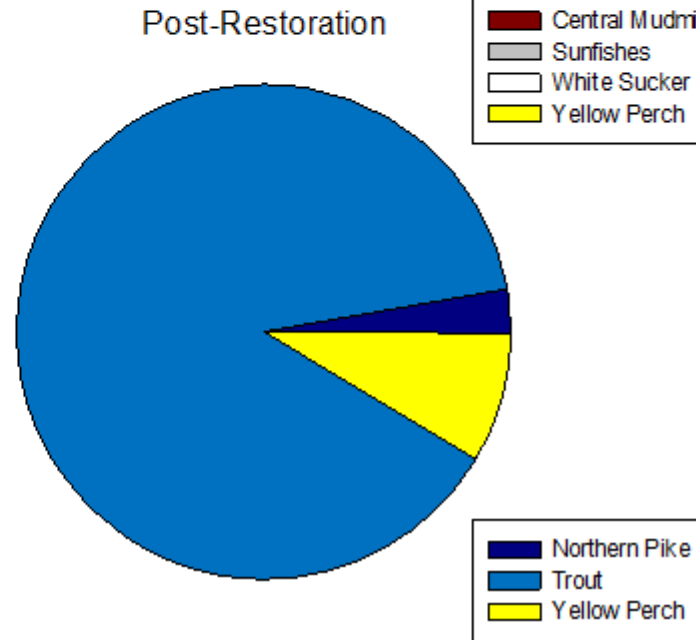
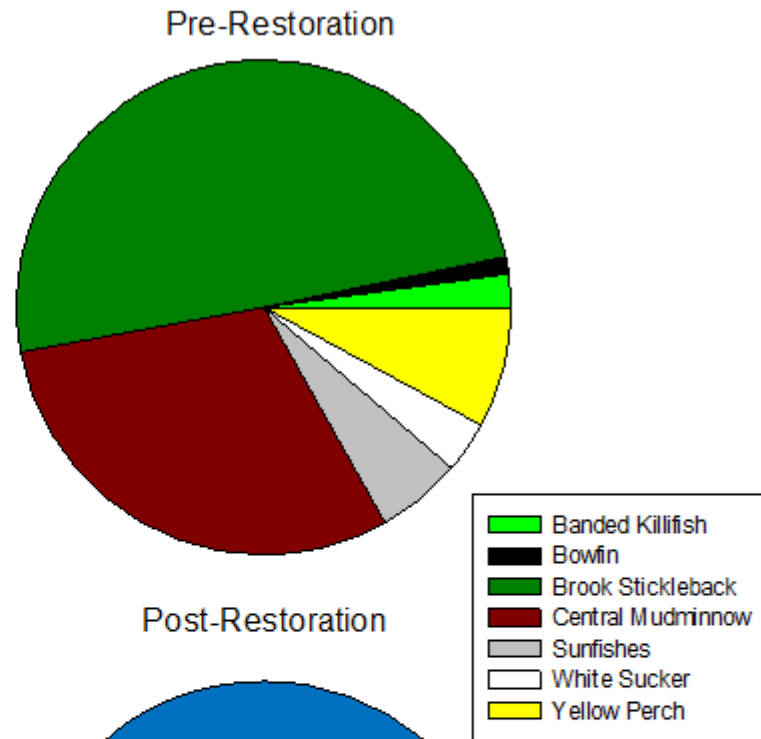
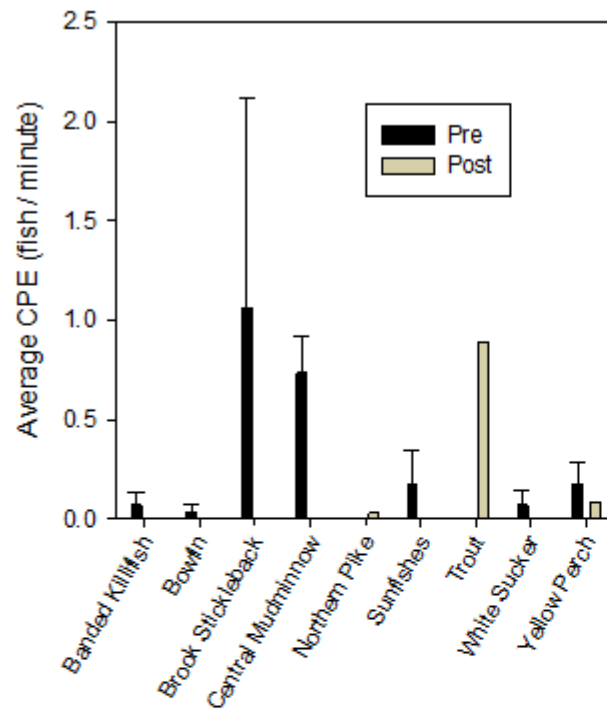
**GLEAS = Great Lakes
Environmental
Assessment Section,
Procedure 51.**
 5 to 9 Excellent
 -4.9 to 4.9 Acceptable
 -5 to -9 Poor

