Quantifying Fish Habitat Impairment in Iowa's Lakes and Reservoirs

Erin M. Haws

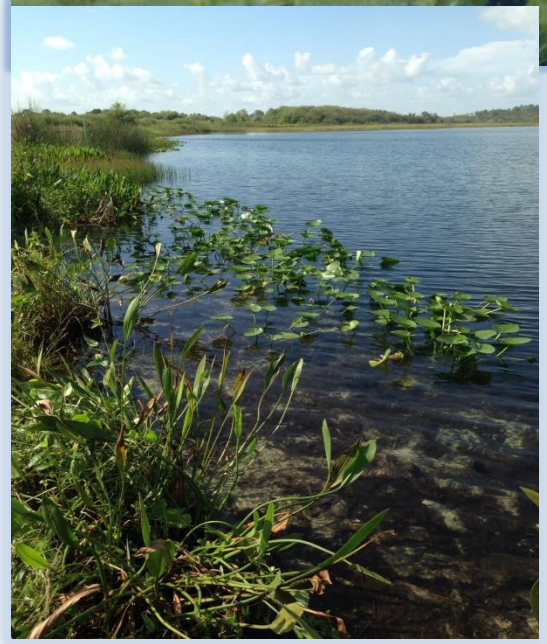
Iowa Department of Natural Resources, Fisheries Research Unit

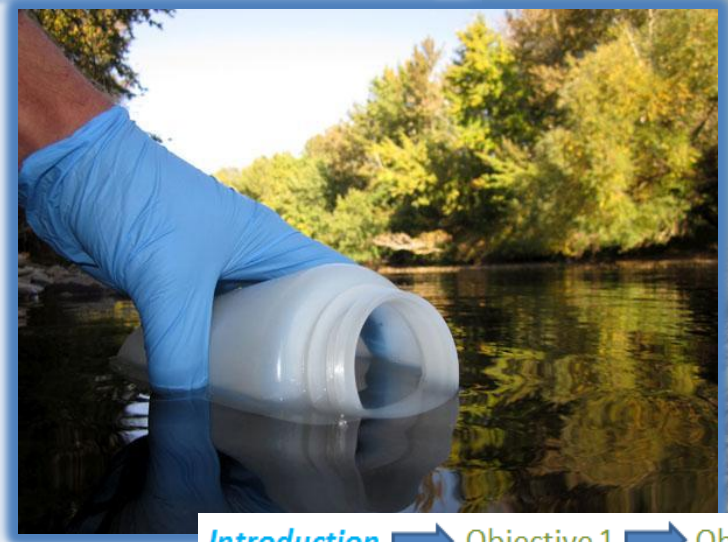
University of Florida, School of Forest Resources and Conservation,

Department of Fisheries and Aquatic Sciences

Defining Fish Habitat

Recent emphasis on developing protective policies and restoration programs aiming to improve aquatic habitat (AFWA 2012)





Tracking Habitat Condition

- Generally focused on water quality parameters (Carlson 1977, Burns et al.1999)
- Major advancements in stream and river assessments (index of biotic integrity, habitat suitability modeling)
- Quantifying aquatic habitat is difficult in lacustrine systems

