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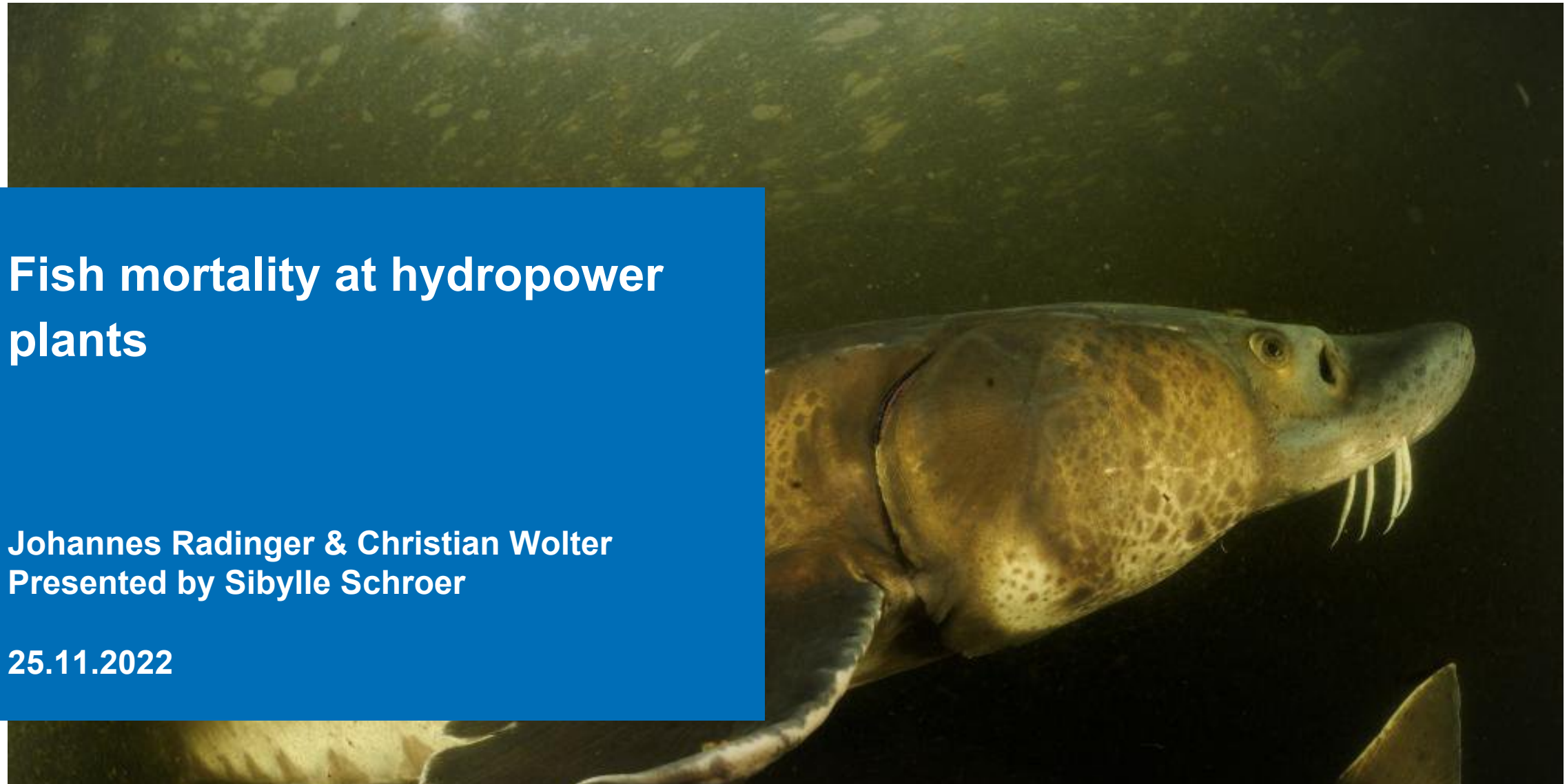

Fish mortality at hydropower plants

Johannes Radinger & Christian Wolter
Presented by Sibylle Schroer

25.11.2022

One in five fish (22.3 percent)
suffers fatal injuries
when passing through a hydropower turbines

