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Acoustic telemetry development for fish passage

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Acoustic telemetry development for fish passage

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INTERNATIONAL CONFERENCE ON ENGINEERING AND ECOHYDROLOGY FOR FISH PASSAGE, CORVALLIS, OREGON

JUNE 21, 2017
Introduction

Juvenile Salmon Acoustic Telemetry System (JSATS) development
- Started in 2001 due to limitation of available technologies
- Initially developed to study juvenile salmon in the Columbia River Basin
- Studied >100,000 fish from various species in different countries since 2005

Further acoustic tag development
- Injectable acoustic tag
- Juvenile sturgeon acoustic tag
- Self-powered tag
- Eel/lamprey tag
The JSATS consists of acoustic transmitters, receivers, and data management and processing software.
JSATS Comparisons to Other Telemetry Options

► JSATS
- Small tags
- Good in noisy environments (fast, shallow, turbulent, near dams/structures)
- Many tags can be in range at the same time with high detection probability
- Works in fresh and salt water
- Many free-ware tools available
- Not ‘black-box’
- Competitive vendors
- Continuing development/improvements
- Receiver cost (of those we have used) is high compared to some systems but the cost has been decreasing.

► Other systems
- May be better for many applications
  - E.g., few fish / large fish in receive range at the same time, salt water, very long life
Injectable Acoustic Transmitter

- Implantation by injection instead of surgery, leading to significant cost reduction in use and training
- Significantly reduced handling to fish
- Dimension: 15 mm x 3.3 mm
- Dry Weight: 217 mg
- Wet weight: 106 mg
- Volume: 0.111 mL
- Source Level:
  - 156 dB at zero deg
  - 155 dB average -90 to 90 deg
- Configurable pulse rate interval & tag code
- Optional temperature, alternating, and hibernation mode
- Tag life: > 120 days at 3-s pulse rate interval

Deng Z, JJ Martinez, H Li, RA Harnish, CM Woodley, JS Hughes, X Li, T Fu, J Lu, GA Mcmichael, MA Weiland, MB Eppard, JR Skalski, and RL Townsend. 2017. "Comparing the survival rate of juvenile Chinook salmon migrating through hydropower systems using injectable and surgical acoustic transmitters." Scientific Reports 7:42999. doi:10.1038/srep42999
Long-term Juvenile Sturgeon Tag Specifications*

- Dimension: 24.2 mm x 5.0 mm
- Dry Weight: 718 mg
- Wet Weight: 219 mg
- Volume: 419 mL
- Source Level: 161 or 163 dB at zero deg
- Configurable pulse rate interval & tag code.
- Optional temperature, alternating, and hibernation mode.
- Tag Life: 365 days at 161 dB and 15-s pulse rate interval.

*Patent pending

Sturgeon Tag Applications

► Small juvenile (< 1 year old) sturgeon.
► Long term monitoring for adult fish such as adult lamprey.
► Noisy environment such as immediate tailrace due to higher source level.
► Mobile tracking due to longer detection range.
Self-powered Acoustic Transmitter*:
Benchtop testing

*Patent pending


Self-powered Acoustic Transmitter

- **Option 1 (i.e. “without battery”):** The weights are 1.05 and 0.80 grams, respectively.
- **Option 2 (i.e. “with battery”):** The weights are 1.10 and 0.85 grams, respectively.
- **Tag lengths can vary based on power requirements and fish characteristics of specific applications.**

* The short tag in the photo used an off-the-shelf piezoelectric beam instead of a custom one and thus was slightly longer than the one shown in the CAD.
65-mm tag implanted in 30 juvenile white sturgeon (37.8 ± 2.9 cm) for laboratory holding study in April 2017.

- Implanted on the flank (side); incision was just posterior of the gills and just above the flank scutes.
- 8–10-mm incision was first made with a No. 11 blade that only cut barely beneath the skin.

- Conduct a field trial on white sturgeon in 2017 in collaboration with Idaho Power Company, Grant County PUD, and ATS.
First Generation Juvenile Eel/lamprey Acoustic Transmitter*

- Dimension: 12.0 mm x 2.0 mm
- Dry Weight: 80 mg
- Source Level: 147 dB
- Configurable pulse rate interval & tag code
- Optional temperature, alternating, and hibernation mode
- Tag life: > 20 days at 5-s pulse rate interval

*Available for licensing, patent pending
Eel tagging: Tag Inserted Anteriorly, no Suture
Juvenile Eel/lamprey Acoustic Transmitter
Pilot Field Trial

- Primary objective: Validate the functionality and evaluate the performance of the new transmitter in field environments

- Juvenile lamprey
  - Tagged and released 100 fish in April and May 2017
  - Three autonomous receiver arrays were deployed between McNary Dam and John Day Dam in the Columbia River
  - Preliminary data showed high detection probability (100%).

- Juvenile Eel
  - At Roanoke Rapids Dam in North Carolina in collaboration with Dominion Power
  - Plan to tag about 100 fish in June 2017
### Development Summary

<table>
<thead>
<tr>
<th>Tag Type</th>
<th>Dimension</th>
<th>Dry Weight (g)</th>
<th>Source Level</th>
<th>Tag Life</th>
<th>Primary Application</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injectable Tag</td>
<td>15 mm X 3 mm</td>
<td>0.216</td>
<td>155-156 dB</td>
<td>&gt; 100 days at 3-s PRI</td>
<td>Juvenile salmon and other small fish</td>
<td>Completed</td>
</tr>
<tr>
<td>Sturgeon Tag</td>
<td>24 mm x 5 mm</td>
<td>0.718</td>
<td>161 or 163 dB</td>
<td>365 days at 15-s</td>
<td>Juvenile sturgeon; adult lamprey; Noisy environment</td>
<td>Completed</td>
</tr>
<tr>
<td>Self-powered tag</td>
<td>70 or 100-mm in length</td>
<td>0.8 to 1.11</td>
<td>150 dB</td>
<td>Long</td>
<td>Long-term monitoring</td>
<td>Planned for 2017 field trial</td>
</tr>
<tr>
<td>Eel/lamprey</td>
<td>12 mm X 2 mm</td>
<td>0.08</td>
<td>148 dB</td>
<td>20 to 30 days at 5-s</td>
<td>juvenile eel; juvenile lamprey</td>
<td>Planned for 2017 field trial</td>
</tr>
</tbody>
</table>
Looking for partners to conduct full scale field study for juvenile eel in 2018 or beyond.

Looking for partners to extend applications to other species such as American shad, delta smelts, river hearing.

Looking for partners to extend self-powered tag to other applications.

Plan to conduct a pilot trial for juvenile sturgeon in the Columbia and Snake River Basin in 2017.
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Questions?

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