Trends in Fish Habitat Impairment

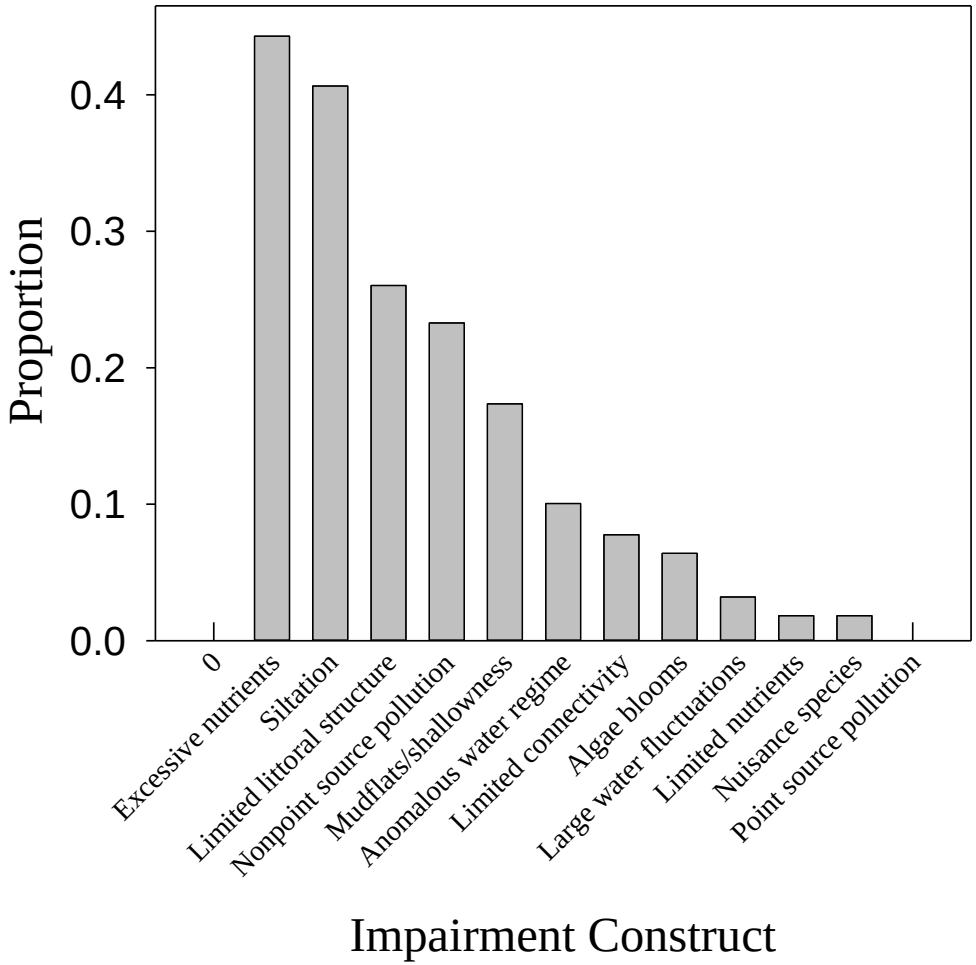
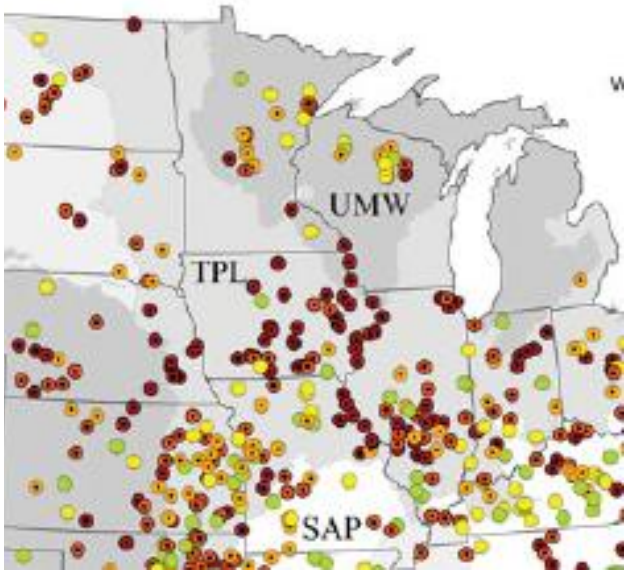
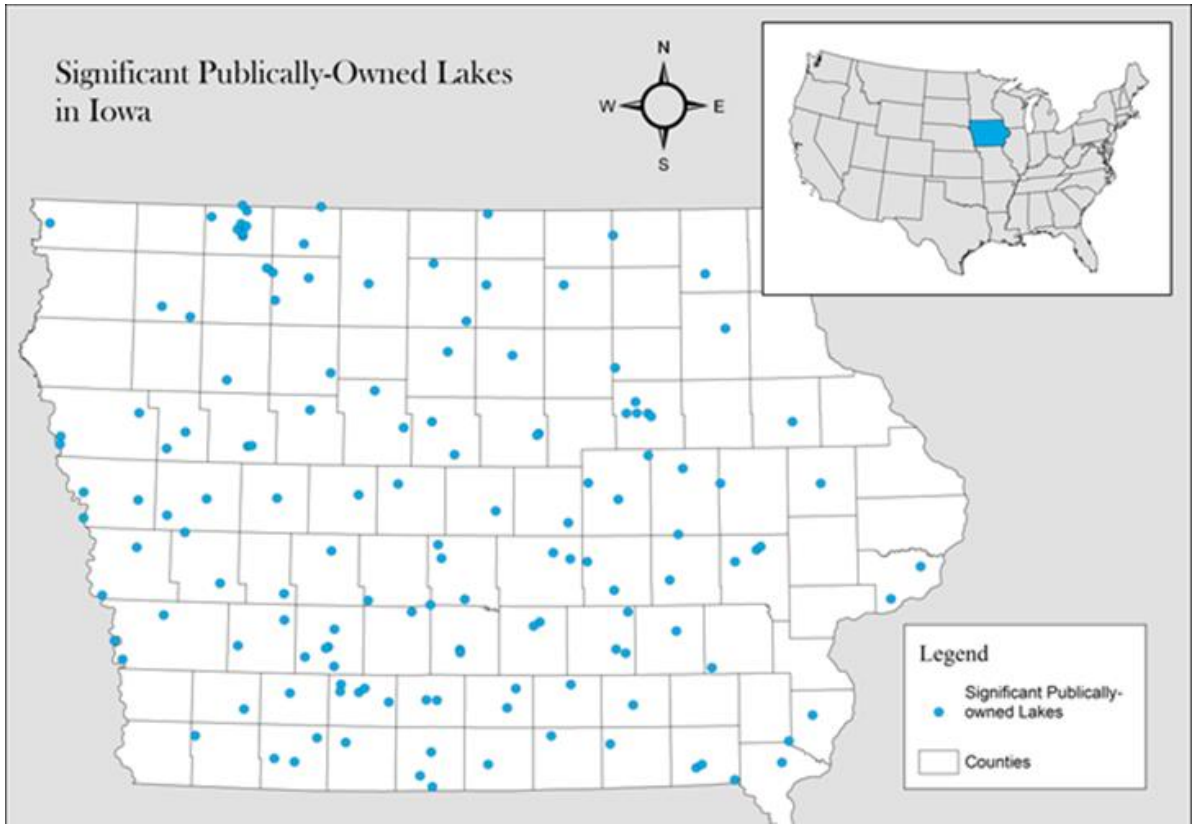


Figure (left): Proportion of large Temperate Plains reservoirs scoring high for the twelve impairment constructs defined by Krogman and Miranda (2016).



Map of TPL ecoregion (Krogman and Miranda 2016)

Trends in Fish Habitat Impairment



Can we identify useful trends by implementing a similar survey on a smaller scale?

Study Purpose

Goals: Identify differences in fish habitat impairment across systems and watersheds for all significant publicly-owned lakes in Iowa. Investigate relationships between qualitative impairment factors and easily-measured water quality, physical, and biological metrics.

Study Objectives

Objective 1: Survey current fish habitat conditions in reservoirs and lakes in Iowa, based on the twelve fish habitat impairment constructs defined by Krogman and Miranda (2016).