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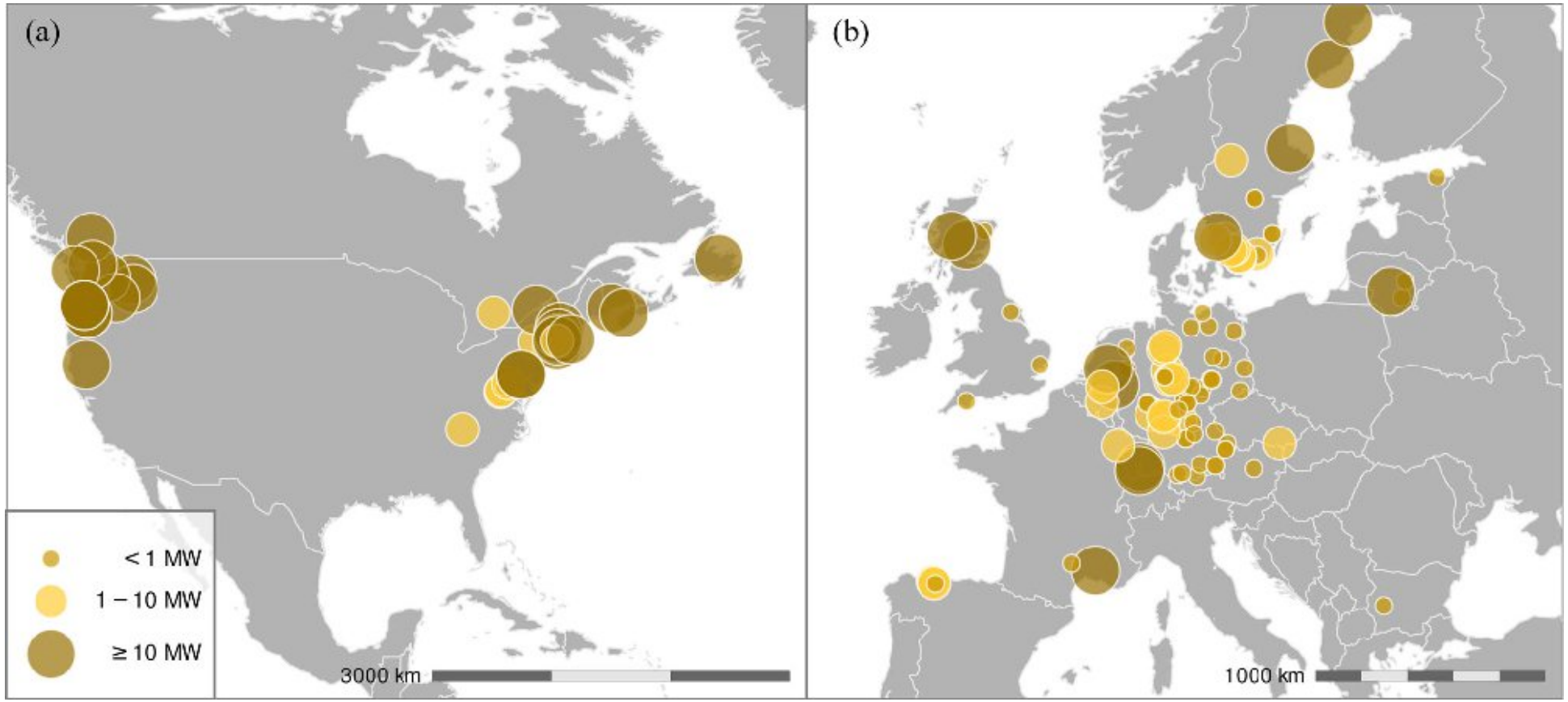
Method

Review of grey literature analysing fish mortality at turbines

1058 turbani-related mortality assessments, 249 experiments, 91 studies, 120 locations, 15 countries



Evident but context-dependent mortality of fish passing hydroelectric turbines

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Abstract

Globally, policies aiming for conservation of species, free-flowing rivers, and promotion of hydroelectricity as renewable energy and as a means to decarbonize energy systems generate trade-offs between protecting freshwater fauna and development of hydropower. Hydroelectric turbines put fish at risk of severe injury during passage. Therefore, comprehensive, reliable analyses of turbine-induced fish mortality are pivotal to support an informed debate on the sustainability of hydropower (i.e., how much a society is willing to pay in terms of costs incurred on rivers and their biota). We compiled and examined a comprehensive, global data set of turbine fish-mortality assessments involving >275,000 indi-

