Natural Fish passage work completed by the EIFAC Working Party on Fish Passage Best Practices

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Improving morphology and fish passage in high energy rivers

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EIFAC Working Party on Fish Passage Best Practices

Convener: Andrea s Zitek (AU), secretary: Gerd Marmulla, (FAO)
35 experts, Greg Armstrong (UK), Michel Lariniér (F), H -J.Gebler (D)

Overall tasks

- Produce Best Practice Guides on upstream and downstream fish passage needs and facilities
- Define common methodologies and best practices for assessing fish pass efficiency
- Identify knowledge deficits, both for different species and geographic regions
- Disseminate information through new publications
- Elaborate a common terminology of fish passage facilities throughout Europe

Priority tasks

- Define design criteria for different types of fish passes in relation to fish species and
- river zones
- Redefine the meaning of “natural fish passes”
- Address the aspects of downstream migration (best practice; R&D needs), particularly
- for eel

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What are nature-like fish passes?

- Structures which mimick the slope, morphology and hydraulic conditions of the stream
- Enable fish of different species and stages to move and migrate – but also:
- Provide suitable habitats for organisms of the river system
- Design is based on natural materials

Under discussion:

- Velocities, turbulence and slopes are higher than in the stream itself, so the fish pass can resemble the next smallest category of river of the biocoenotic region
- Are gentle sloped bypass channels (< 0,5%), typical for low land rivers and suitable for habitats, included?

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Guidelines for the design and building of nature-like fish passes

Definitions

- According to location:
  - Full width facility (submerged weir)
  - Partial width facility (ramp)
  - On one bank (bypass channel)

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Definitions

- According to ways of dissipating energy:

  -uniform structure (rock ramps,rough ramps)

  -dispersed structure (regularily distributed boulders)

  -pool structure (boulders bars, cascade construction)

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Design philosophy

- Bioceonotic region (fish zone), from epirithron to hypo-potamon and on species living in this zone (Austria, Germany)
- Size, swimming performance and behaviour of target species (France)

Discussion

- Approach depends on existing legislation
- WFD should help to brigdge the differences

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Swimming capabilities

- Hydraulic and geometric of nature-like fish ways should be designed in accordance with the fish species concerned (like with other fish pass types)
- Relate fish length with

  - maximum cruising speed

  - maximum burst speed or maximum swimming speed

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Flow conditions and design parametres

- Depend on arrangement of blocks and the ways dissipating energy (rough ramps, regularly didstributed, pool type)

Rough ramp fish passes

- Fish must pass the bolders without resting
- Hydraulic characteristics: flow depth is low and velocity high, dependin on size of blocks and discharge
- Design criteria: maximum slope, max and min discharge which determine max velocity, min depth and max length of the ramps

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Distibuted boulders structure

- Requirements
- Resting area between bolders
- Possibility of crossing narrow spaces between bolders
- Geometrical dimensions
- Fish characterstics (minimum dimensions)
- Stability of the structure and flow pattern
- Hydraulic characteristics flow patterns and velocity field are very complex (3D field)
- Depend on dimensions, form and spacing of blocks, bottom roughness, slope and discharge
- Design criteria: max velocity, min depth, depending on slope and discharge

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Pool structure fish passes

- Requirements similar to technical pool fish passes
- Precence of resting areas, (max volumetric dissipated power)
- Possibility of fish crossing slots (new criteria: 3 x fish width)
- Geometrical dimensions (new criteria: 3 x fish length)
- Hydraulics: pool geometry, drop height, discharge
- Design criteria: max drop (velocity) between pools, minimum flow depth and max volumetric dissipated power

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Linkages of fish passes to different measures in HMWB's

Impact

- Loss of connectivity
  - fish, good/weak swimmers
  - invertebrates
- Loss of reproduction habitats
  - damming rapids to stagnant condition
  - dredged and filled channels
- Discharge patterns
  - regulation
  - dry old channels
  - fish pass flow summer/winter

Mitigation or compensation

- Fish passes
- **Nature-like bypass channels**
- **Constructing new compensative side channels**
  - spawning channels
  - rearing channels
  - restoration of dredged rapids
- Environmental flows
  - Minimum flows in hydropower permits
  - Requirements for migration and juvenile habitats

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Can we promote fulfilling the demand of WFD by constructing nature-like bypasses?

