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Surface bypass as a means to protect downstream-migrating fish – lack of standardized evaluation criteria complicates evaluation of efficacy

Elena-Maria Klopries
RWTH Aachen University, Pacific Northwest National Laboratory

Zhiqun (Daniel) Deng
Pacific Northwest National Laboratory

Theresa Ursula Lachmann
RWTH Aachen University

Holger Schüttrumpf
RWTH Aachen University

Bradly A. Trumbo
U.S. Army Corps of Engineers,

Surface bypass as a means of protecting downstream migrating fish

Elena-Maria Klopries[A,B], Zhiqun Daniel Deng[B,C], Theresa U. Lachmann[A], Holger Schüttrumpf[A], Bradly A. Trumbo[D]

[A] Institute of Hydraulic Engineering and Water Resources Management, RWTH Aachen University

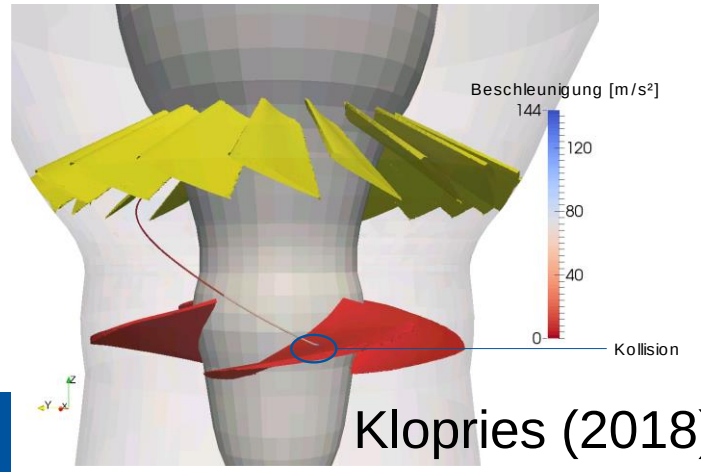
[B] Pacific Northwest National Laboratory, Energy and Environment Directorate

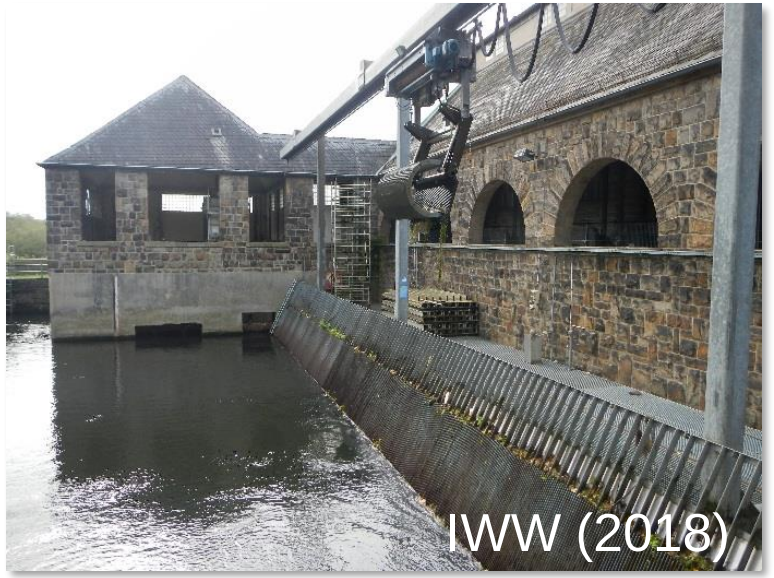
[C] Department of Mechanical Engineering, Virginia Tech

[D] US Army Corps of Engineers, Walla Walla District

Motivation


Hartl


Beschleunigung [m/s²]
144
120
80
40
0
Kollision
Klopries (2018)


IWW (2018)