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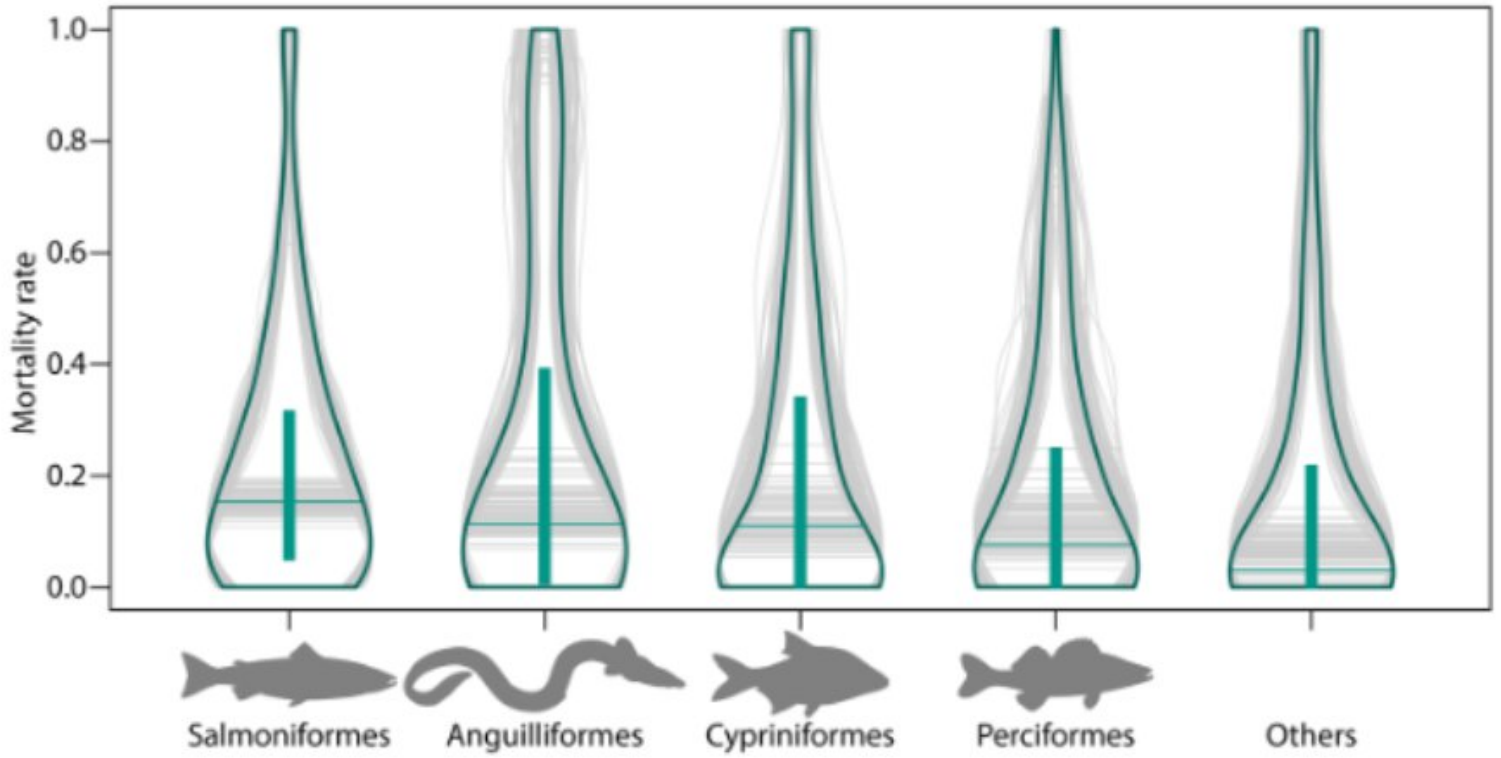
Observed fish mortality rates at hydroelectric turbines across orders



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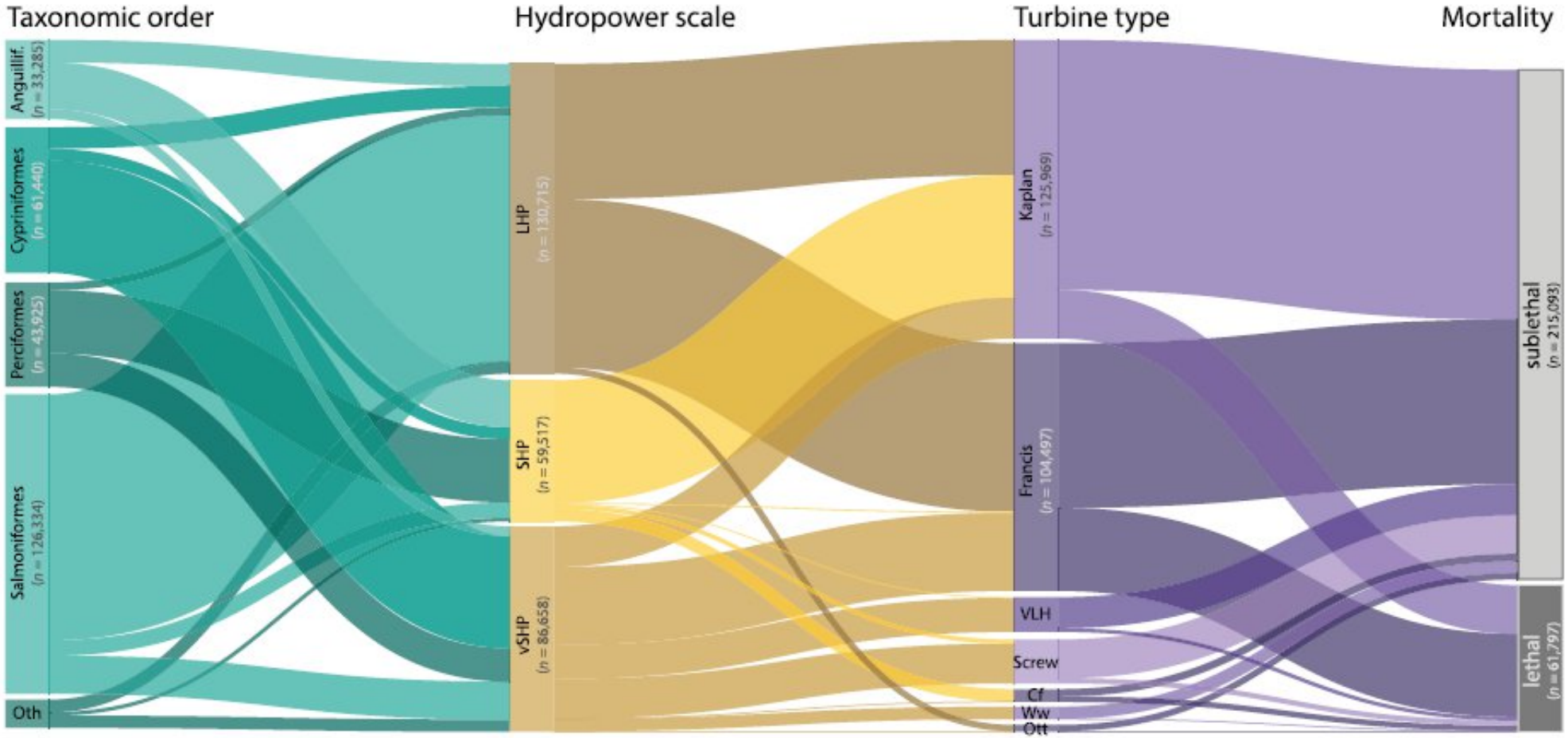
Relations among taxonomic order, hydropower scale, turbine type, and mortality in assessments of fish mortality in hydroelectric turbines



