EPRI Research on Use of Traveling Water Screens for Fish Protection
International Fish Screening Techniques Conference 2011

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International Fish Screening Techniques Conference
Southampton, UK
March 30, 2010
EPRI History …

• Founded in 1973
• Independent, nonprofit center for public interest energy and environmental research
• 450+ collaborative participants in more than 40 countries
  – EPRI members generate more than 90% of U.S electricity
• Major offices in Palo Alto, CA; Charlotte, NC; Knoxville, TN
  – Laboratories in Knoxville, Charlotte and Lenox, MA

EPRI’s Founder
Chauncey Starr
The U.S. EPA has proposed regulations requiring reduction in impingement and entrainment at cooling water intake structures.

- EPRI, in anticipation of regulations, has been conducting research on closed-cycle cooling and alternative fish protection technologies.

- The focus of this paper is traveling fine mesh screen technologies with fish protection:
  - Alternative traveling screens tend to have a lower cost than exclusion devices
  - Documenting performance is essential to determine viability as a compliance alternative
New Developments for Cooling Water Intake Structures

• U.S. EPA issued proposed regulations for cooling water intake structures on Tuesday of this week:
• All facilities using more than 2 MGD must reduce impingement mortality by:
  – Reducing through screen design velocity to not exceed 0.5 fps or
  – Reducing impingement mortality by 88%
• Facilities using more than 125 MGD subject to entrainment mortality reduction standards on a case by case basis. Must evaluate:
  – Cost, benefits and impacts of closed-cycle cooling
  – Use of alternative fish protection screening (2 mm mesh or smaller) and associated costs, benefits and impacts
• Final Rule expected in July 2012
Scope of EPRI Traveling Screen Research

Laboratory
- Impingement performance
  – Large flume
- Entrainment reduction performance
  – Bench top
  – Large flume
- Fish return system survival

Field
- Beaudry screen testing at OPPD
- Debris handling on Missouri River
Existing U.S. Fine Mesh Installations

- Xcel’s Prairie Island NPS
- AES’s Somerset & Dunkirk
- KCP&L’s Hawthorn
- Topaz’s Barney Davis
- Progress’ Brunswick NPS
- TECO’s Big Bend
Screen Fouling Performance Study
Screen after 9 months operation
Modified Traveling Screens Evaluated

Ristroph

Geiger

Beaudry

Molded Plastic

Geiger

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Prototype Screen Test Facility

Concrete Flume
- 120 ft long (80 ft test section)
- 20 ft wide
- 10 ft deep

Closed-loop Pump System
- Two, 60-inch diameter bow thrusters

Variable Frequency Drives
- Up to 500 cfs (224,000 gpm) flow

Water Quality Maintenance
- Chilling-100 ton chiller
- Particulate filtration- bag filters to 25µm
- UV sterilization

Passavant-Geiger
- 2.0 mm

EIMCO
- 2.0 mm

Hydrolox
- 1.78 mm
Test Species

- **Bigmouth Buffalo**
  *Ictiobus cyrinellus*

- **Bluegill**
  *Lepomis macrochirus*

- **Common Carp**
  *Cyprinus carpio*

- **Golden Shiner**
  *Notemigonus crysoleucas*

- **White Sucker**
  *Catostomus commersonii*
EPRI Fine Mesh Traveling Screen Research Projects

1. Larval survival studies with 4 types of screens in laboratory setting
   - 2006-2008: 0.5 mm
   - 2009: 2.0 mm
   - 2010: 2.0 mm Beaudrey vacuum screen

2. Fish return effects on larval/juvenile fish survival

3. Engineering issues to be faced with potential retrofit
Study Design – Prototype Screens

- 100 organisms per replicate
- Handling controls
- Approach velocity
  - 0.5, 1.0, and 1.5 ft/s
- Screen size
  - 2.0 mm
- Fish size

