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International Conference on Engineering and Ecohydrology for Fish Passage 2016

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Fish Passage Studies III: Fish-Size-Based Criteria for Assessing Attraction Flow

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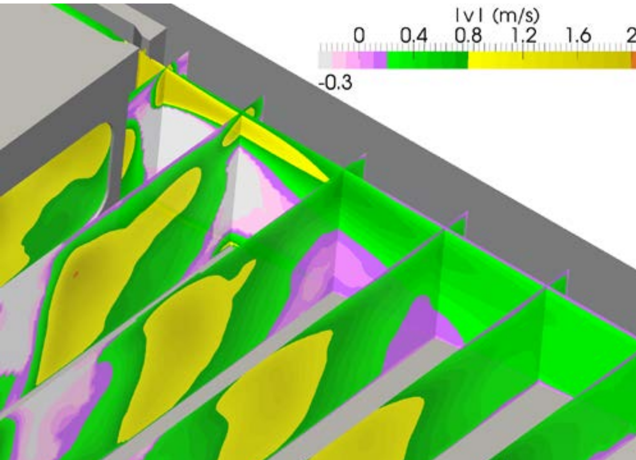
BAW
Bundesanstalt für Wasserbau
Federal Waterways Engineering and Research Institute



David GISEN
Patrick HENEKA
Cornelia SCHÜTZ

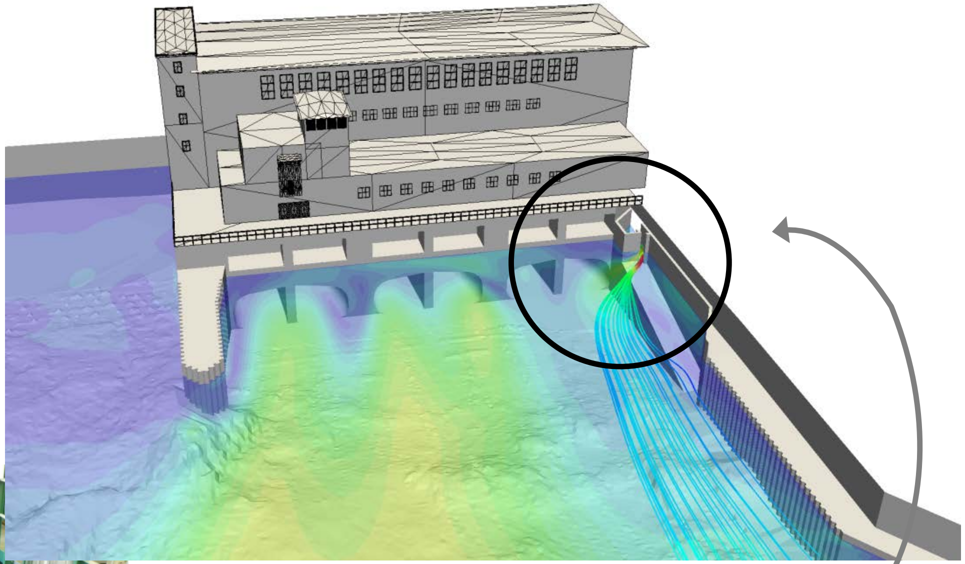
Fish-size-based criteria for assessing attraction flow