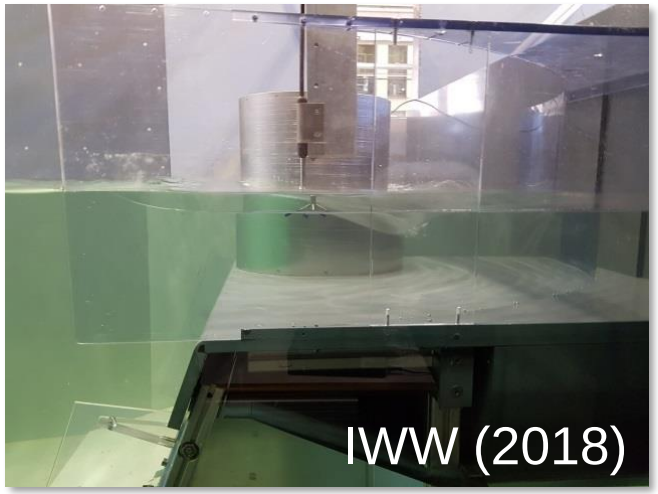

RWE Energie AG

Bypasses as a means of protecting downstream migrating fish

- Types of bypasses: submerged ↔ surface
- Surface bypasses: especially advantageous for salmonids

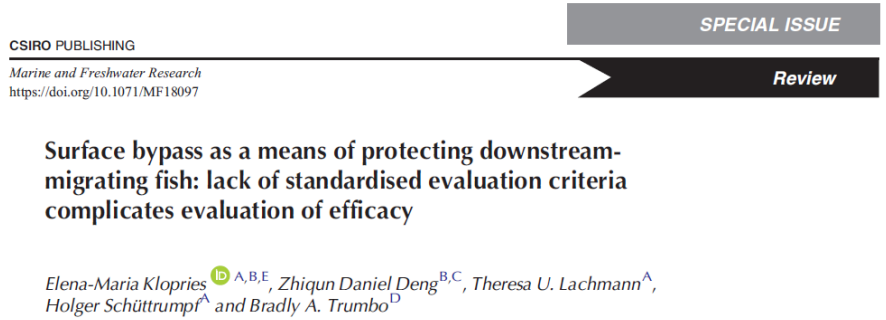
→ Are they feasible for other species?

→ Which parameters are responsible for a good performance?



Bypass performance

- Literature study
  - 50 papers, reports and books from North America, Europe and Australia
  - Species studied:
    - Atlantic salmon
    - Pacific salmon
    - Brown trout
    - Steelhead
    - Eels
  - 148 datasets containing study year, species, bypass type, bypass dimension, guiding structures, behavioural guiding measures, trash-rack spacing, bypass efficiency, …
  - Supplementary material available with all datasets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SPECIAL ISSUE

Marine and Freshwater Research
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Review

Surface bypass as a means of protecting downstream-migrating fish: lack of standardised evaluation criteria complicates evaluation of efficacy

Elena-Maria Klopries[A,B,E], *Zhiqun Daniel Deng*[B,C], *Theresa U. Lachmann*[A], *Holger Schüttrumpf*[A] *and Bradly A. Trumbo*[D]

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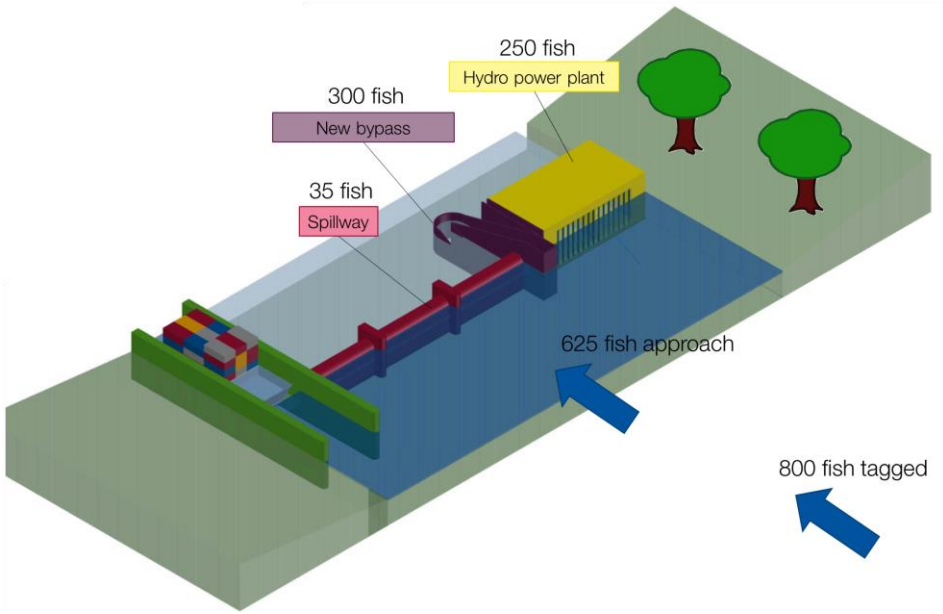
Bypass performance

- When is a bypass working well?