”…once all mitigation measures have been taken to ensure the best approximation to ecological continuum in particular with respect to migration of fauna and appropriate spawning and breeding grounds ”

Kaukas fish pass, R. Keravanjoki, Finland, with Brown trout juveniles

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Two approaches to connect the functions of migration and habitats

- Combination: designing the whole channel to a fish pass and for habitats

  Sagarsfors bypass, R.Siuntionjoki, Finland, with habitats

- Diversion in separate channels for migration and reproduction

  Ruppoldigen fish pass and reproduction channel, R.Aare, Switzerland

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Largest reproduction channel in Europe Rheinfelden near Basel

- Lenght h 900 m , width 60 m, 10-30 m3/s

Badische Zeitung

Sensation: Lachs wandert bis nach Rheinfelden

Rheinfelden spawning habitat April 2012 ,
opened in March

May 2012

Experince from Canada: Constructed spawning and rearing channels to increase reproduction

- **Weaver Creek**
  Spawning channel for Sockeye or Red salmon *Oncorhynchus nerka*
  - regulated discharge 0,43 m3/s, depth 0,24 m, gradient 0,065%
    length 2,8 km

  - maximazed area by meandering channel

  Results
  - incubating rates of eggs many fold compared to natural rivers
  - saved the declining stock
  - added value for cathes in the sea

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Canada: rearing channels

- **Seton river rearing channel**
- Originally spawning channel for Pink salmon

  Onchorhynchus gorbuscha
- 2003 complexing to become rearing channel for Chinook *Oncorhynchus tshawytscha* and Steelhead *Oncorhynchus mykiss ,*

  - discharge 1,12 m3/s, depth 0,38 m, gradient 0,1% to 0,7%, length 3,8 km

- **Results**
- Juvenile amounts of Pink exceeded the original reproduction
- Succeeded compensation to

  powerplant construction of

  British Columbia Hydro

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Canada: constructed side channels Chilliwack River

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Spawning and rearing channel for Atlantic salmon
- Dunglass side channel, Conon river, Scotland

- Gradient 0,33 %, minimum flow 0,5 m3/s, length 1 km
- Juvenile rates:

age 0+ 160 /100m2

age 1+ 70 /100 m2

Data and photo

Simon McKelvey

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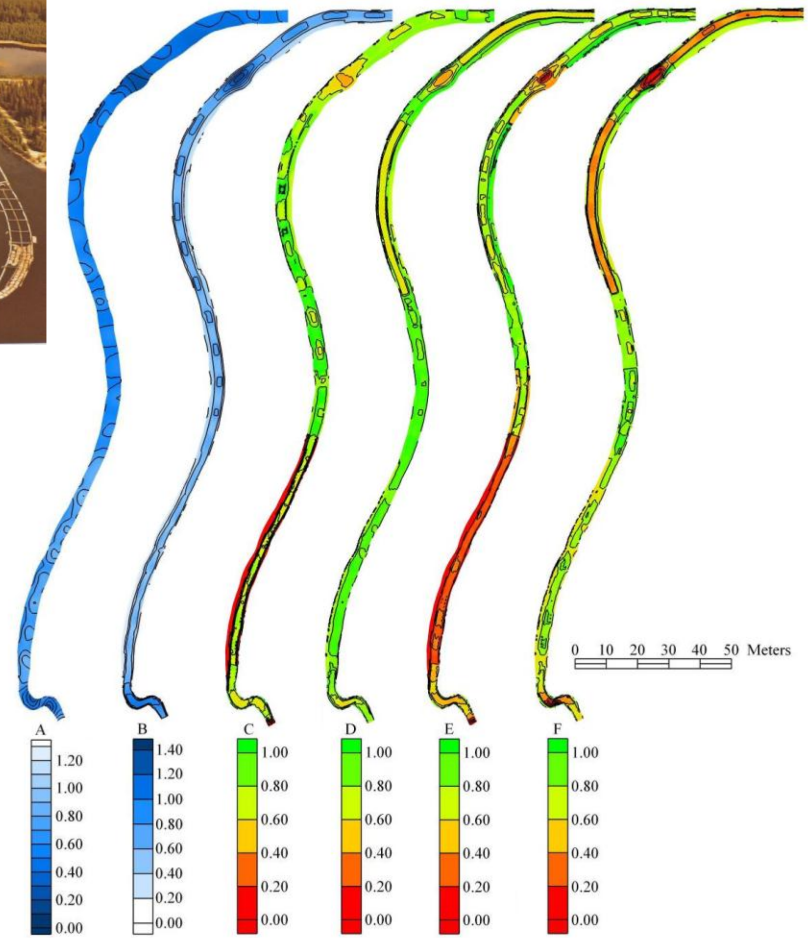
2 D flow and habitat modeling of a planned bypass channel Maximum habitat area and quality with limited discharges

Montta bypass plan

R.Oulujoki,

Finland

- A velocity
- B depth
- C Salmon spawning
- D Salmon rearing
- E Brown trout spawning
- F Brown trout rearing



Modeling: Simo Tammela 2008

Fish preference data based on research of Aki Mäki-Petäys and Pauliina Louhi

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Discussion and conclusions

- The EIFAC guidelines will mostly focus on migration
- WFD requires also mitigation of reproduction
- Advisable to connect reproduction areas with fish pass projects
- One channel saves water compared to separate channels

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