Applying environmental flow in hydropower rivers of Finland

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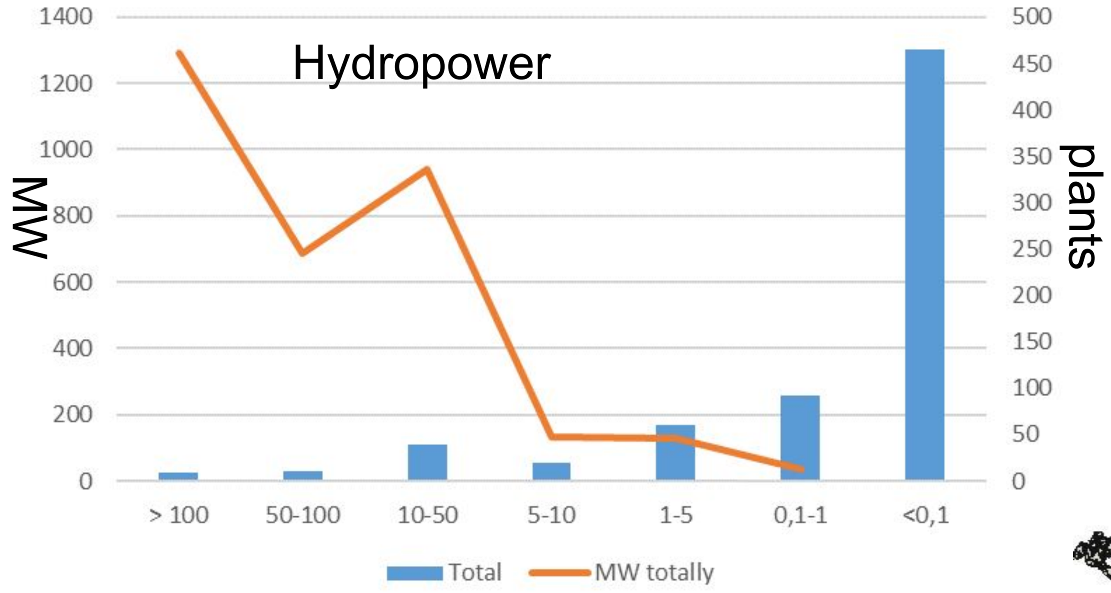
Europe-INBO 2022

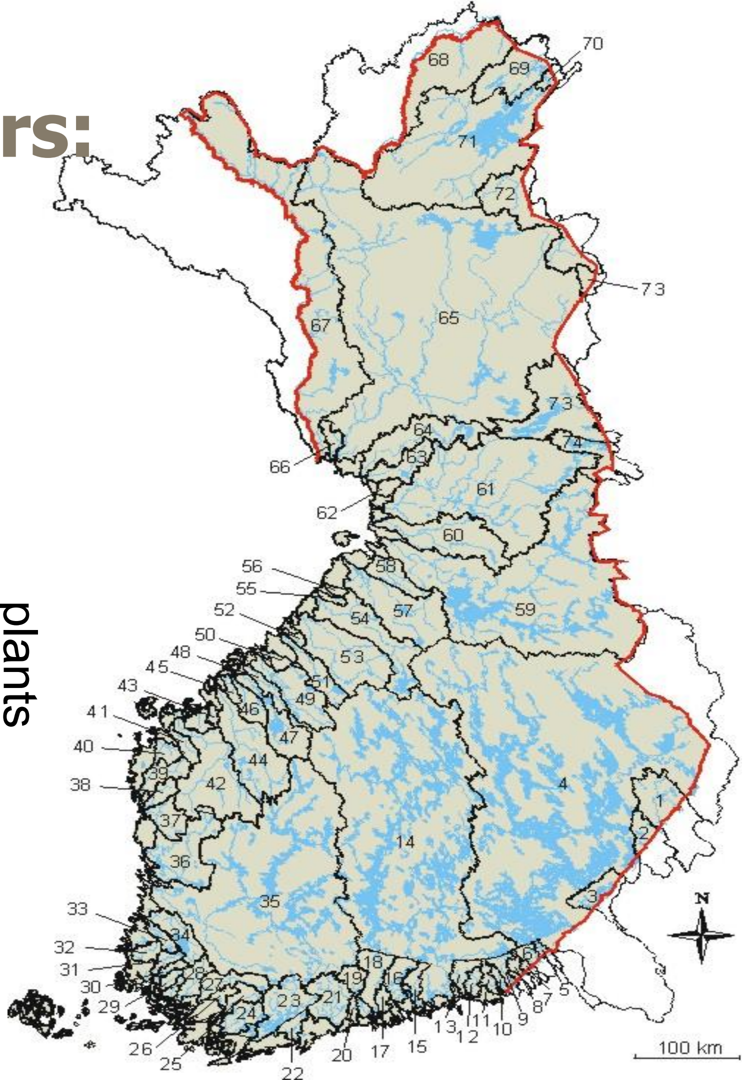
September 26th 2022 - September 29th 2022 - Annecy, France