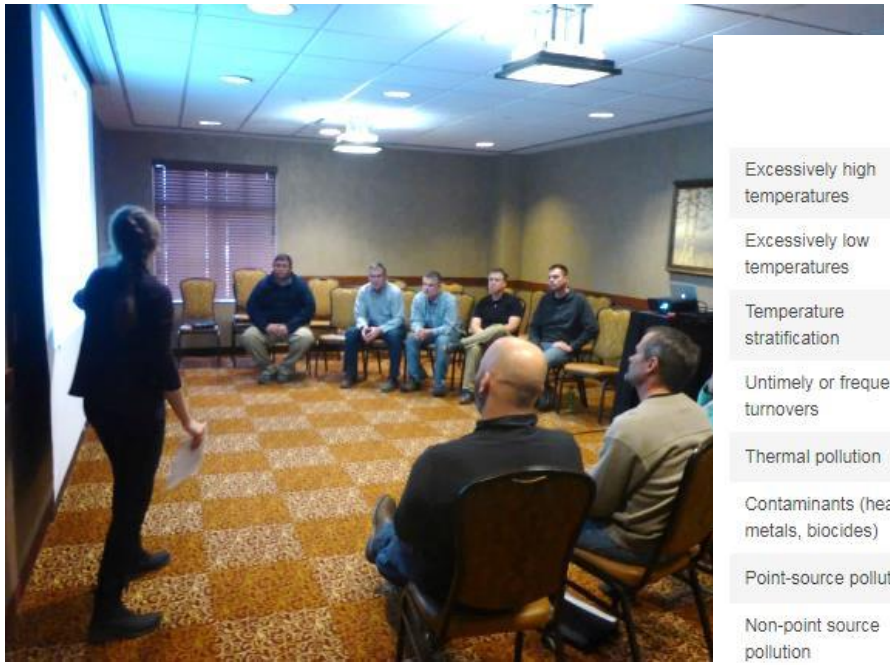
Objective 2: Identify patterns of habitat impairment, if present, by lake classification, HUC-4 watershed, and status in the Iowa Lake Restoration Program.

Objective 3: Explore relationships between impairment constructs and fishery issues. Develop predictive models that quantify identified relationships.

Objective 4: Explore and quantify relationships between habitat impairment factors and measured water quality, physical, and biological parameters.

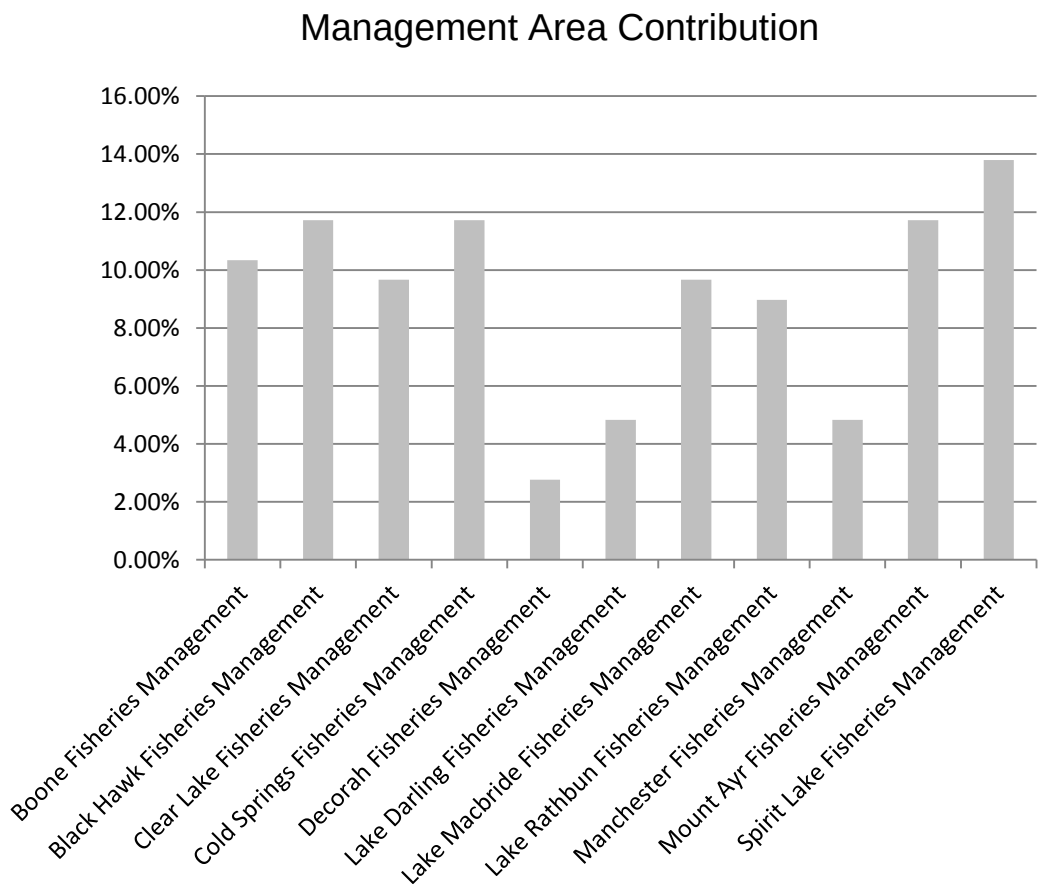
Methods: Data Collection

- A survey was sent out to 11 Iowa Department of Natural Resources Fisheries Management Biologists to collect scores for each significant-publicly owned lake (SPOL) in Iowa



	None (0)	Low (1)	Low to Moderate (2)	Moderate (3)	Moderate to High (4)	High (5)
Excessively high temperatures	○	○	○	○	○	○
Excessively low temperatures	○	○	○	○	○	○
Temperature stratification	○	○	○	○	○	○
Untimely or frequent turnovers	○	○	○	○	○	○
Thermal pollution	○	○	○	○	○	○
Contaminants (heavy metals, biocides)	○	○	○	○	○	○
Point-source pollution	○	○	○	○	○	○
Non-point source pollution	○	○	○	○	○	○

Methods: Data Collection



- 52 survey questions
- Open for response from March 10th-May 4th 2018
- **Survey response: 100%**
- **Total SPOLS reported: 140**