**BCI = Biotic
Condition Gradient
(Northern Lakes and
Forests)**
 36 to 50 Good
 24 to 34 Fair
 10 to 22 Poor

Channelized Segment Fish Community (Pre-Restoration Only)

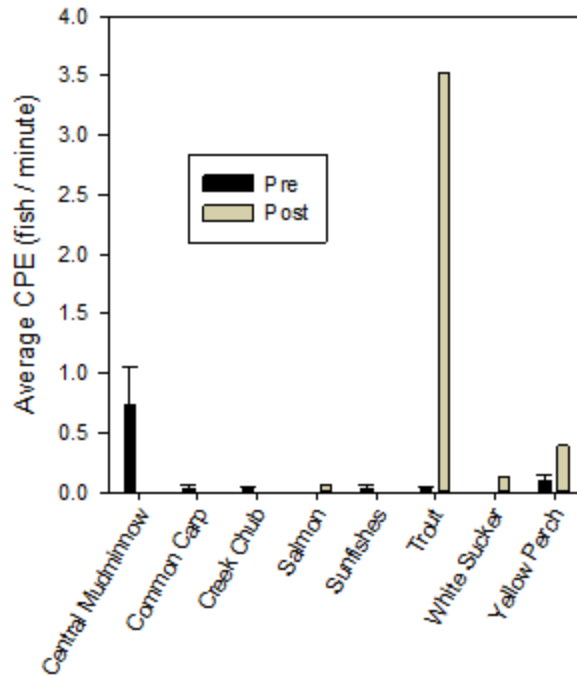


Bowens Creek, Lower Historical Channel

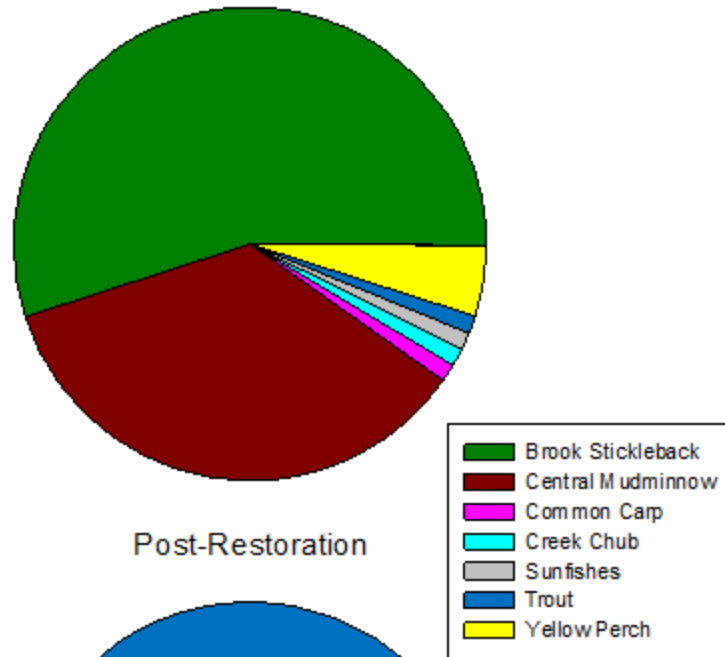


Northern Pike

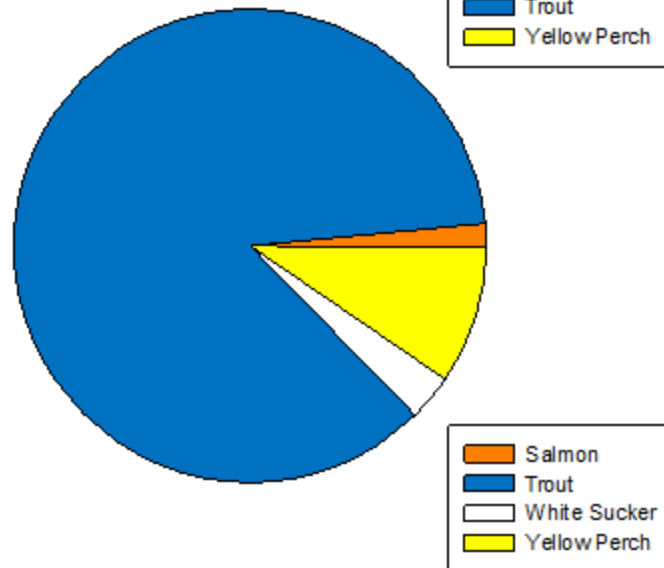
Bowens Creek, Middle Historical Channel