SYKE

Finland – the land of waters:

- Landarea 338 424 km²
- 187 888 lakes (>0.05 ha)
  - Lake water bodies 4714

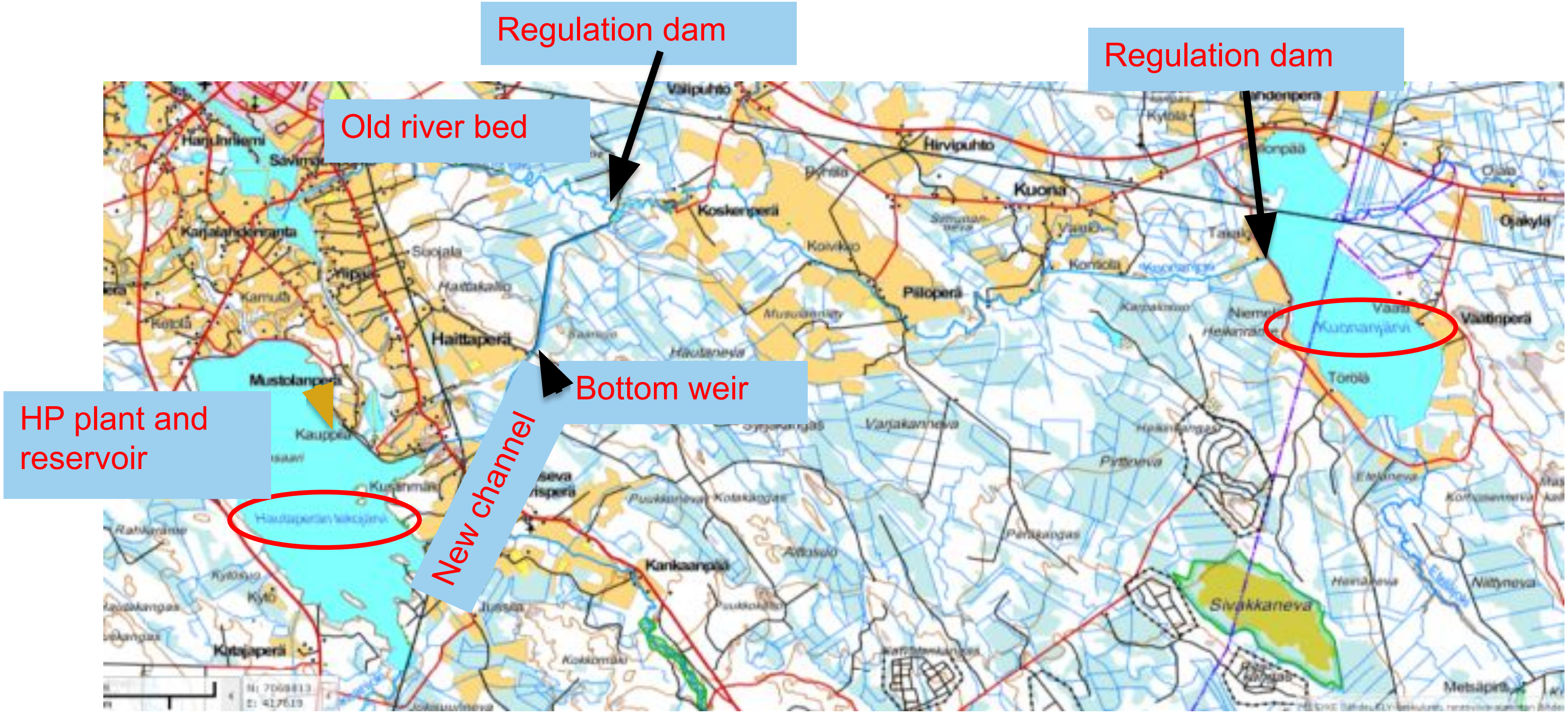




Current situation in hydropower rivers of Finland

- 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 natural river stretch

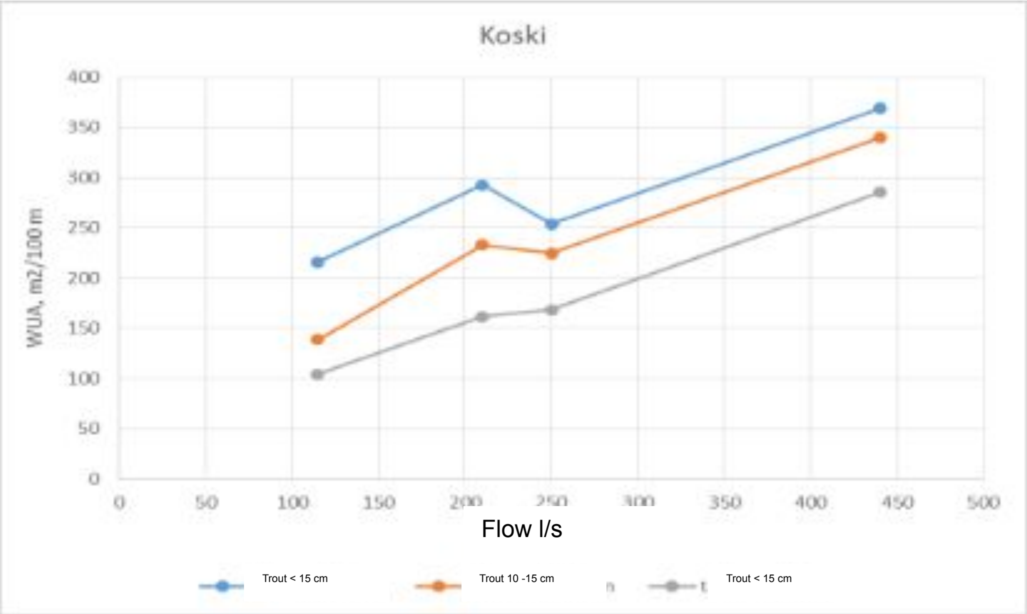
- length 6,8 km
  - Elevation difference 37 m
- Since 1970 until 2006 only some temporary discharges
  - Since 2006 1.6.-31.8. 100 l/s
- Rapids restored 2005-2006 after timber floating
- Natural grayling population, trout disappeared

- 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.