Methods: Impairment Scoring

Point source pollution	point source environmental problems stemming from watershed activities, thermal inputs, and contaminants
Nonpoint source pollution	nonpoint source environmental problems stemming from broadly distributed watershed activities
Excessive nutrients	excessive nutrient inputs originating from a broad area of the watershed
Algae blooms	water quality problems associated with variable oxygen, high temperature, and algae blooms
Siltation	high suspended and deposited sediments, and associated loss of habitat
Limited Nutrients	deep and oligotrophic, or may be undergoing undesired oligotrophication
Mudflats/shallowness	excessively shallow particularly in the littoral zone, with extensive mudflats
Limited connectivity to adjacent habitats	lack or loss of connectivity to adjacent habitats, including backwaters and tributaries
Limited littoral structure	insufficient physical structure and homogenized littoral habitats
Nuisance species	aggressively expanding, typically nonnative, plant or animal species
Anomalous water regime	frequent or poorly timed fluctuations or flushing
Large water fluctuations	large and/or or long-duration water level fluctuations

Impairment score= $f'_m + f'_{m+1} + \cdots f'_n$

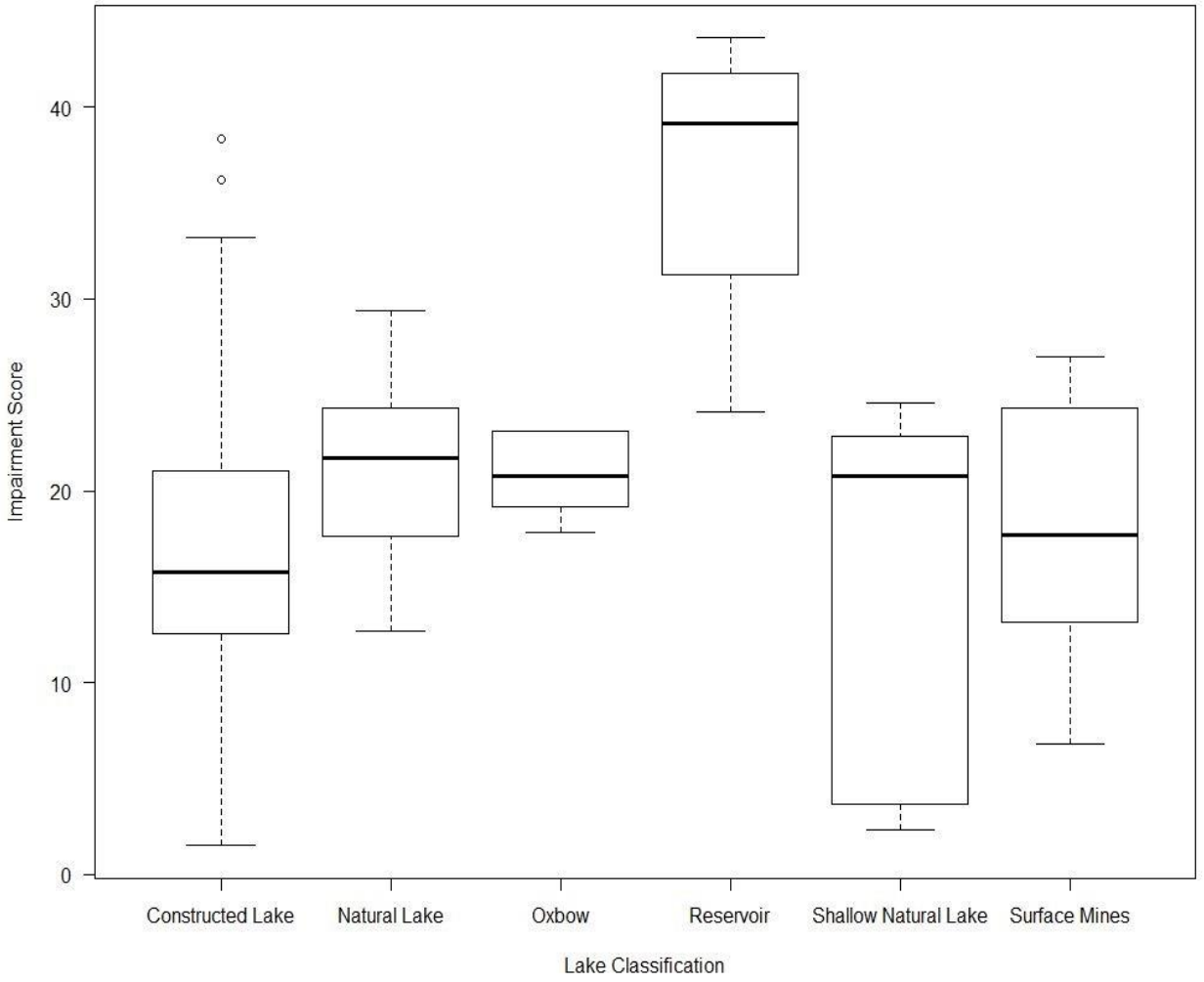
$$f'_m = \begin{cases} 0, & f_m < 0.5 \\ 1, & 0.5 \le f_m < 1.5 \\ 2, & 1.5 \le f_m < 2.5 \\ 3, & 2.5 \le f_m < 3.5 \\ 4, & 3.5 \le f_m < 4.5 \\ 5, & f_m \ge |4.5 \end{cases}$$