Radinger et al. (2022)

Hydropower plants (HPP) - Risk assessment for fish

Assessment of the constellation-specific risk

Space-related parameters

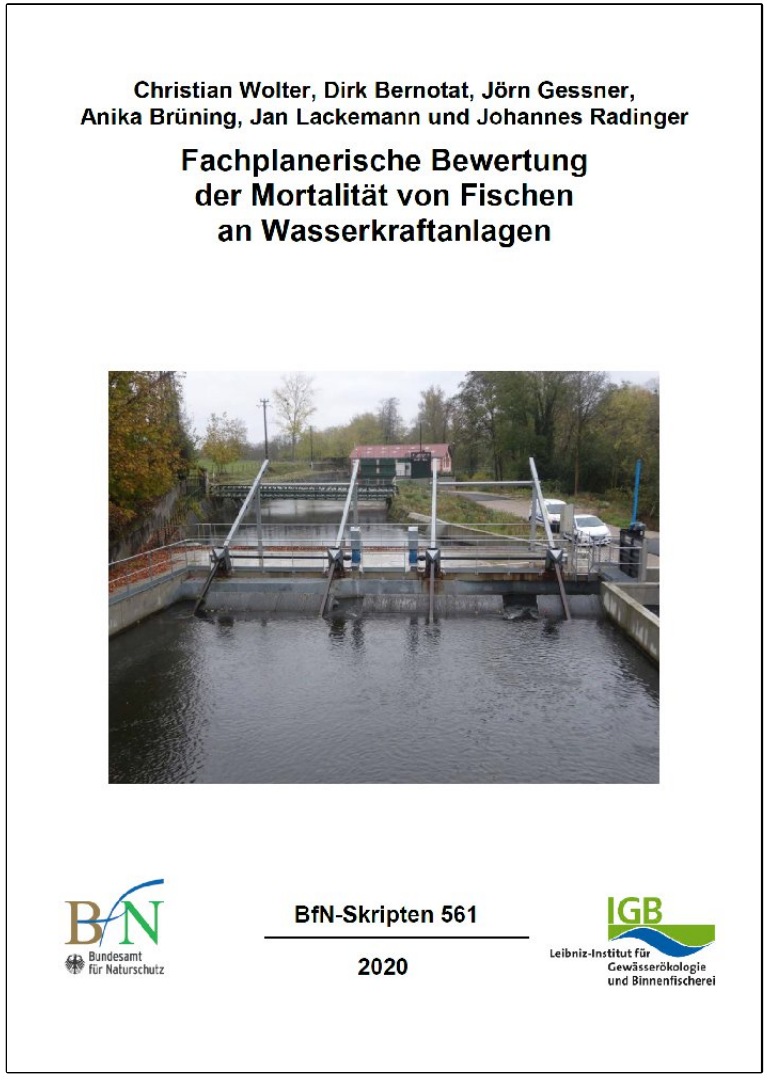
- Occurrence / distribution of species
- Water body size
- Ecological status
- Significance for nature conservation

Project associated parameters

- Engine type
- Technical parameters (turbine type, orbital velocity)
- Distance of the HPP in relation to the dispersal distance
- Number of HPPs in the catchment area

Measures for damage prevention / protective action

- Fine screen
- Bypass
- Fish-friendly plant operation



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Assessment population biology sensitivity index

Assessment index	Criteria	Parameter /indicator
Population Biology Sensitivity-Index	Mortality	Mortality rate old animals
		Maximum age
	Reproduction	Age of fertility
		Reproduction potential
		Reproduction rate
	Population size	National stock size
	Population development	National stock trend

Wolter et al. (2020)

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Stock assessment

Sources: FFH reporting data > Expert assessments/literature > Red List classifications.

