Quantifying Fish Habitat Impairment in Iowa's Lakes and Reservoirs

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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.
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

**Impairment score**:

\[ f'_m = \begin{cases} 
0, & f_m < 0.5 \\
1, & 0.5 \leq f_m < 1.5 \\
2, & 1.5 \leq f_m < 2.5 \\
3, & 2.5 \leq f_m < 3.5 \\
4, & 3.5 \leq f_m < 4.5 \\
5, & f_m \geq 4.5 
\end{cases} \]

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’)

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

The box plot above shows the distribution of impairment scores across different lake classifications. The y-axis represents the impairment score, while the x-axis shows the various lake classifications, including Constructed Lake, Natural Lake, Oxbow, Reservoir, Shallow Natural Lake, and Surface Mines. The box plots illustrate the median, interquartile range, and outliers for each category, providing insights into the relative impairment levels for each type of lake.
Results: Lake Classification

- Constructed Lakes
- Natural Lakes
- Oxbow Lakes

- Reservoirs
- Surface Mines
- Shallow Natural Lakes

Bar charts showing impairment scores for various lake types.
Results: HUC-4 Watershed Location
Results: Lake Restoration Status

The box plot shows the distribution of Fish Habitat Impairment for different Lake Restoration Status categories:

- **Completed**
- **In Progress**
- **None**
- **Planning**

The box plots indicate the median, quartiles, and outliers for each category, providing insight into the condition and progress of lake restoration efforts.
Results: Lake Restoration Status

Completed Restoration

In Progress

No Restoration

Planned Restoration

Introduction → Objective 1 → **Objective 2** → Objective 3 → Discussion
Fishery Issues

• How do habitat condition and fishery problems relate?

• Monitoring and evaluation are essential to measuring short and long term success
Results: Objective 3

Introduction → Objective 1 → Objective 2 → Objective 3 → Discussion
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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References