- Efficiency: how many fish pass through a bypass?
  → percentage of fish
  → what is the right basic population?



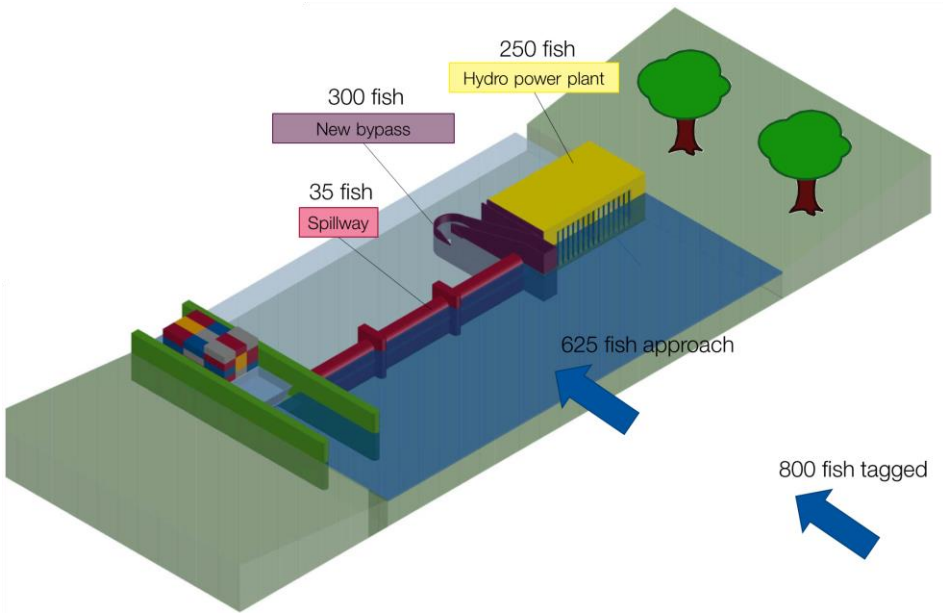
Case study:

- New bypass: 300 fish
- Turbine. 250 fish
- Spillway: 35 fish
- Fish tagged for study: 800 fish
- Fish that approached dam: 625 fish

Bypass performance

- When is a bypass working well?

- Efficiency: how many fish pass through a bypass?
  → percentage of fish
  → what is the right basic population?



Case study:

- New bypass: 300 fish
- Turbine. 250 fish
- Spillway: 35 fish
- Fish tagged for study: 800 fish
- Fish that approached dam: 625 fish

Definition 1 (passed dam):	300/585 = 51.3 %
Definition 2 (approached HPP):	300/625 = 48.0 %
Definition 3 (bypass + turbine) :	300/550 = 54,5 %
Definition 4 (tagged):	300/800 = 37,5 %

Bypass performance

- Bypass 1
- Efficiency: 50 %

- Bypass 2
- Efficiency: 40 %

→ Which one is better?

- Bypass inflow: 50 %

- Bypass inflow: 10 %

- Effectiveness: 1

- Effectiveness: 4

$$\text{effectiveness} = \frac{\text{efficiency}}{\text{proportion of inflow}}$$

$$\text{proportion of inflow} = \frac{\text{bypass spill}}{\text{mean annual discharge}}$$

