Environmental flow prioritization in Finland– criteria and the prioritization method

Jarno Turunen, Senior researcher
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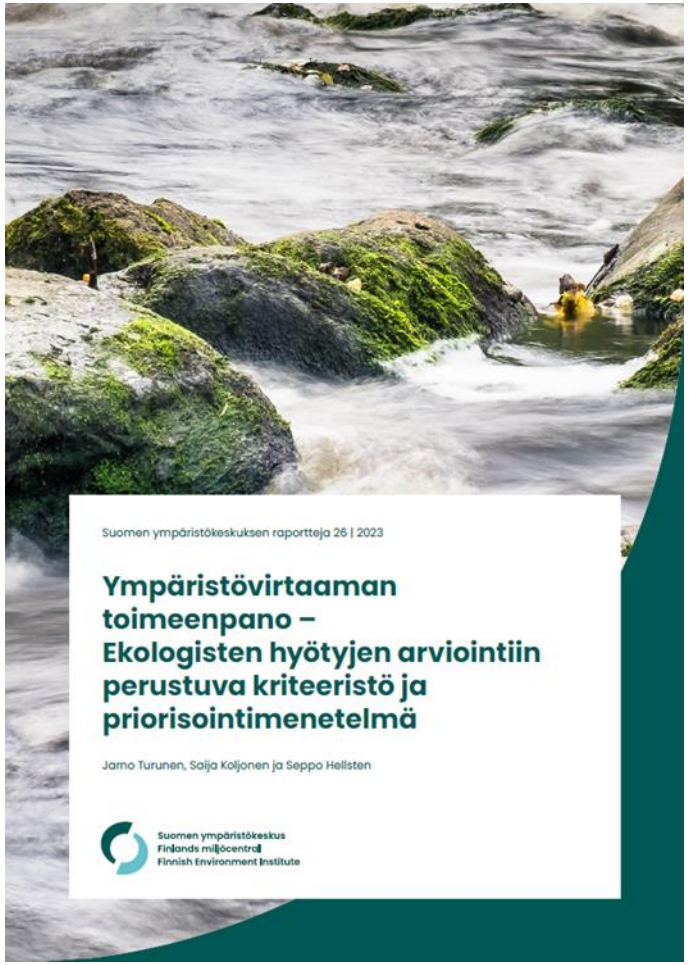
eFlow prioritization

- As a member state feedback from the second river basin management planning, European Commission has urged Finland to define and implement ecological and environmental flows in river basin districts
- However, there was no systematic assessment where environmental flow could yield the largest ecological benefits and where further work on the implementation should be conducted
- Environmental criteria and a prioritization method was developed as a guidance
- Prioritization was done for 219 hydroelectric powerplants in Finland (> 0.1 MW)
- Emphasis on benefits to migratory fish stocks/salmonids



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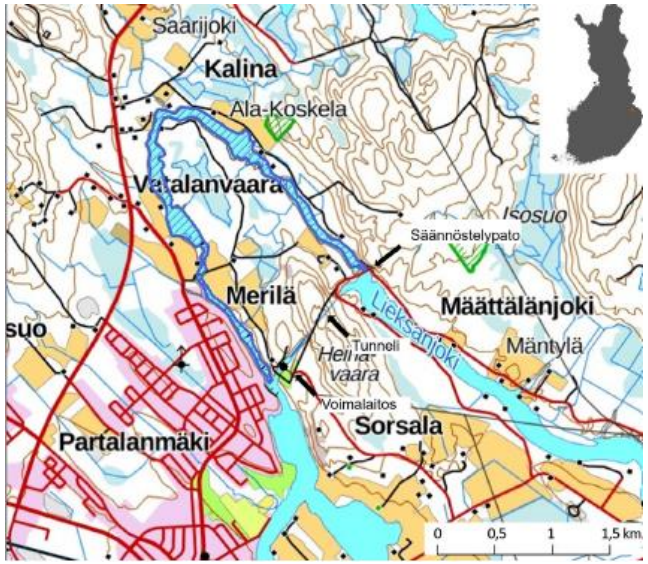
The approach

- Two different types of environmental flow application sites
  - Group A: Dry spillover/bypass channels that are used to release excess flows
  - Groub B: Natural river streches that are impacted by flow regulation
- Each of the assessed sites (219) were either classified in Group A or B based on expert judgement on where the measure could have the largests benefits (old dry river channel or the main river area)
- Partly different criteria that were assessed in each group
- Scoring system was used to give points (scale 0-4) from each criteria
- Simple sum of points was used to rank the hydropower stations → higher the points higher the priority

Group A



Group B

Selected criteria/metrics

Prioritization criteria	Spillover channels	Natural river streches
Potential spawning/juvenile habitat area	x	
Current flow release to spillover channel	x	
Occurence of endangered fish species	x	x
Connectivity to feeding migration areas	x	x
Water quality	X	x
Number/area of riffles and rapids		x
Current flow regulation rules in the permit		x

Potential spawning/juvenile habitat area in the spillover/dry channels

- For each site that had spillover channels the potential salmonid spawning/juvenile habitat was roughly estimated
- For example 5% of the mean annual flow of the river allocated to the channel
- Caissie's formula of wetted width $W = 9.7 * \sqrt{Q}$
- Rough heuristic formula for suitable juvenile habitat area. Area = 3.5*h*Q,
- Where h = fall height, Q = eflow
- Scoring
    - Area < 25 percentile of the data = 1 p.
    - 25% - Median = 2 p.
    - Median – 75 % = 3 p.
    - > 75 percentile = 4p.