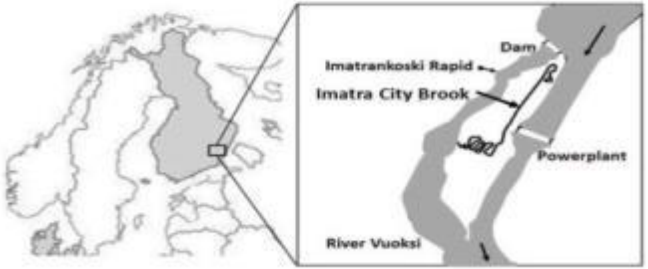
Costs

- 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

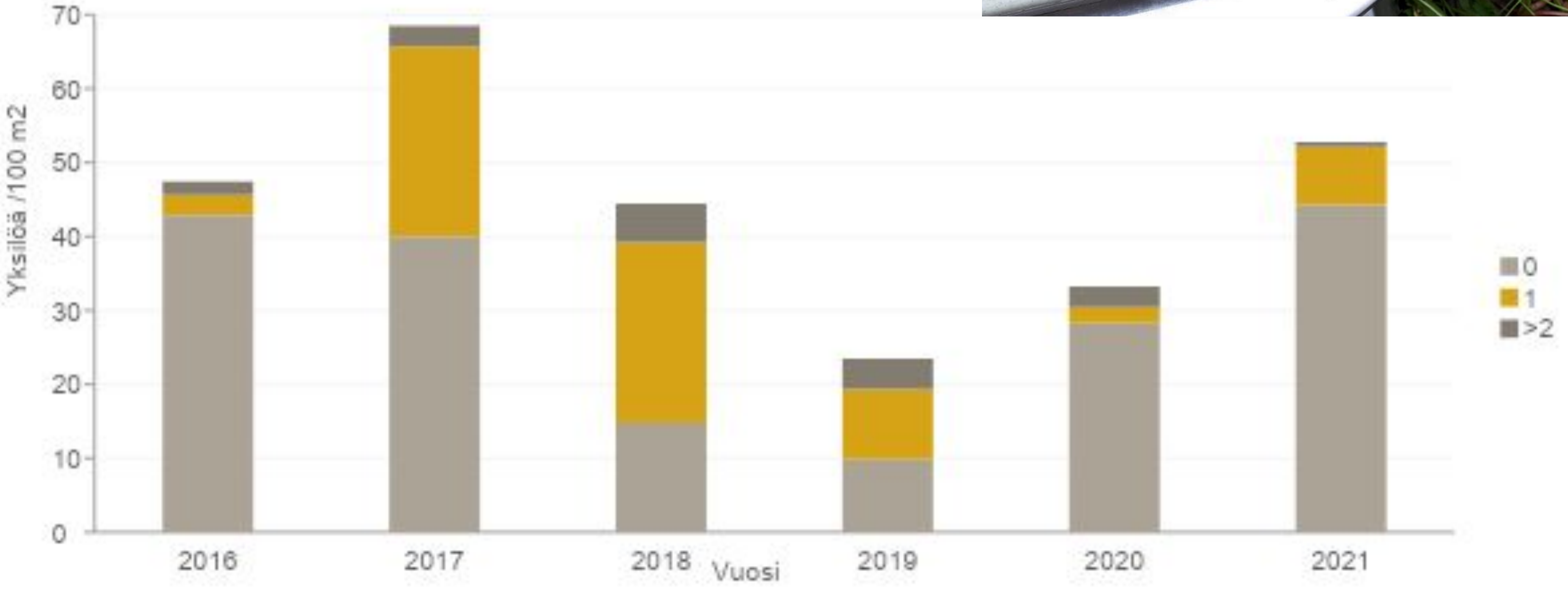
- 10 species of natural fish
- High density of brown trout
- First summer juveniles 40 / 100 m2
- High survival rate, 75 % of