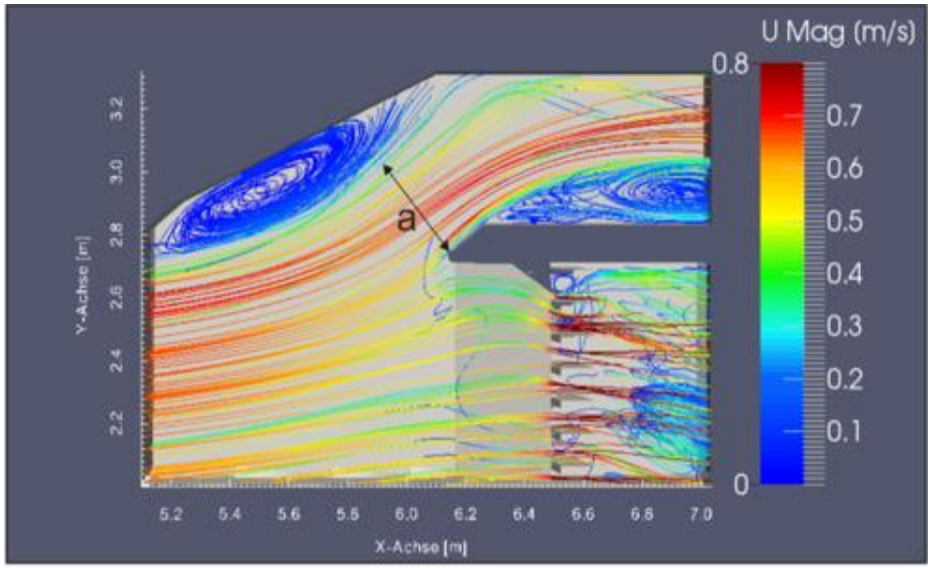
Results and conclusions

Result 1

- Bypass efficiency statistically dependent on
  - Bypass area (Pearson correlation r = 0.33, p-value = 0.0036)
  - Proportion of inflow (Pearson correlation r = 0.37, p-value = 0.0032)

- No statistical evidence but possible factors of influence
  - Guiding structures
  - Trash-rack spacing
  - Flow-field characteristics

→ No bypass design possible with this information

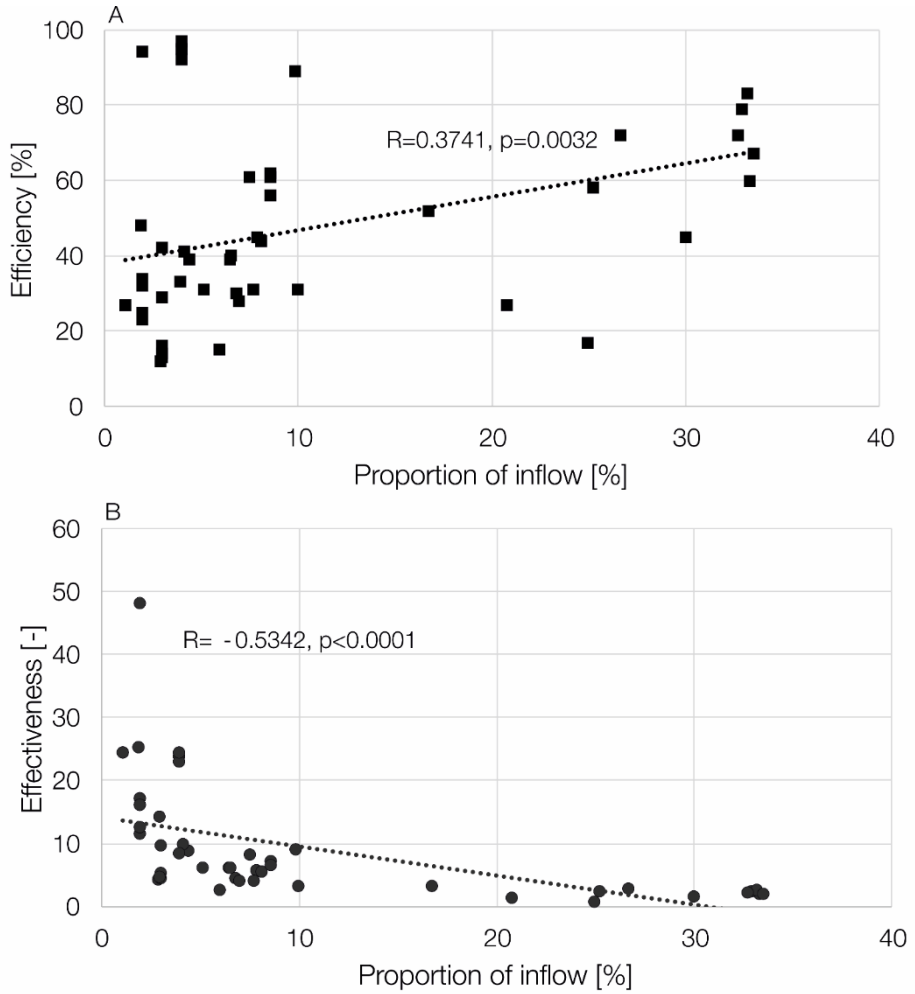


Results and conclusions

Result 2

- Proportion of inflow increases bypass efficiency
- Proportion of inflow decreases bypass effectiveness

