Applying environmental flow in hydropower rivers of Finland

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Finland – the land of waters:

- Landarea 338 424 km²
- 187 888 lakes (>0.05 ha)
  - Lake water bodies 4714
- 647 major rivers
  - River water bodies 2028

Hydropower
Current situation in hydropower rivers of Finland

- The majority of the minimum flows is discharging from the power plant to the main river channel.
  - Most of the minimum flows are constant throughout the year (45%) or are varying due to season (25%).

- 53 power plants have had zero flows during the last three years.
  - Majority zero flows weekly or monthly with an average length of less than 24 hours.
  - Main reason for zero flows is the normal operation of the plant.

- At least 7 power plants have sloping (more than one meter difference to next dam) on river stretch
  - Completely dry river stretch

- Need to apply environmental flow
Heavily modified small rivers with dry stretches - River Kuonanjoki

- Old river bed
- New channel
- Bottom weir
- HP plant and reservoir
- Regulation dam
Old natural river stretch

- length 6,8 km
  - Elevation difference 37 m
- Since 1970 until 2006 only some temporary discharges
  - Since 2006 1.6.-31.8. 100 l/s
- Rapids restored 2005-2006 after timber floating
- Natural grayling population, trout disappeared

- NEED FOR ENVIRONMENTAL FLOW
115 l/s

250 l/s

440 l/s
Final environmental flow plan 2017

Discharges to old river bed
- Winter (16.11.) 200 l/s.
- Spring at least 8 days more 5 m$^3$/s.
- After spring flood 350 l/s.

Costs
- Total hydropower loss 204 000 €, new regulation dam 35 000 €
- Agreement: Vattenfall ltd. 47,3 %, Haapajärvi city 14,6 %, Local environmental centre 38,1 %
Artificial small rivers and brooks with limited flow

Imatra city brook 2015, River Vuoksi

- Constructed channel with 300 /150 litres/sec (summer/winter)
- Touristic landscape (aspect of environmental flow)
- New spawning habitat for the brown trout of the main river
- Flow and habitat modeling were used in the planning to optimize habitat area and quality for trout juveniles.

Imatrankoski HPP is the largest facility in Finland

Built 1922-1929
Head 24 m
192 MW
1 000 GWh
Monitoring 2016-2022
KAS ely-centre, SYKE

- 10 species of natural fish
- High density of brown trout
- First summer juveniles 40 / 100 m²
- High survival rate, 75 % of first - second summer juveniles
- Production 5 times greater/area than in natural rivers
- Monitoring of benthic macroinvertebrates:
- Enough feeding habitats, fish in good condition
- Indices of macroinvertebrates: the brook is in good ecological state in 2-3 years
- Succeeded compensative habitat
Average brown trout density (individuals per 100m²) age groups 0, 1 and over 2 yrs in 2016-2021.

New electrofishing results from September 2022; will be the best year for brown trout juvenile density. Some sites over 250 individuals per 100m²
How to define e-flow

- Hydrological methods (Tennant) suitable only to evaluate large variations (near natural flow)
- Hydraulic methods (Wetted perimeter) fits to U-shaped rivers better than V-shaped
- Habitat modelling gives best results but is relatively expensive
- Building block methodology (holistic) most suitable, but results are dependent on available data
Conclusion to develop e-flow

- Regulation practices should be developed to match the annual operation schedule of hydropower and the natural migration cycles of fish.
- More flexibility in water permits (flexible compensation etc).
- Focus on most valuable sites and prioritization using cost-benefit analysis that incorporates ecological and societal benefits.
- Co-operation with different stakeholders using expert workshops and data-analysis.
- Water act should be changed:
  - to allow change old regulation permits.
  - possibilities to compensate harmful impacts also in other water courses instead of hydropower river.
Environmental or ecological or GEP-flow should be applied as part of programme of measures in river basin planning

Building block methodology is simple way to start

Eutrophication must be reduced at first stage to get good status of waters

And finally
Thank you!