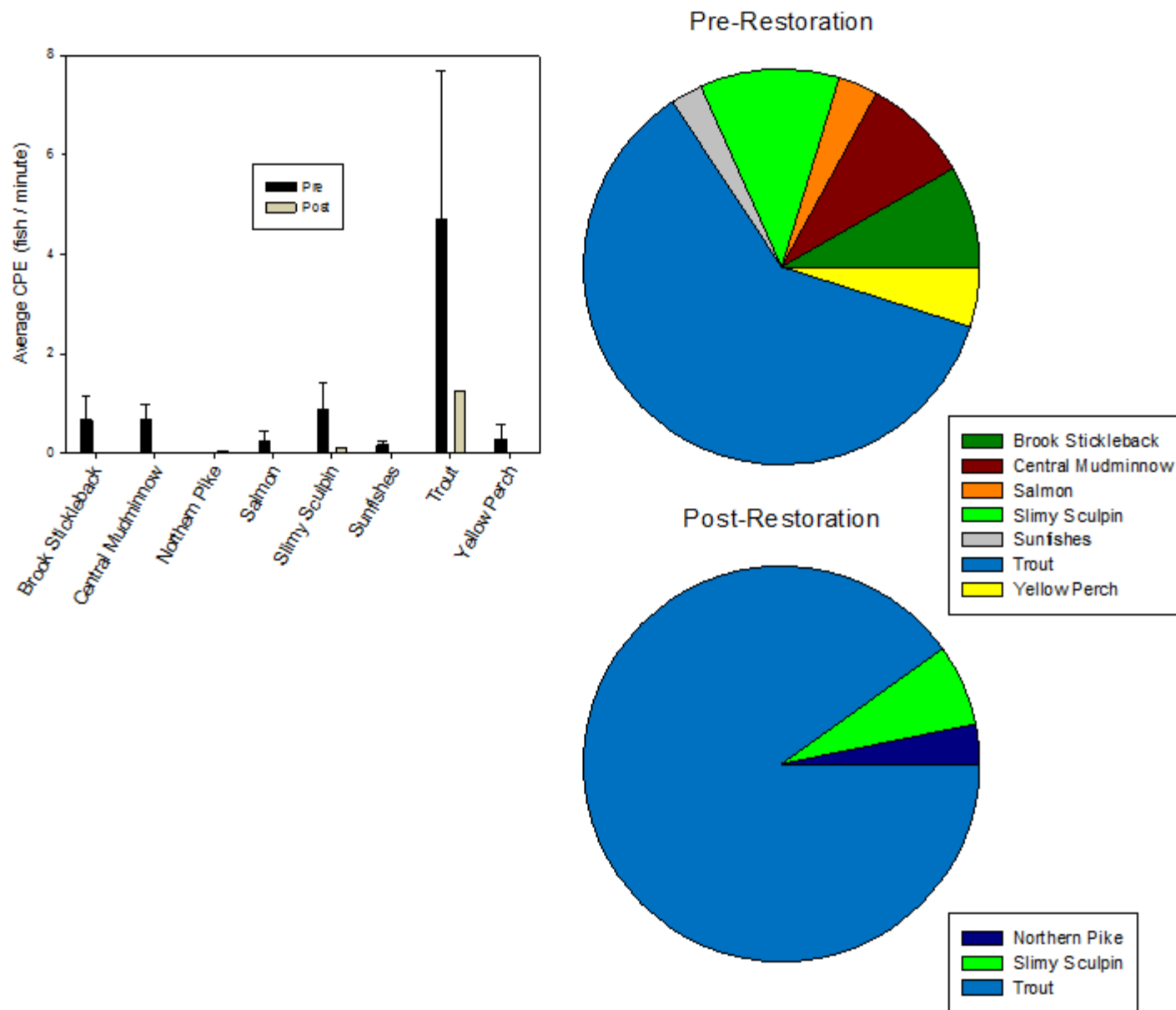
Pre-Restoration



Post-Restoration



Bowens Creek, Upper Historical Channel

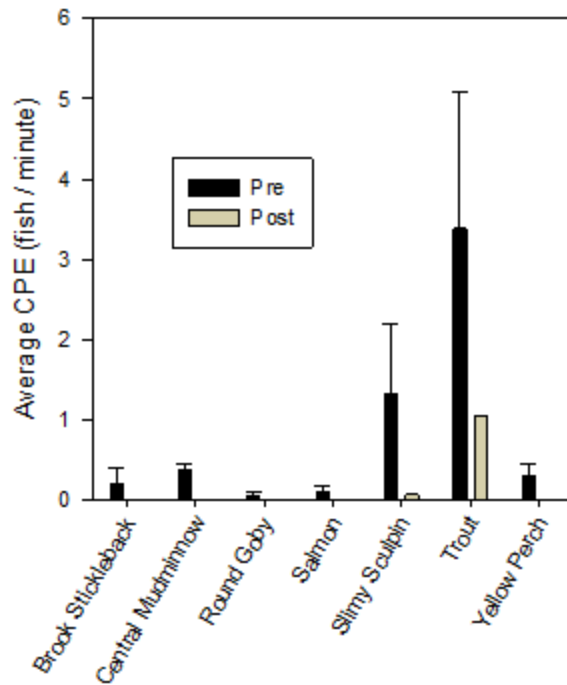


Bowens Creek, Upper Historical Channel

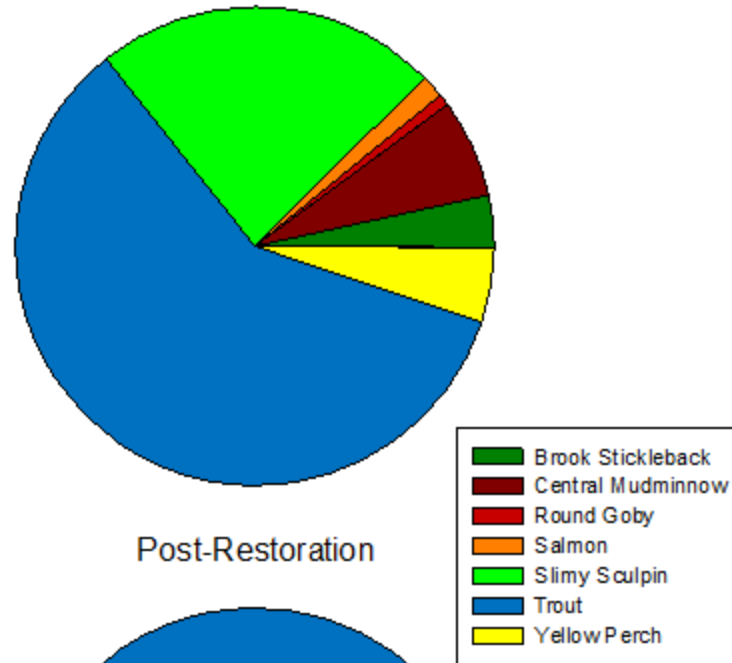
Coaster Brook Trout



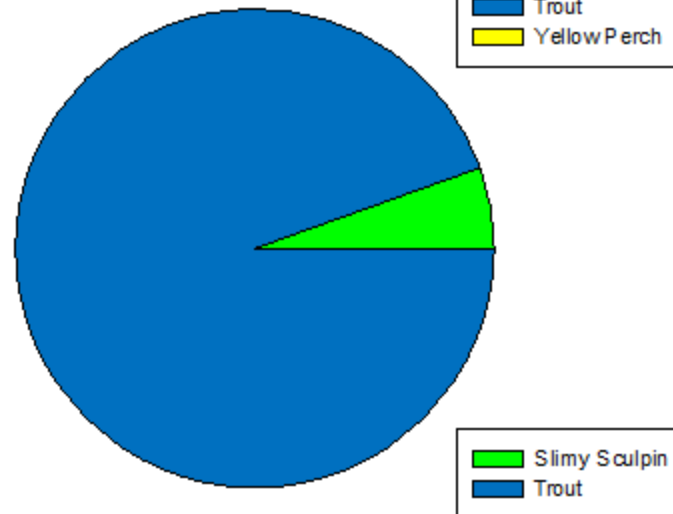
Bowens Creek, St. Pierre Road



Pre-Restoration



Post-Restoration



Conclusions: Lower Watershed

- Improved water quality, habitat and substrate
 - Cold, well oxygenated water
 - Narrower and deeper channels (still changing)
 - Less silt, more sand and woody debris
- Immediate shift in fish communities
 - Warm/cool water species → Cool/cold water species
 - Substantial increase in brown and rainbow trout

Partners

