Jun 24th, 12:05 PM - 12:30 PM

Session D7: Entrance Arrangement of Fishways – Interaction of Entrance Location, Turbine Flow and Attraction Flow

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Entrance arrangement of fishways – Interaction of entrance location, turbine flow and attraction flow

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General design recommendations

How do fish find the fishway and enter it?

Relevant Aspects

• Location
• Design according to the requirements of the relevant species – long distance migratory fish and resident fish
• Entrance geometry
• Bed oriented species: Hydraulic migration corridor with substrate connection essential

Source: DWA 2014
General design recommendations

How do fish find the fishway and enter it?

Relevant Aspects

• Location
• Design according to the requirements of the relevant species – long distance migratory fish and resident fish
• Entrance geometry
• Bed oriented species: Hydraulic migration corridor with substrate connection essential
• Guiding flow / formation of migration corridor
  • Angle of fishway flow
  • Flow conditions in the tailwater
  • Velocities
  • Discharge

Clear, definite design recommendations often do not exist.
Example designs

Source: Amt für Neckarausbau Heidelberg
Example designs
Entrance design

Typ A

Typ B1&2
Entrance design

Typ A

Typ B1&2

Typ C
Physical Model (M=1:10)
Evaluating hydraulic conditions

<table>
<thead>
<tr>
<th>Swimming mode</th>
<th>Endurance</th>
<th>Velocity threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. sprint speed</td>
<td>≤ 20 sec</td>
<td>10 * TL/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 – 20 TL/s (for small fish)</td>
</tr>
<tr>
<td>Prolonged speed</td>
<td>&gt; 20 sec; &lt; 200 min</td>
<td>5 * TL/s</td>
</tr>
<tr>
<td>Max. sustained speed</td>
<td>&gt; 200 min</td>
<td>2 * TL/s</td>
</tr>
</tbody>
</table>

Source: Adam & Lehmann 2011, modified

TL = 0,40 m  
(barbel, roach)

TL = 0,15 m  
(bleak)
Evaluating hydraulic conditions

Criteria / Requirements:

• Continuous migration corridor
• Connecting different migration corridors
• Flow velocities in the migration corridor at sustained speed
• Avoid areas with prolonged or burst speed
• Avoid backflow areas

\[ \text{TL} = 0.40 \text{ m} \]
(barbel, roach)

\[ \text{TL} = 0.15 \text{ m} \]
(bleak)
Typ A

High design flow

\( Q_{\text{Turb}} = 80 \text{ m}^3/\text{s} \)

\( Q_{FW,\text{total}} = 2.1 \text{ m}^3/\text{s} \)
Typ B1

High design flow

\[ Q_{Turb} = 80 \text{ m}^3/\text{s} \]

\[ Q_{FW,total} = 1.9 \text{ m}^3/\text{s} \]
Typ B2

High design flow

\[ Q_{\text{Turb}} = 80 \text{ m}^3/\text{s} \]

\[ Q_{\text{FW, total}} = 3.9 \text{ m}^3/\text{s} \]
Typ C

High design flow

\[Q_{\text{Turb}} = 80 \text{ m}^3/\text{s}\]

\[Q_{\text{FW,total}} = 3.9 \text{ m}^3/\text{s}\]
Conclusions

Typ A:
• hydraulic migration corridor is existing for all studied conditions
• extends until the end of the ramp
• velocities are high at the entrance but still at a feasible level

Typ B1:
• hydraulic migration corridor is short at the surface
• hydraulic corridor at the bottom is disconnected
• surface velocities are high at the entrance and low at the bottom
• backflow area

Typ B2:
• hydraulic migration corridor is existing for all studied conditions
• velocities are in a suitable range
• necessary discharge is comparatively high

Typ C:
• hydraulic migration corridor is existing for all studied conditions
• velocities are in a suitable range
• limited connection between lateral and vertical corridor
• necessary discharge is comparatively high
Summary/Outlook

• Different entrance designs comply with the regulations

• Comparison/evaluation of the hydraulic conditions

• Optimize the tested entrance designs

• Further design suggestions being used have to be tested

• We have to ask the fish! Biological Monitoring is essential:
  Large role in our R&D Program for the next years at different pilot facilities (PIT-Tags, Telemetry, DIDSON, etc.)
Thank you for your attention!

This presentation was made possible by the Research and Development program

*Ecological continuity in German Waterways*