Session B4- Question Answering and Problem Solving: Using Bio-Telemetry Monitoring Techniques to Assess Silver Eel Emigration at Hydroelectric Projects

S. Leach
Normandeau Assoc.

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Question Answering and Problem Solving: Using Bio-Telemetry Monitoring Techniques to Assess Silver Eel Emigration at Hydroelectric Projects

Steve Leach
Normandeau Associates, Inc.

National Conference on Engineering & Ecohydrology for Fish Passage
June 27-29, University of Massachusetts, Amherst
Introduction
What is the problem?

- American eel (*Anguilla rostrata*) have complex life history:
  - catadromous, panmictic; long-lived.

- Upstream passage at hydroelectric projects = significant increases in numbers of adults requiring downstream passage.

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>N</th>
<th>Source</th>
</tr>
</thead>
</table>
Introduction

• Route selection can have significant impacts on reproductive potential.

• An understanding of passage route selection and variables that affect route as well as relative survival is necessary to evaluate the impacts of a particular project, and subsequently estimate cumulative impacts in a basin where multiple dams are present.
Objective
• Review some biotelemetry and passage survival case studies done to investigate route and develop downstream protection measures.

Methods
• Depend on questions asked and site specifics
  • 3D acoustic telemetry to examine fine scale movements, for example: determination of downstream bypass placement.
  • PIT for monitoring relative passage by discrete routes.
  • Radio / acoustic telemetry to assess route selection.
  • Specialized techniques to assess passage survival.
  • Passive and active monitoring to infer survival.
What are the approach and passage routes?

- Conventional fixed-station radio telemetry study.
- All passage routes and upstream and downstream gateways monitored.
- Small sample (N=20).

<table>
<thead>
<tr>
<th>Code</th>
<th>Route</th>
<th>% Flow</th>
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</thead>
<tbody>
<tr>
<td>34</td>
<td>Unit 2</td>
<td>70%</td>
</tr>
<tr>
<td>35</td>
<td>Unit 2</td>
<td>68%</td>
</tr>
<tr>
<td>25</td>
<td>Unit 1</td>
<td>68%</td>
</tr>
<tr>
<td>26</td>
<td>Unit 2</td>
<td>67%</td>
</tr>
<tr>
<td>32</td>
<td>Unit 1</td>
<td>55%</td>
</tr>
<tr>
<td>44</td>
<td>Bypass</td>
<td>22%</td>
</tr>
<tr>
<td>30</td>
<td>Bypass</td>
<td>22%</td>
</tr>
<tr>
<td>27</td>
<td>Bypass</td>
<td>22%</td>
</tr>
<tr>
<td>42</td>
<td>Unit 2</td>
<td>52%</td>
</tr>
<tr>
<td>33</td>
<td>Unit 2</td>
<td>53%</td>
</tr>
<tr>
<td>38</td>
<td>Bypass</td>
<td>41%</td>
</tr>
<tr>
<td>36</td>
<td>Unit 1</td>
<td>38%</td>
</tr>
<tr>
<td>43</td>
<td>Spill</td>
<td>44%</td>
</tr>
<tr>
<td>29</td>
<td>Bascule</td>
<td>40%</td>
</tr>
<tr>
<td>31</td>
<td>RD5</td>
<td>40%</td>
</tr>
<tr>
<td>37</td>
<td>RD5</td>
<td>40%</td>
</tr>
<tr>
<td>28</td>
<td>Canal</td>
<td>14%</td>
</tr>
<tr>
<td>100</td>
<td>Spill</td>
<td>54%</td>
</tr>
</tbody>
</table>

Results

• All routes were used.
• Route was not necessarily related to proportion of flow.

The Main Points

• Each site presents unique complexities. The physical characteristics and variable flow along with behavior data should be considered.
• There often is not a single answer for downstream passage…
The Main Points

- Arrival and passage timing closely related, but may be dependent on increased flows.
- Flow priority?
What are the passage routes?
Are proposed protection measures effective?

- Conventional fixed-station radio telemetry study.
- Manipulated sluice and deep gates.

Results

- Eels passed via spill, turbines, and deep gate.
- Eels did not pass via sluice gates.
- Increased discharge to deep gate increased proportional passage by it.

The Main Point

- While eels may use all routes, deep gate is an effective passage route from the canal.
- Relatively small increase in flow yielded large gain in passage.
- Proposed to open deep gate to 300 cfs nightly during emigration season.
Evaluate effectiveness of deep gate at various flows

- Previous study showed that eels followed predominant flow field toward Units 7 and 8 and passed through them.
- Can passage be optimized by restricting nighttime use of Units 7 and 8 and using deep gate?

Results

- Increased discharge via the deep gate increased proportional passage by it.
- Whether passing by Units or by deep gate, most swam along intake trash racks.

The Main Point

- Limiting night operations of Units 7 and 8 and opening deep gate increased passage via deep gate from 8% (in 2007 study) to 83%.
Weston Project, Kennebec River, Skowhegan, ME, 2008

What are the passage routes?

Is passage effective?

- **North Channel**: Taintor, Obermeyer, and stanchion gates
- **South Channel**: powerhouse, log sluice, stanchion gate.
- No deep gate.

Two scenarios tested

• North- Taintor #1 open 0.5 ft, Obermeyer #2,5 open; South- Units 2-4, sluice at 2.25 ft, up to 240 cfs.
• North- Obermeyer #2,5 open; South: Units 2-4, sluice at 3.25 ft, up to 360 cfs.

Results

• No eels used log sluice
• 29% used Obermeyer Gates, 13% used Taintor Gates, 58% used Units.

The Main Point

• Unlike Lockwood and Shawmut, no deep gate is available. Further evaluation required
What else can be learned?

- Though not direct survival estimates, when telemetry studies are thoughtfully applied, survival may be inferred.
- Direct turbine survival assessment


# Downstream Passage - Survival

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Turbine</strong></td>
<td>99%/91%</td>
<td>84%/74%</td>
<td>100%</td>
<td>64%</td>
<td>90%</td>
<td>86%</td>
</tr>
<tr>
<td>Spill and other non-turbine routes</td>
<td>n/a</td>
<td>n/a</td>
<td>73%</td>
<td>n/a</td>
<td>57% / 92%</td>
<td>90%</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>99%/91%</td>
<td>74%</td>
<td>84%</td>
<td>78%/93%</td>
<td>86%</td>
<td>88%</td>
</tr>
</tbody>
</table>

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1 at 1 hr and ‘delayed’, respectively
2 at 1 hr and 88 hr, respectively
3 at 200 cfs and 300 cfs power canal flow, respectively; 56 % / 80% used deep gate
4 at 270 cfs and 425 cfs through Deep Gate, respectively
Conclusions

• Safe and effective downstream passage is important to American eel productivity.
• Investigations of site-specific (but variable) route selection is important to understand the passage / survival relationship and to devise downstream passage strategies.
• Biotelemetry techniques are suited to those investigations, but the appropriate technique depends on the question.
Questions?