<table>
<thead>
<tr>
<th>Species</th>
<th>Average SL (mm)</th>
<th>Minimum SL (mm)</th>
<th>Maximum SL (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigmouth Buffalo</td>
<td>18.1</td>
<td>12.4</td>
<td>22.7</td>
</tr>
<tr>
<td>Bluegill</td>
<td>17.6</td>
<td>11.8</td>
<td>25.8</td>
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<tr>
<td>Common Carp</td>
<td>17.8</td>
<td>8.1</td>
<td>24.8</td>
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<tr>
<td>Golden Shiner</td>
<td>22.5</td>
<td>15.9</td>
<td>28.8</td>
</tr>
<tr>
<td>White Sucker</td>
<td>13.8</td>
<td>13.0</td>
<td>14.6</td>
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</tbody>
</table>
Common Carp Survival (2007 vs 2008): 0.5 mm

Improvements in Sample Handling
Common Carp Survival (2009): 2.0 mm

![Graph showing Common Carp survival rates under different treatment velocities. The graph compares survival rates at 0.5 ft/s (Smaller Larvae), 1.0 ft/s, 1.5 ft/s, and Control. The bars indicate higher survival rates for faster velocities.]
Bigmouth Buffalo: 0.5 vs 2.0 mm

Bigmouth Buffalo

0.0%  20.0%  40.0%  60.0%  80.0%  100.0%

Control
0.5 ft/s - 2.0 min
0.5 ft/s - 4.0 min
1.0 ft/s - 2.0 min

Bigmouth Buffalo

48-Hour Total Survival (%)

0.0%  20.0%  40.0%  60.0%  80.0%  100.0%

0.5 ft/s  1.0 ft/s  1.5 ft/s  Control
Bigmouth Buffalo: Survival by Length (2.0 mm)
Fish Return Effects
Laboratory Flume Project: Summary Learning to Date (0.5 - 2.0 mm)

- **0.5-1.0 mm** survival poor! Even control mortality high (>50%)
- **2.0 mm** survival increases dramatically (>80%) for test larvae (> 12.0 mm - organism length/stage matters - organisms rapidly gain strength/rigor with growth)
- Species matters (some much more sensitive than others)
- Approach velocity matters (mortality increases with increasing velocity) for larvae smaller >12 mm but less so for larvae >12mm for species tested
- Fish return effects does not appear to be a significant source of added mortality

**BUT** – results are for relatively hardy test species and not those that dominate actual IM&E
Beaudrey Fine Mesh Vacuum Screen Tested in 2010
Preliminary Beaudrey Performance (2.0 mm)

48-Hr Post-Collection Survival
(week of 9-Aug)

<table>
<thead>
<tr>
<th>Treatment Velocity</th>
<th>Percent Survival (48-hr)</th>
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</thead>
<tbody>
<tr>
<td>1.0</td>
<td>90.0%</td>
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<tr>
<td>1.5</td>
<td>80.0%</td>
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<tr>
<td>2.0</td>
<td>70.0%</td>
</tr>
<tr>
<td>Control</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

- Bigmouth Buffalo
- Common Carp
- White Sucker
Preliminary Beaudrey Performance (2.0 mm)

48-Hr Post-Collection Survival (week of 9-Aug and 23-Aug)

Percent Survival (48-hr)

- Bigmouth Buffalo
- Common Carp
- White Sucker

Treatment Velocity

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Preliminary Beaudrey Performance (2.0 mm)
August 9 – September 10

NOTE: There is a fish length effect for increased survival

48-Hr Post-Collection Survival

Percent Survival (48-hr)

Treatment Velocity

High Velocity Testing

- Bigmouth Buffalo
- White Sucker
- Common Carp
- Bluegill
316(b) Symposium at AFS Annual Meeting

September 4-8, Seattle, WA

- Technology developments
- IM&E sampling and magnitude
- AEI analysis
- BTA selection
- Closed cycle cooling issues
- Economic analysis

- www.fisheries.org
Questions?
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