Class	Stock in Germany (individuals)	Assessment
1	<100	very small stock
2	100-1,000	
3	1,000-10,000	
4	10,000-100,000	
5	100,000-1M	
6	1 – 10 M	
7	10 - 100 M	
8	100 – 1 Bn	
9	> 1 Bn	Very large stock

Wolter et al. (2020)

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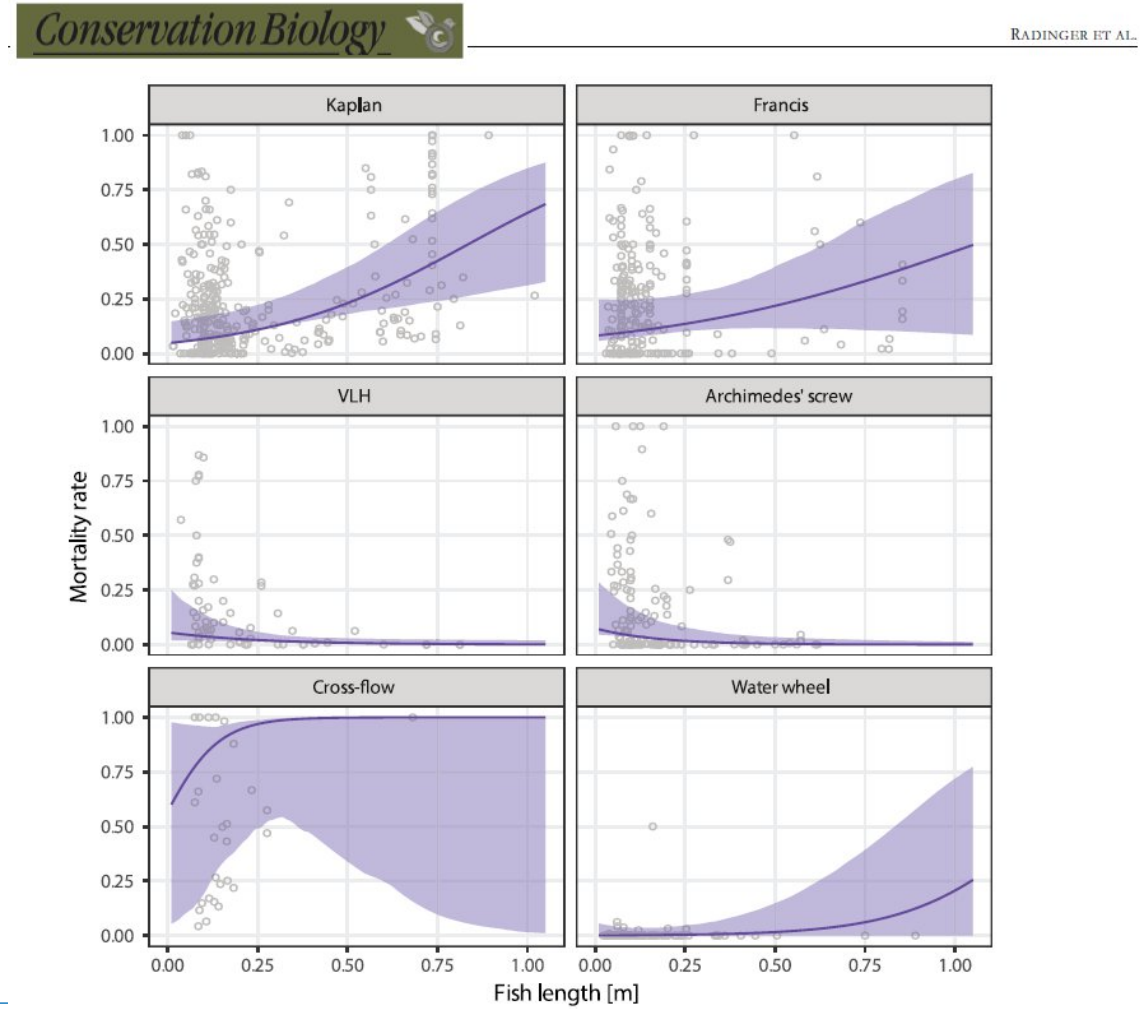
Technical parameters of turbines correlating with fish mortality

- Falling height (positive)
- Turbine speed or rotational speed at the outer or middle impeller diameter (positive)
- Number of impeller blades (positive)
- Distance between impeller blades (negative)
- Gap between impeller and impeller casing/grain
  - Kaplan, Archimedes' screw (positive) <2mm
  - Water wheel (negative)
- Operating mode of the turbine/s e.g. half load or full load (positive)
- Frequency of hydropower plants in the watercourse section (kumulative)