  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

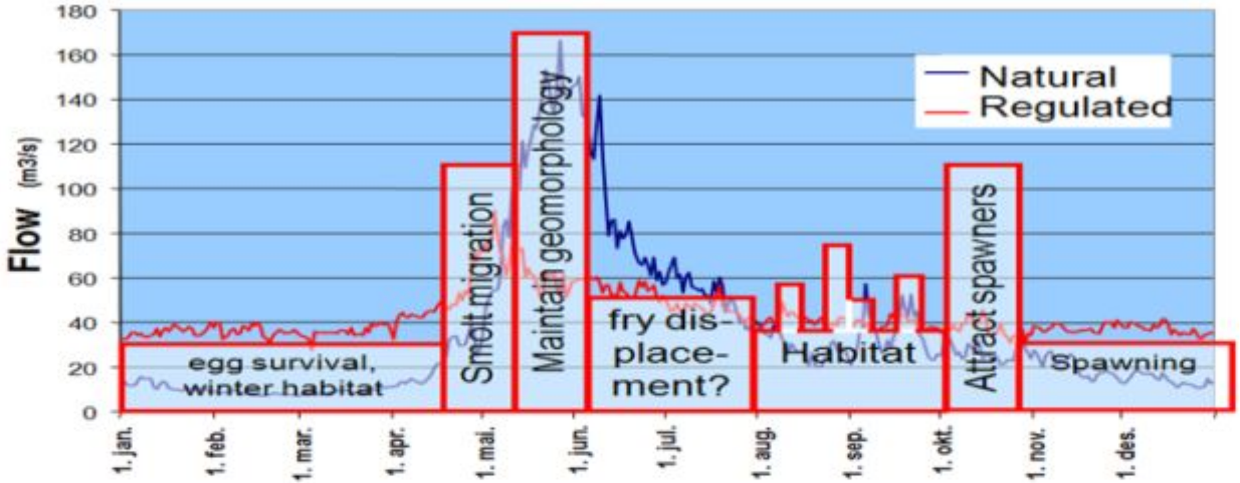
Average brown trout density (individuals per 100m^2) age groups 0, 1 and over 2 yrs in 2016-2021.

New electrofishing results from September 2022; will be the best year for brown trout juvenile density. Some sites over 250 individuals per 100m^2



How to define e-flow

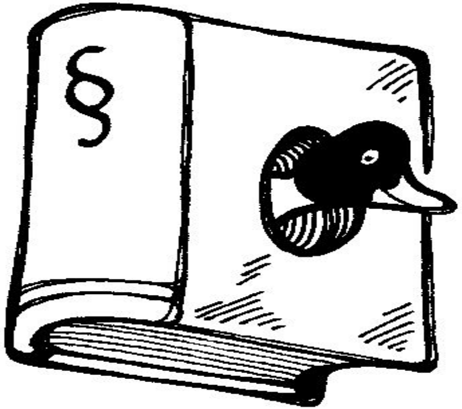
- Hydrological methods (Tennant) suitable only to evaluate large variations (near natural flow)
- Hydraulic methods (Wetted perimeter) fits to U-shaped rivers better than V-shaped
- Habitat modelling gives best results but is relatively expensive
- Building block methodology (holistic) most suitable,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



Conclusion to develop e-flow

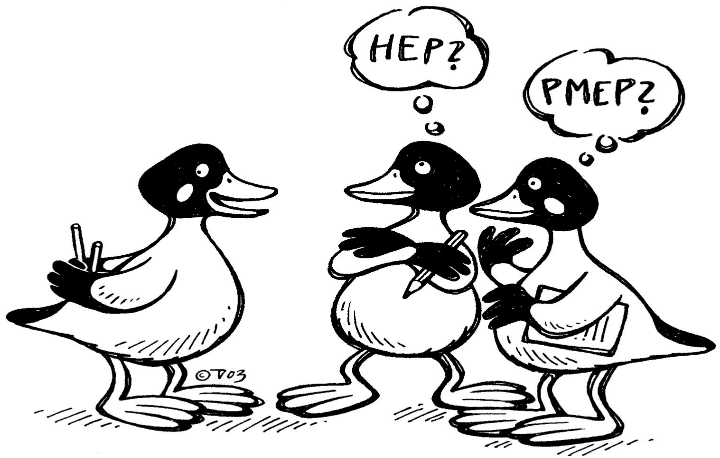
- Regulation practices should be developed to match the annual operation schedule of hydropower and the natural migration cycles of fish
- More flexibility in water permits (flexible compensation etc)
- Focus on most valuable sites and prioritization using cost-benefit analysis that incorporates ecological 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



And finally

- 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



Thank you!

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