$$f_m = \frac{v_i + v_{i+1} + \cdots v_j}{j},$$

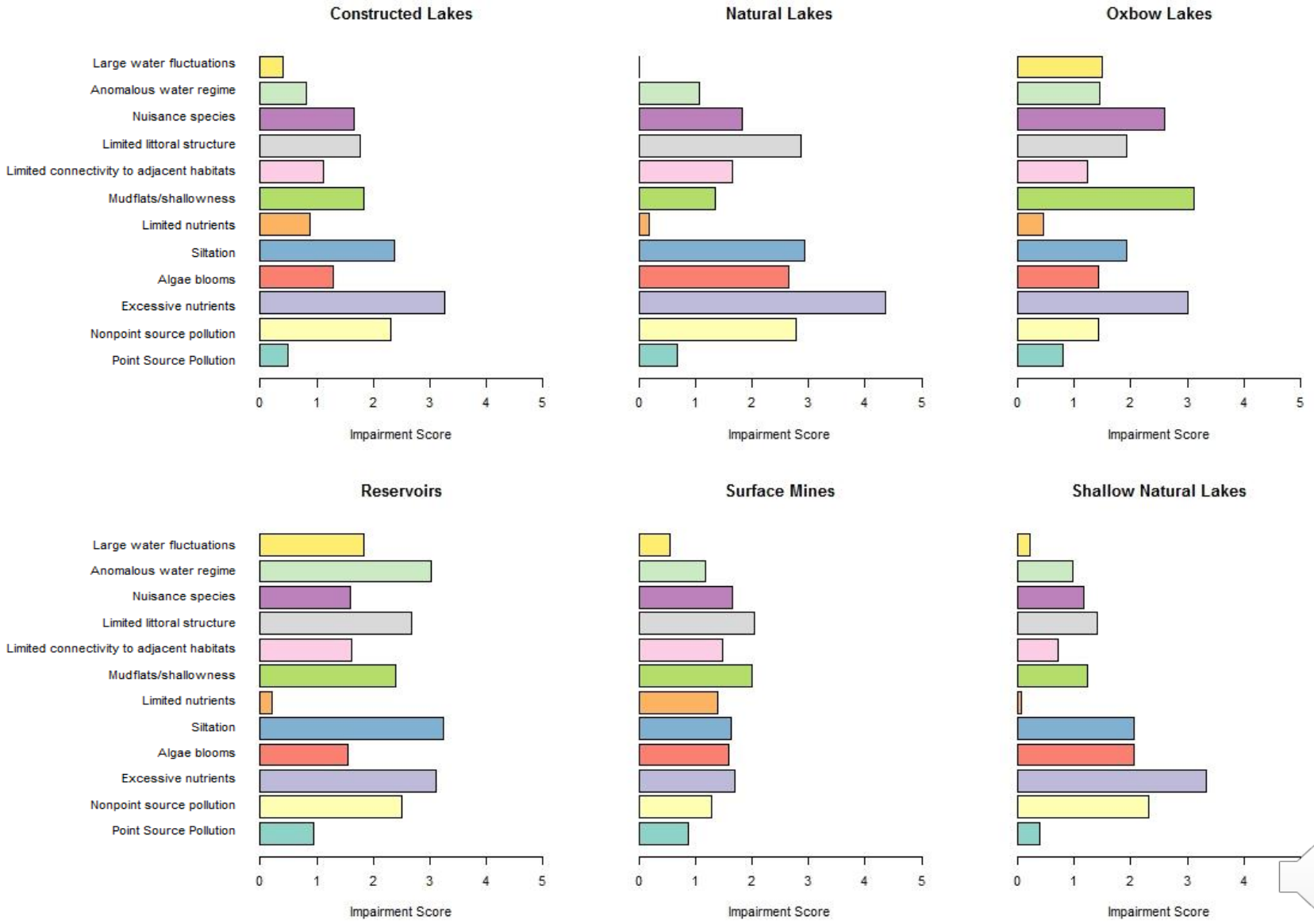
Equation 1: Formula used to calculate individual construct scores and comprehensive fish habitat impairment scores for each SPOL.

- Model check using confirmatory factor analysis (CFA) in program R.3.3.1 ('lavaan package')