Wolter et al. (2020)

Relationship between fish length and mean mortality rate across the six main turbine types



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European Fish Hazard Index


Sustainable Energy Technologies and Assessments 43 (2021) 100903

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Original article

The European Fish Hazard Index – An assessment tool for screening hazard of hydropower plants for fish

Ruben van Treeck [a,*,1], Johannes Radinger [a], Richard A.A. Noble [b], Franz Geiger [c], Christian Wolter [a]

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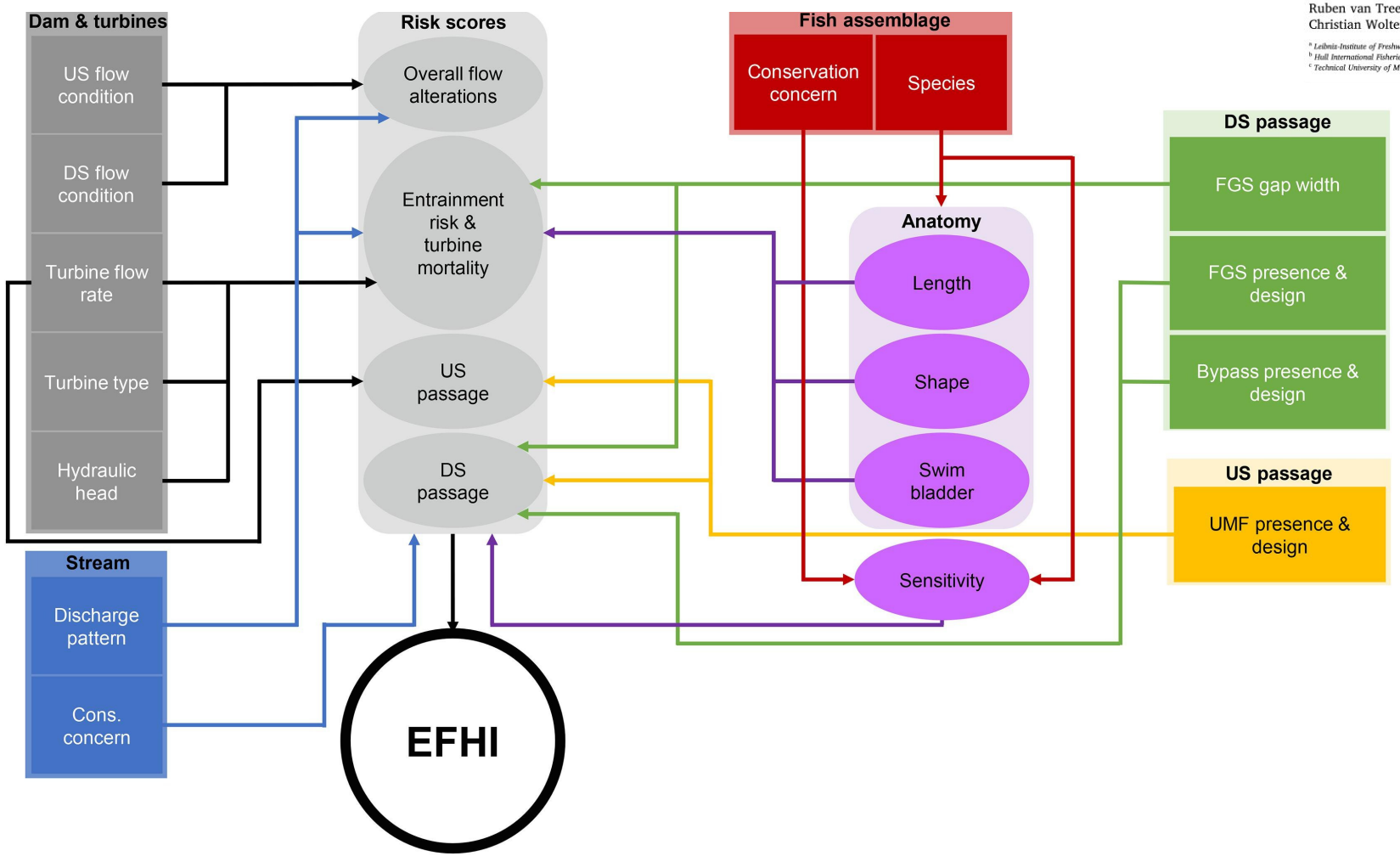

Van Treeck et al. (2021)

