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Case Studies II: Fish Migration Restoration at the Gabčíkovo Dam: A Prefeasibility Study

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Fish migration restoration at the Gabčíkovo Dam – A prefeasibility study

Fish Passage Conference 21-06-2016 Amherst
Wilco de Bruijne – LINKit Consult
Presentation outline

1. Project
2. Background
3. Scheme layout Gabčíkovo dam
4. Fish migration in the Danube
5. Species specific design criteria
6. Conclusions
7. Potential measures for upstream migration
8. How to proceed?
1. Project

- Consortium of partners, experienced in fish migration projects in the Rivers Danube, Rhine and Meuse.
- Project funded by the EIB.
- Supported and encouraged by the ICPDR, IAD, WSCS and WWF.
1. Project

• Objectives:
  – Progress investigation to restore fish migration at the Gabčíkovo dam.
  – Extend the opportunities for fish species, including sturgeon, to migrate further upstream in main Danube and tributaries.

• Activities included:
  – Site visit & data collection
  – Literature study (sturgeon) fishway design criteria
  – Meeting with local stakeholders & international experts.
  – Potential solutions analysis incl. preliminary designs of fishways.
2. Background
2. Background

(figure adapted from Schiemer et al, 2003)
3. Scheme lay out Gabčíkovo dam

- Multi-annual flow (1840-2006) ca. 5,000 m³/s.
- Flow can vary from ca. 900 m³/s (1985) to ca. 15,000 m³/s (2006).
- Discharge divided between headrace canal & old Danube.

(background figure: google earth)
3. Scheme lay out: HPP

- Head drop 16.0-23.3m
- Seepage canal
- Low upstream waterlevel fluctuation; regulated flow.
- 8 Kaplan turbines x 92 MW (720 MW total).
3. Scheme lay out: Dunakility Weir

- Weir and rock ramp
- Regulates water level old Danube.
- 4-5m head drop.
3. Scheme lay out diversion dam

- Head drop 7-8m
- Weir, HPP, spilgate, white water ramp, weirs.
- Complex hydraulic regime.
- 4 turbines (24.3 MW total).
## 4. Fish migration in the Danube

<table>
<thead>
<tr>
<th>Long distance migrants</th>
<th>Medium distance migrants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acipenser gueldenstaedti (Russian sturgeon)</td>
<td>Abramis brama (common bream)</td>
</tr>
<tr>
<td>Acipenser nudiventris (ship sturgeon)</td>
<td>Abramis sapa (danubian bream)</td>
</tr>
<tr>
<td>Acipenser stellatus (stellate sturgeon)</td>
<td>Acipenser ruthenus (Sterlet)</td>
</tr>
<tr>
<td>Acipenser sturio (Atlantic sturgeon)</td>
<td>Aspius aspius (asp)</td>
</tr>
<tr>
<td>Huso huso (beluga or great sturgeon)</td>
<td>Barbus barbus (barbel)</td>
</tr>
<tr>
<td></td>
<td>Chondrostoma nasus (nase)</td>
</tr>
<tr>
<td>Alosa caspia (caspian shad)</td>
<td>Hucho hucho (danube salmon)</td>
</tr>
<tr>
<td>Alosa immaculate (pontic shad)</td>
<td>Lota lota (burbot)</td>
</tr>
<tr>
<td></td>
<td>Vimba vimba (vimba)</td>
</tr>
</tbody>
</table>

*Migratory species (Adapted from Schmutz & Trautwein, 2009)*
5. Specie specific design criteria

- Geometry
- Hydraulics
- Operation time

\[ s_{\text{min}} = 3 \times W_{\text{Fisch}} \]
5. Specie specific criteria - Sturgeons

- Very little known on Danube sturgeons, Russian studies used as reference (Volgograd river, Pavlov et al. 2012).
- Bottom dwellers, migration patterns along the shores in deep parts.
- Nocturnal behaviour.

Building code for i.e. Fishways – State building committee of the USSR (1989):

- Flow velocity characteristics for Acipenseridae:
  - $V_{\text{threshold}} = 0.15 - 0.20 \text{ m/s}$
  - $V_{\text{attraction}} = 0.70 - 1.20 \text{ m/s}$
  - $V_{\text{drift adults}} = 0.90 - 1.40 \text{ m/s}$
  - $V_{\text{drift juveniles}} = 0.15 - 0.20 \text{ m/s}$

(From: Pavlov et al. 2012).
7. Conclusions – literature review

• Good info on migration periods, fishways operation time and species characteristics for most present fish species, limited for sturgeon.

• State-of-the-art designs and criteria available for various types of upstream fishways for most migratory species.

• No standard upstream fishways for Sturgeon, limited design criteria available for Sturgeon from literature & telemetry study. Uncertainties:
  – Entrance location and depth
  – Passability criteria (V, Q, depth, etc.)
  – Attraction flow (V, Q, direction)
7. Conclusions potential measures

- Multiple restoration measures needed at different locations;
- Based on site-specific conditions and current understanding the most adequate and feasible fish pass solutions for upstream migration are:
  - Convey fish into the Old Danube from below Gabčíkovo Hydropower Plant;
  - Allow natural upstream migration of fish along the Old Danube until Dunakility Weir (~20 km);
  - Enable migration of fish at Dunakility Weir;
  - Allow further natural upstream migration along the Old Danube until Čunovo Dam (~10 km);
  - Restore passage for fish at Čunovo Dam.
7. Conclusions potential measures
8. Potential measures - main dam
8. Potential measures – Dunakility weir
8. Potential measures – diversion dam
9. How to proceed?

• Modification of existing structures (e.g. ship locks) as a potential initial effort and “quick win”;
• Staged design approach, for example by using interim and/or mobile entrance dummies;
• Complex local situation on border;
• Ownership needed;
• Report adopted by ICPDR;
• Things are moving, hopefully the sturgeons soon too....
Questions?

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Photo: Radu Suciu DDNI Romania