Results: Lake Classification

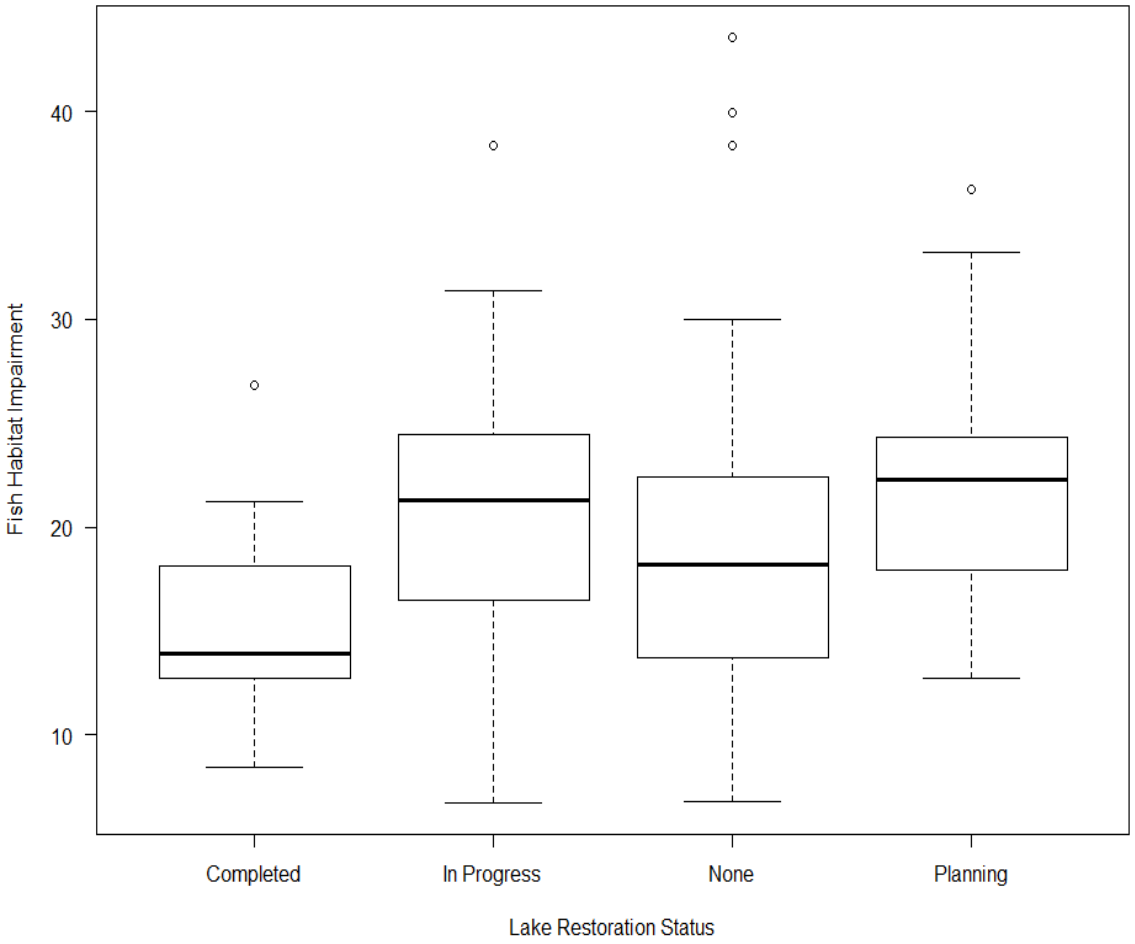


Results: Lake Classification

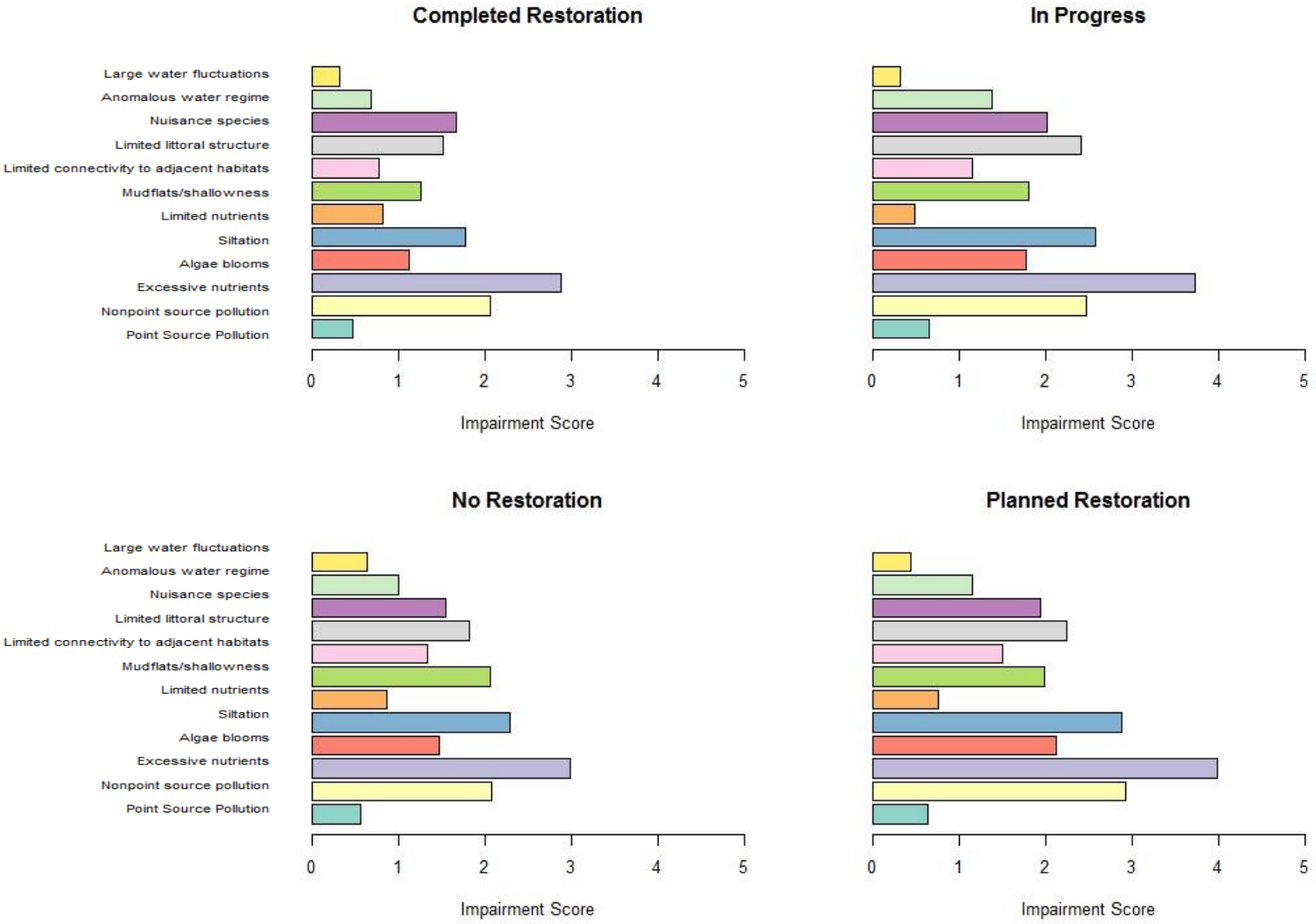


Results: HUC-4 Watershed Location

Results: Lake Restoration Status



Results: Lake Restoration Status



Fishery Issues

- How do habitat condition and fishery problems relate?
- Monitoring and evaluation are essential to measuring short and long term success

Michigan State University • Extension Bulletin E-1776 • April 2002 (Minor Revision)

Help!

MICHIGAN STATE UNIVERSITY EXTENSION

My Bluegills are Stunted.