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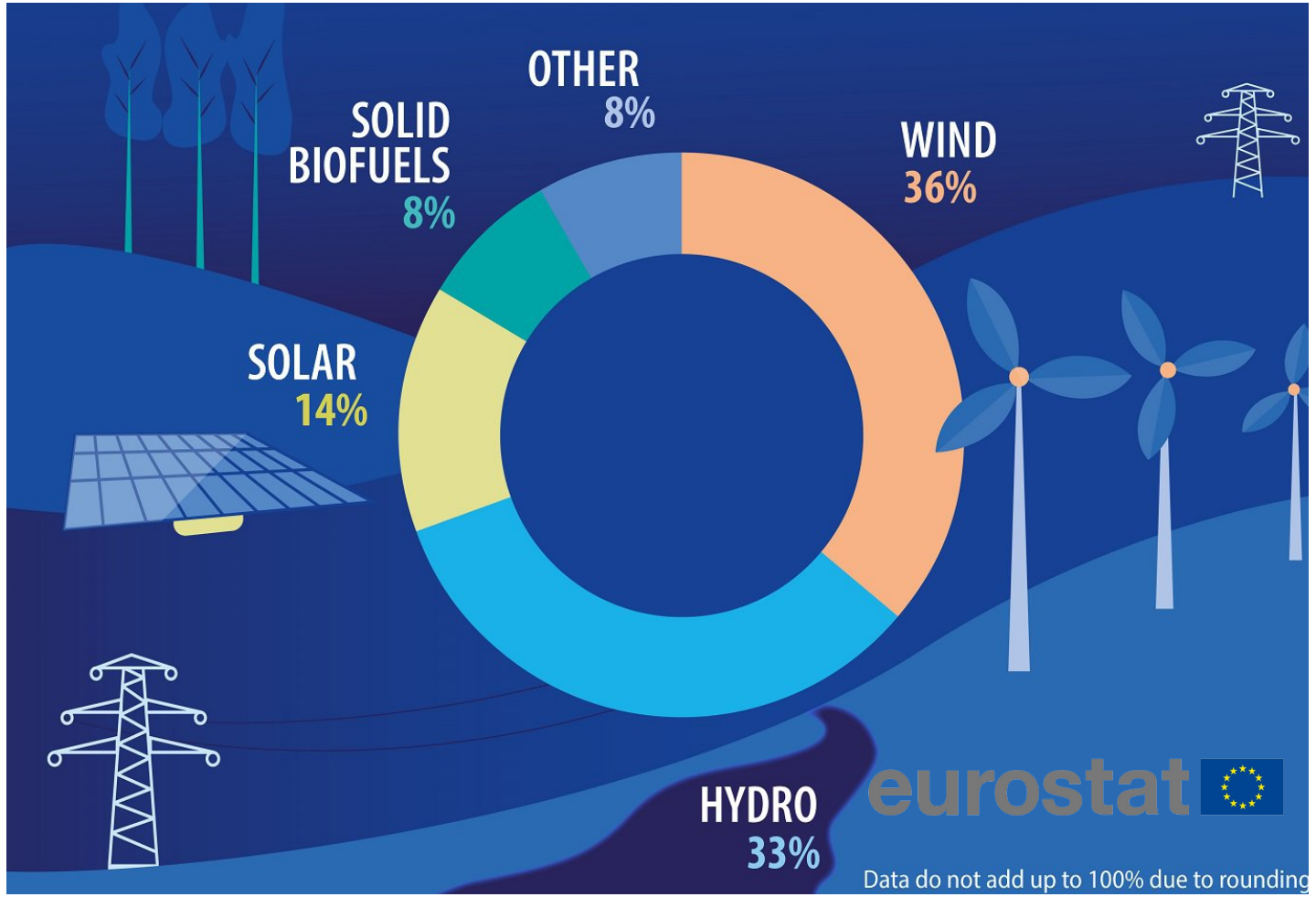
Share of hydropower on renewable energy sources in the EU

2020



In Europe, 21,000 hydropower plants are in operation, and 8,500 more are planned

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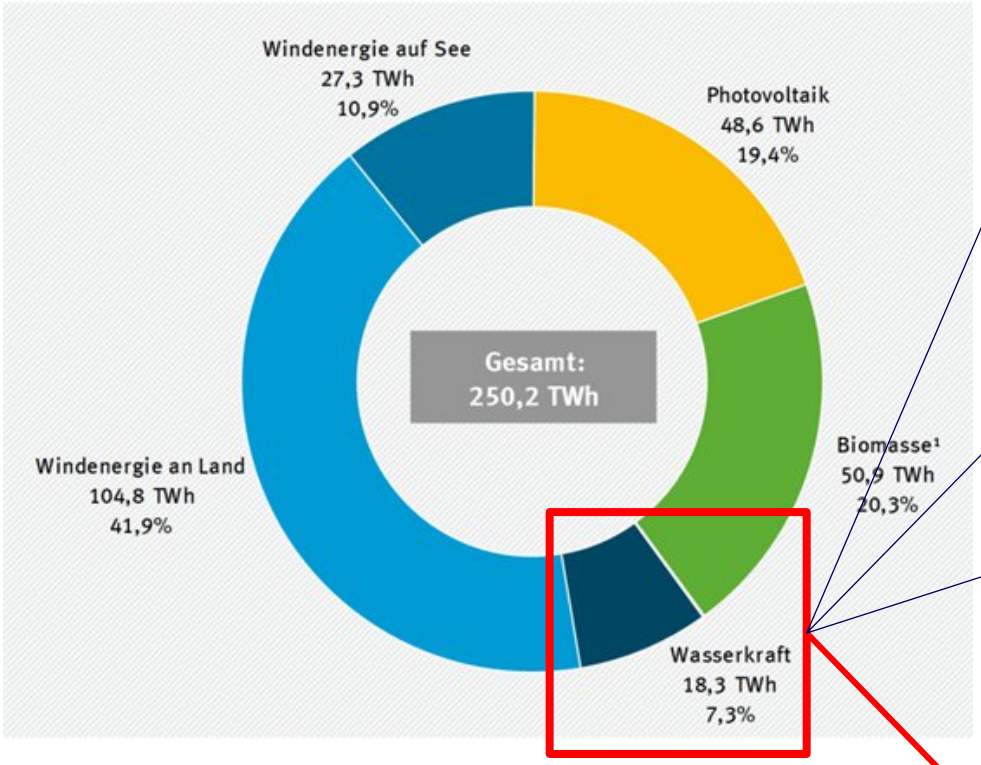
Share of hydropower on renewable energy sources in Germany