→ Economical aspects should be considered in the design process as well

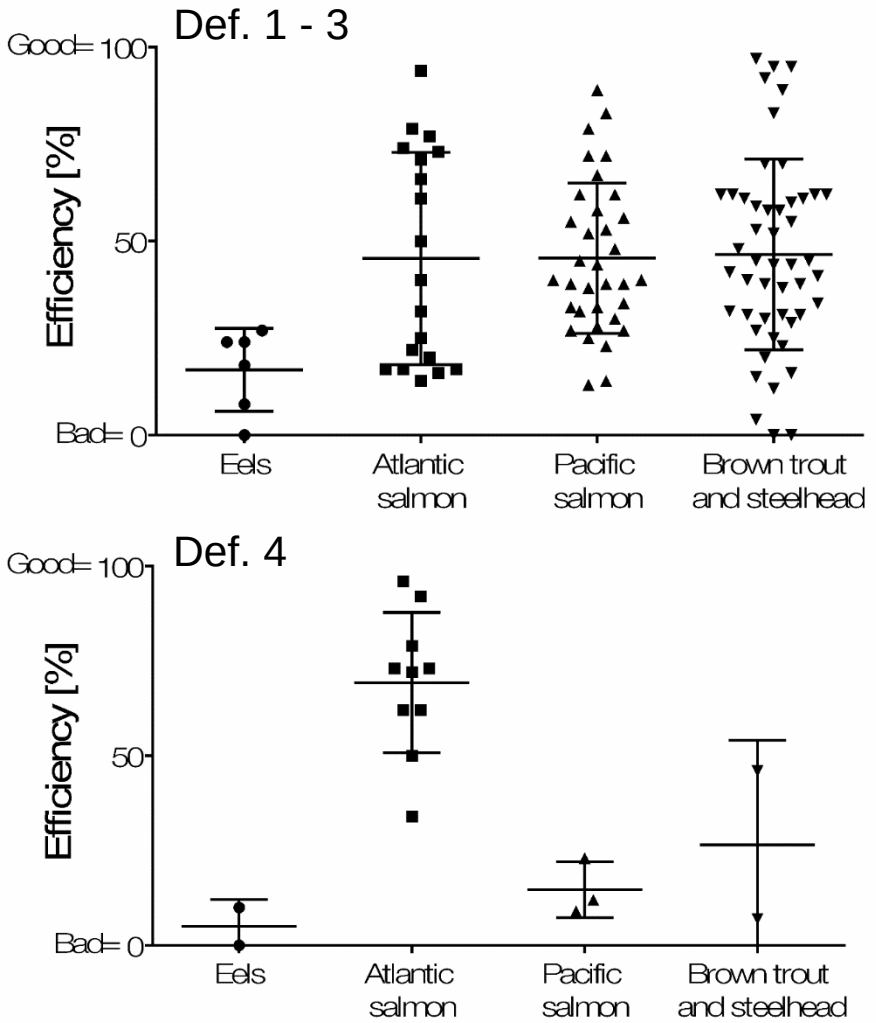


Results and conclusions

Result 3

- Efficiency higher for Atlantic salmon, Pacific salmon, brown trout and steelhead than for eels
- Potamodromous species not considered because insufficient data available

→ If several species need to be considered at one site, several bypass types could be a solution



Results and conclusions

Result 4

- Results concerning statistical dependents were derived without differentiation among species and efficiency definitions

→ List of biological parameters and engineering and hydraulic parameters is given (standardized performance parameters)

→ Make the most of studies with regard to meta-analysis and cost-benefit analysis

→ Combining and exchanging findings from all over the world

Parameters	Unit
Biological parameters	
Fish species	-
Body length	cm
Bypass efficiency	%
Bypass-efficiency definition	-
Passage time	S
Injuries	-
Engineering and hydraulic parameters	
Study year	-
Country	-
Project specifics	
Number of turbines	-
...	

Thank you for your attention!

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