By Don Garling,
Department of Fisheries and Wildlife,
Michigan State University

The problem of stunted bluegills is one of the most often received complaints that we hear about Michigan inland pond and lake fishing. Though many other types of fish are also prone to stunting — such as bullheads, perch and crappie — stunted bluegills are the main problem. We recommend that these fish not be stocked in ponds.

To determine if the bluegills in your pond or lake are stunted, you need to determine their ages from scale samples and compare age to total length. For more information, see "How to Determine the Age of Fish," MSU Extension Bulletin E-1774.

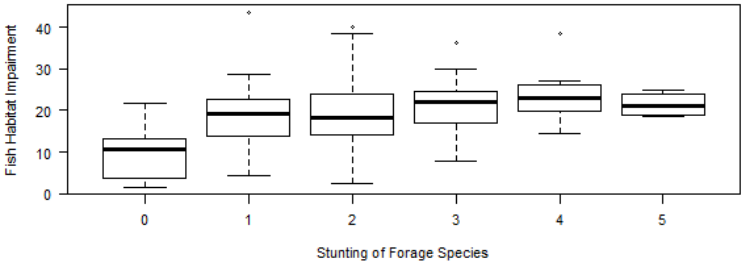
The mean sizes of bluegills in our region are:

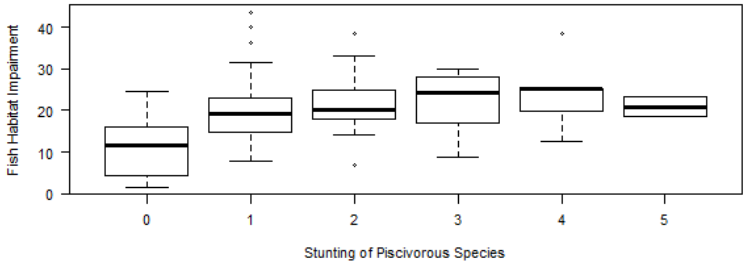
Age (years)	1	2	3	4	5	6	7	8
Size (inches)	1.8	3.4	4.5	5.7	6.5	7.0	7.5	8.0

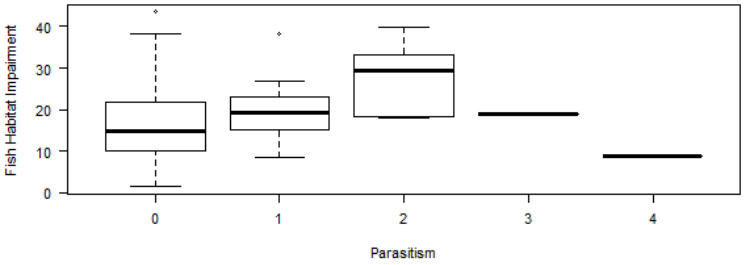
If the bluegills are significantly smaller, they are