Current flow release to spillover/dry channel

- How much water is currently released due to permit regulations
- The more released the less need for eFlow measures
- Scoring
  - > 5 % of the mean flow is released = 0 p.
  - 1-3 % of MQ released = 1 p.
  - < 1 % of MQ released = 3 p.
  - Zero continuos flow = 4 p.

Occurence of endangered fish species

- Currently or historically occured fish species
- National Red Book (IUCN) of fish species conservation status used in scoring
- Fish points summed for the occurence of each endangered species
- Scoring
  - 1-2 fish points = 1 p.
  - 3-4 fish points = 2 p.
  - 5-6 fish points = 3 p.
  - ≥7 fish points = 4 p.

Species	Status	Points
Anguilla anguilla	Critically endangered	3
Landlocked salmon (Salmo salar m. sebago)	Critically endangered	3
Salmo trutta (all forms)	Endangered	2
Coregonus lavaretus maraena	Endangered	2
Salmo salar	Vulnerable	1
Thymallus thymallus	Vulnerable	1
Coregonus lavaretus pallasi	Vulnerable	1
Lampetra fluviatilis	Vulnerable	1
Aspius aspius	Vulnerable	1

Connectivity to feeding areas

- Important especially for migratory fish
- If free access from the sea or large lakes (lake-migrating salmonid stocks) the site gets larger points
- Some ”penalty” if accessible only by fishways
- Some points given whether access or not as resident fish and other biota could benefit from the measure
- Scoring
    - Direct access from the feeding areas = 4 p.
    - Acces by fishways = 2 p.
    - No access currently = 1 p.

Water quality

- Poor water quality could limit the ecological benefits of flow measures
- Physico-chemical status used in scoring
- Scoring
  - Water quality high = 4 p.
  - Good = 3 p.
  - Moderate = 2 p.
  - Poor = 1 p.
  - Bad = 0 p.

Number/area of riffles and rapids

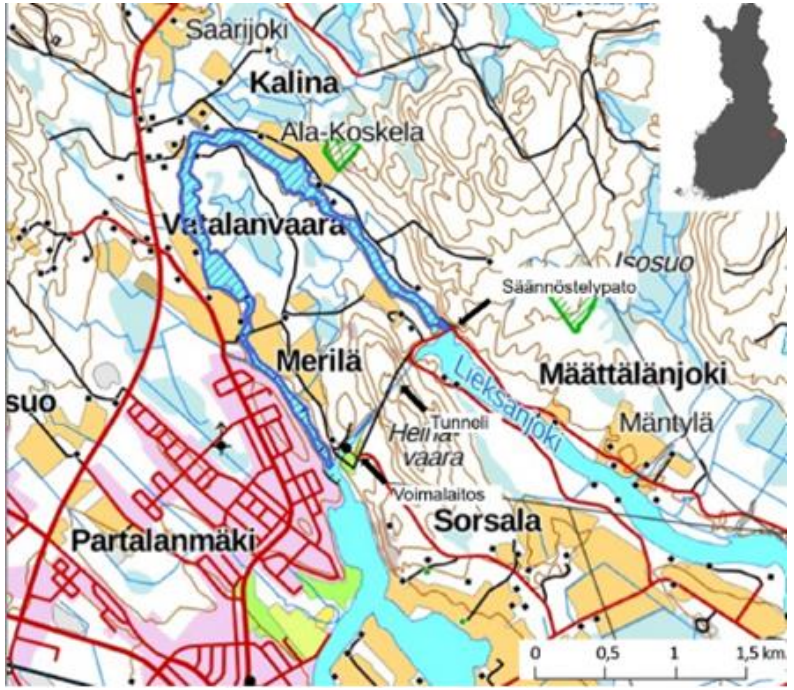
- Riffles are a key habitat feature of rivers as spawning and juvenile habitats of salmonids and other fish species
- High biological diveristy of benthic invertebrates
- The most sensitive habitats for flow variation
- We quantified the number of discrete riffle habitats that were below hydropower facilities and could be impacted by flow regulation (above confluences of major unregulated tributaries)
- Scoring
    - No riffles = 0 p.
    - 1-2 = 1 p.
    - 3-4 = 2 p.
    - 5-6 = 3 p.
    - ≥ 7 = 4 p.

Current flow regulation rules in the permit

- Especially the occurence of 0-flows and regulations in the permit related to allowance of 0-flows was screened
- Scoring
  - HP uses only small fraction of the flow = 1 p.
  - Regulation or agreement on the minimum flow = 2 p.
  - No regulations or agreement on minimum flow, 0-flows have not occured = 3 p.
  - No regulations or agreement on minimum flow, 0-flows occur = 4 p.

Case: River Lieksanjoki

- Drains from Russia (White Karelia) to Finland in Lake Pielinen in Northern Karelia
- Group A: eFlow target is the spillover/dry channel
- Habitat area top 75 % = 4 p.
- Current flow release < 1% of MQ = 3 p.
- Occurence of endangered species = 4 p.
- Direct connectivity to large lake where lake-migrating brown trout, salmon and white fish feed = 4 p.
- Water quality good = 3 p.
- Total score = 4+3+4+4+3 = 18 p (Ranks in top 5 of all the sites in group A)



Conlusions

- The method gives insights and aids in first-hand screening on of potential eflow application sites based on ecological potential in current conditions
- It prioritizes sites relative to each other in their potential to provide ecological benefits from eflow, but does not tell whether implementation of eflow is overall the best measure on the site
- Prioritization is only done at hydropower station scale → implementation of eflow in one site likely influences the use of other stations in the system
- Site-specific analysis of costs, technical restrictions and ecological benefits (e.g. hydraulic habitat modelling) is obviously needed to analyze the scale and feasibility of the measure

Thank you!

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