hydropower potential largely exhausted (P_{inst} >1 MW)



Amount of HPP in Germany:

7300 (BDW, Keuneke 2019)

7679 (BMU 2007)

8300 (UBA 2021)

86% produced by **436** HPPs with P_{inst} >1 MW

6900-7900 HPPs produce in total only 2.6 TWh (1%)

≈ 6900-7900 * 22.3% fish mortality /HPP

Federal Environmental Agency (UBA), AGEE Stat (2022)

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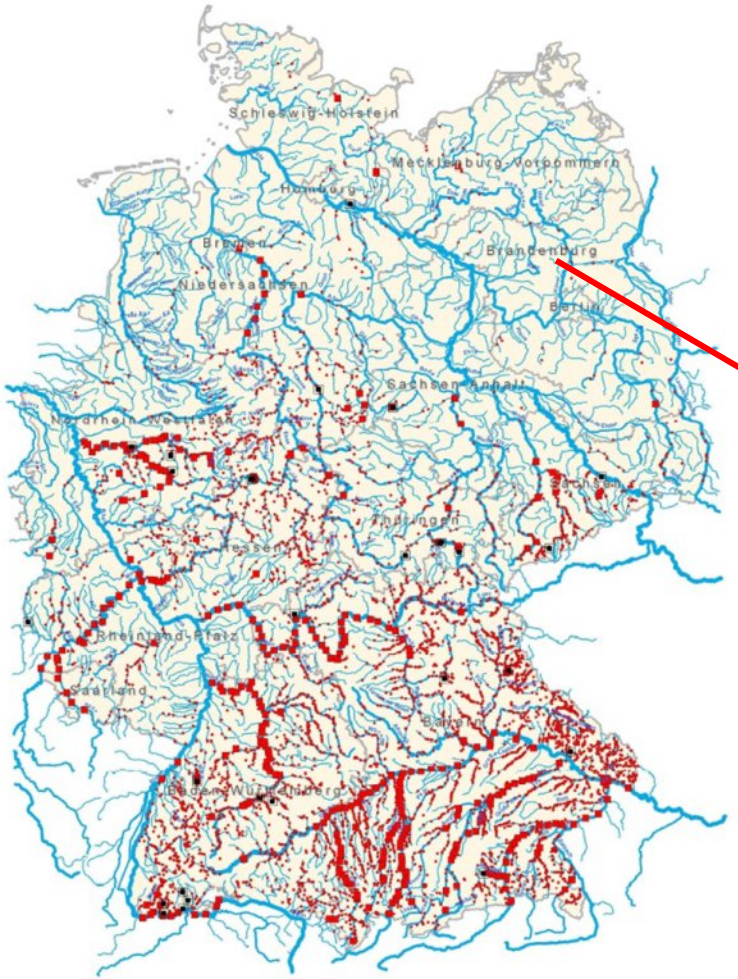
Hydropower plants in Brandenburg



HPP in Germany

137 sites with a total of 9.9 MW P_{inst}

Conclusions

- Hydropower is a solid renewable source and contributes to the energy transition

- In Germany **436 plants produce 86% of the electricity from hydropower**,
  - These are to be provided with state-of-the-art fish protection
  - The vast majority, **>6900 installations contribute with 1% to renewable electricity** production, but have equally high trade offs, missing the WFD targets.

- State-of-the-art fish protection is non-negotiable
  - bypass - fine screen - management (shutting down during the main fish migration period)
- Exemption test according to Art. 4 WFD mandatory for each HPP
- Create financial incentives for the replacement and dismantling of small hydropower plants.
- Permits should make 20% MQ (= non-turbineable) mandatory for fish and river ecology functionality

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Thank you very much for your attention!

If you have any questions, please contact:

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