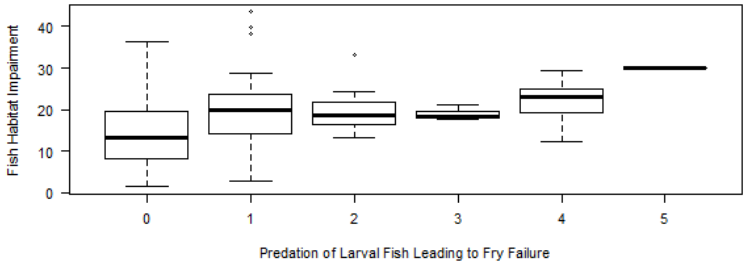
Iowa DNR

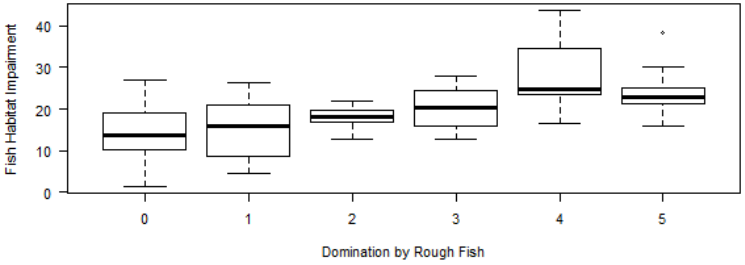
Results: Objective 3

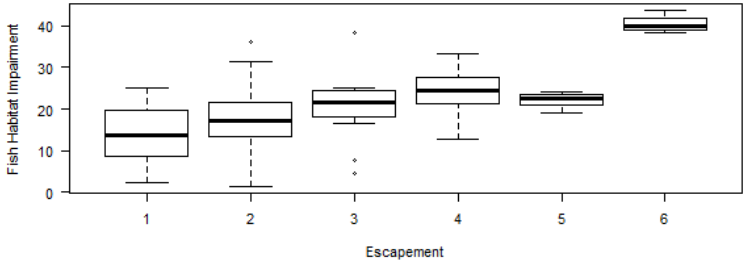






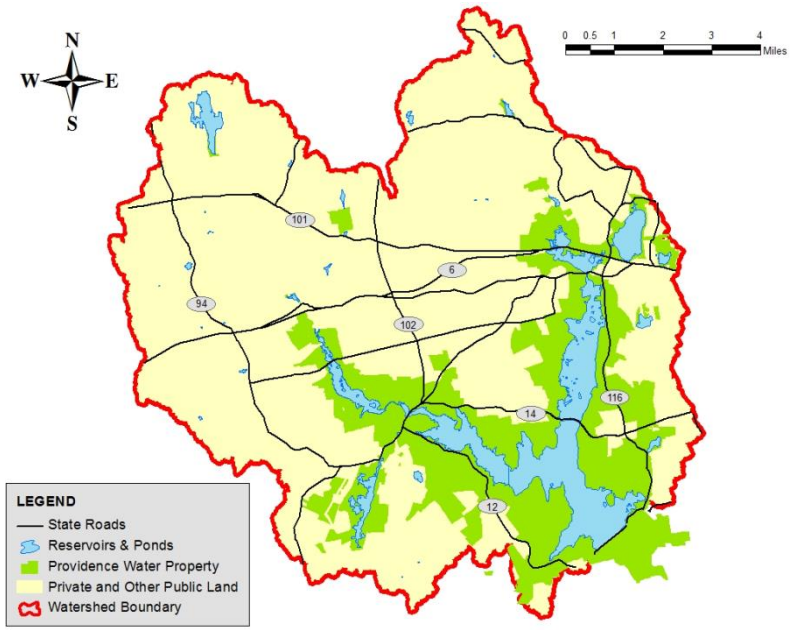






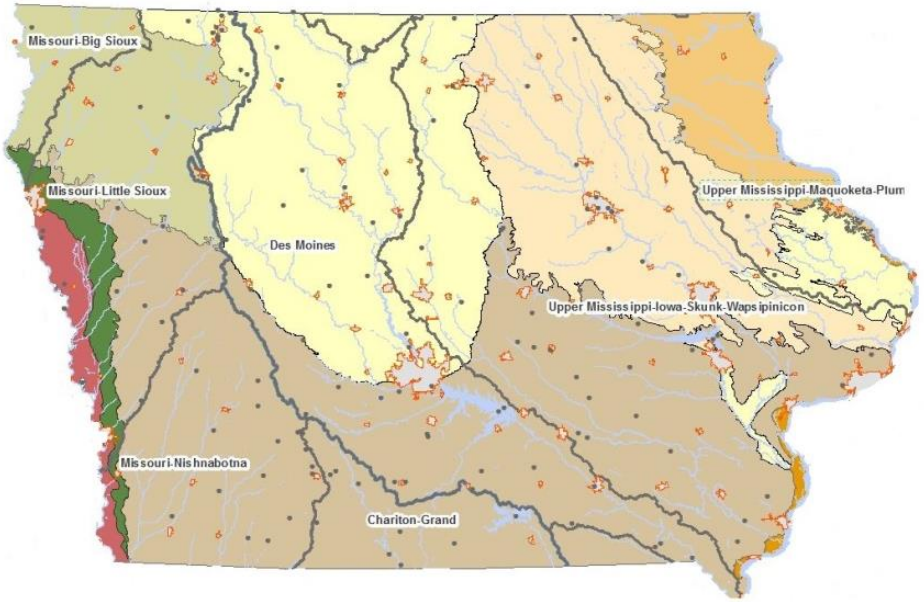
Discussion: Lake Classification

- Fish habitat impairment in reservoirs: why so high?
- Problems across the board
- Unique impairment patterns



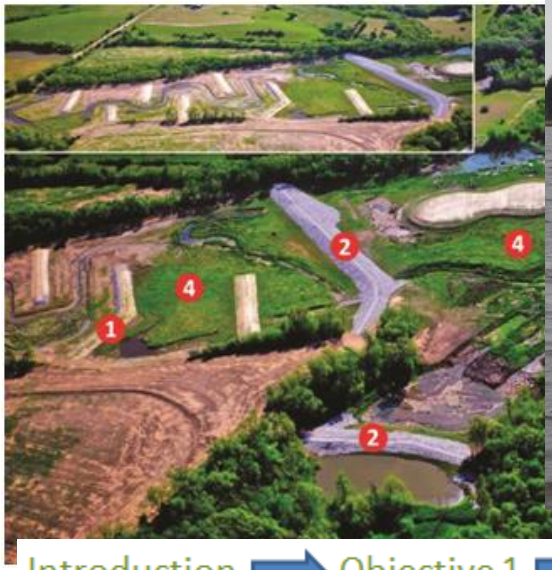
Discussion: HUC-4 Watershed Location

- Mississippi vs. Missouri River basin
- Watershed land use patterns



Discussion: Lake Restoration Status

- Constructs showing the largest improvements
  - Is this a result of bias?



Next Steps

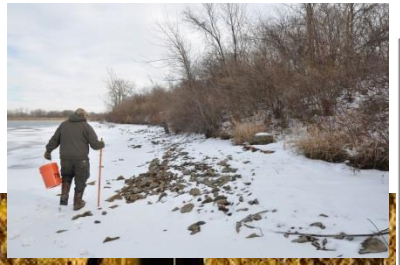
Objective 4: Explore and quantify relationships between habitat impairment factors and measured water quality, physical, and biological parameters

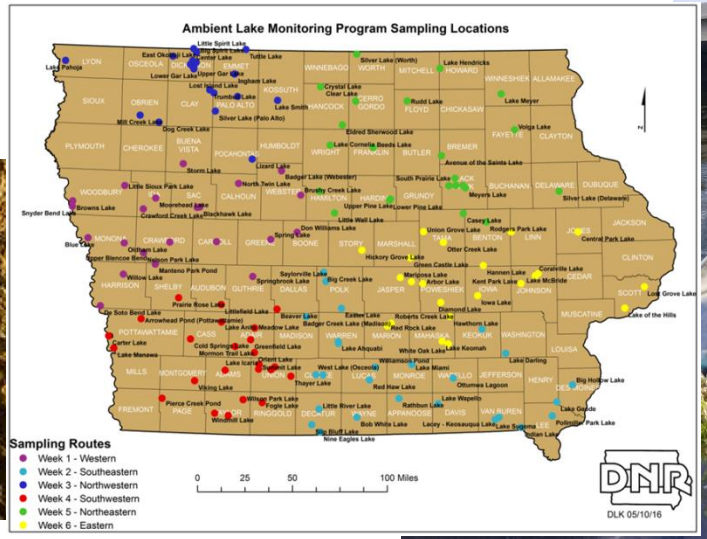
Identify metric gaps

*Do we have the resources to effectively measure **all** facets of fish habitat impairment?*

Future Work

Can we develop a feasible and comprehensive fish habitat assessment protocol to monitor and evaluate changes in construct scores?





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