Session D3 - Fish Passage Restoration at the Briggsville Dam: Using Sediment Transport Analysis for Natural Channel Design

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Evaluation of Two Rock Ramp Fishways in a Colorado Transition Zone Stream

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Overview

Introduction to transition zone streams
South Boulder Creek study
  - Methods
  - Preliminary results
Conclusions & future work
Transition Zone Streams

- Unique Environments
  - Warmwater and coldwater fishes
  - Extensive human influence

- Vertical Distance
- Horizontal Distance

- Lower ↔ Temperature → Higher
- Larger ↔ Substrate → Smaller
- Steeper ↔ Slope → Flatter

Photo: Roy Winkelman

Photo: Koreen Zelasko
Study Area: South Boulder Creek

- Extensive human effects
  - Agricultural, urban land use
  - Historic dredging, channelization
  - Agricultural diversions
    - Some have rock ramp fishways
    - Efficacy not tested
Study Area: South Boulder Creek

- Species presence controlled by
  - Stream network position
    - Temperature, gradient
  - Channel work and barrier presence
    - Species must tolerate limited floodplain
    - Species must persist in upstream fragment
The Big Question

- Do these rock ramps work??
- Are passage rates comparable to the control site?
- Is the timing of passage similar to the control site?
Methods: a PIT Tag Study of Small Fish

- PIT tag advantages
  - Accurate identification
  - Capture probabilities
- Disadvantages
  - Fish size limitations
- Tests of assumptions
  - Survival and swimming performance of nonsalmonid fishes given PIT tags
Monitoring Fish Passage

- Fish marked with 23-mm half-duplex PIT tags

- Six swim-through antennae maintained for one year
Antenna Placement

- Paired antennae
  - Bracketed the two diversions and the control site
  - Maintained year-round from May 2010 through July 2011

- Detection assumptions
  - Success = detection at paired antennae within one day
  - If paired antennae were not crossed, we assumed fish did not move.
Data Analysis

- Program MARK allows hypothesis testing
  - Current analysis only examines upstream movement
  - Monthly time steps
- Roles of structure, distance, and time analyzed with $\text{AIC}_c$
Hypothesis Testing in MARK

Model | Transition Probabilities
--- | ---
Null | $\Psi_1 = \Psi_2 = \Psi_3 = \Psi_4 = \Psi_5 = \Psi_6$
Distance Only | $\Psi_1 = \Psi_2 = \Psi_3; \Psi_4 = \Psi_5; \Psi_6$
Distance * Structure | $\Psi_1; \Psi_2; \Psi_3; \Psi_4; \Psi_5; \Psi_6$
Time | Transitions would vary seasonally
Preliminary Results: Movement Rates

<table>
<thead>
<tr>
<th>Transition</th>
<th>Number of fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower diversion only</td>
<td>58</td>
</tr>
<tr>
<td>Control reach only</td>
<td>57</td>
</tr>
<tr>
<td>Upper diversion only</td>
<td>15</td>
</tr>
<tr>
<td>Lower diversion &amp; control reach</td>
<td>2</td>
</tr>
<tr>
<td>Upper diversion &amp; control reach</td>
<td>10</td>
</tr>
<tr>
<td>Both diversions</td>
<td>4</td>
</tr>
</tbody>
</table>

- 1,143 fish marked, 660 detected at least once
  - 137 (12%) marked fish moved past antenna pairs
  - Fish of all species moved over both diversions
  - 9 of the 137 made multiple upstream movements
- Movement rates lower over upper (steeper) diversion
### Preliminary Results: Seasonal Patterns

- Movement minimal between November and March
- Structure-related differences in seasonal movement?
Implications for Fishway Design

- Fishway channel morphology affects passage success
  - Increased slope may decrease upstream movement
  - Confinement of low-flow channel may decrease upstream movement, even if slope is relatively low
    - May alter seasonal movement patterns
- Little standardization in rock ramp design
  - Few attempts to relate passage success with rock ramp design in Colorado
  - But we have plans...
In the Works...

- Relating rock ramp design to passage success
  - Laboratory studies
    - Measures of velocity profiles, Reynolds stress in unit width rock ramp models
    - Experiments with passage success run with four fish species
      - Longnose dace and longnose sucker included
  - Field studies
    - Combined study with sites on a nearby transition-zone stream
    - LIDAR mapping of structures for detailed hydraulic information
    - Passage rates will be estimated with MARK
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