Fish Passage Conference 2016, Amherst, MA

21 June 2016

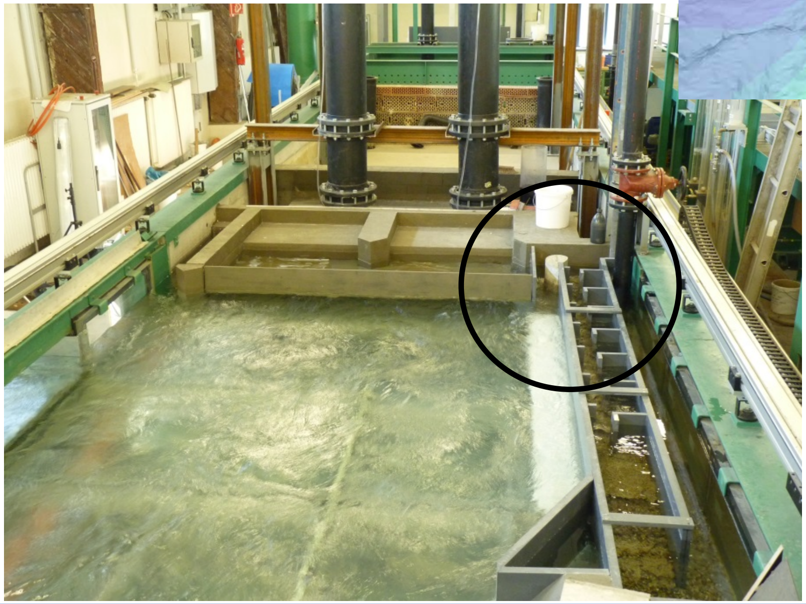
Upstream fish passage: Germany

- Optimize attraction flow rate
  - „Fight for liters“
- Hydraulic tailrace models
- Develop criteria framework
  - Transparency
  - Comparability



Eddersheim numerical model

Fishway main entrance

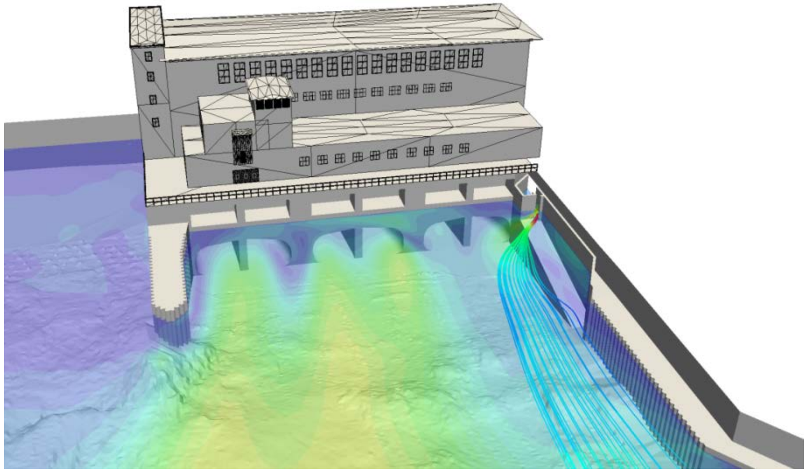


Lauffen physical model

Quantitative evaluation

Criteria

1. Existence of Migration Corridor
2. Velocity barriers
3. Corridor dimensions
4. Back flow @ shore
5. Still water @ entrance



Evaluation matrix

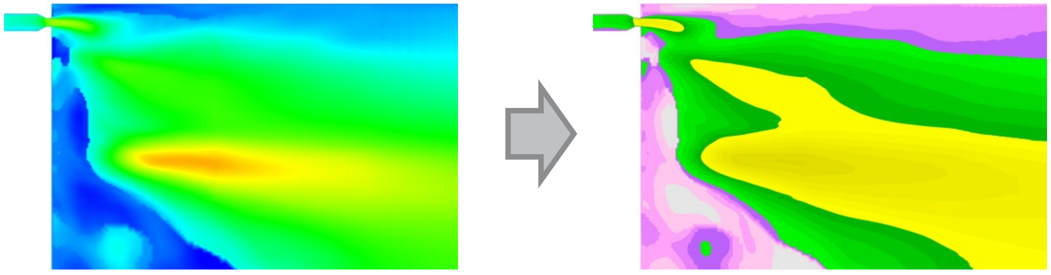
- 2 hydraulic scenarios
  - River flow & stage (fixed)
  - Entrance geometry (fixed)
  - Attraction flow (2 options)
- 2 different TL (total length)
  - Multi-species design (~40)

	Q_attr (m^3/s)	1.0		1.7	
	Q_attr (cfs)	(35.3)		(60.0)	
	TL (m)	0.40	0.15	0.40	0.15
1	Corridor existence				
2	L(barrier)				
3a	Min width				
3b	Min heigth				
4	Back flow @ shore				
5	Still water @ entrance				

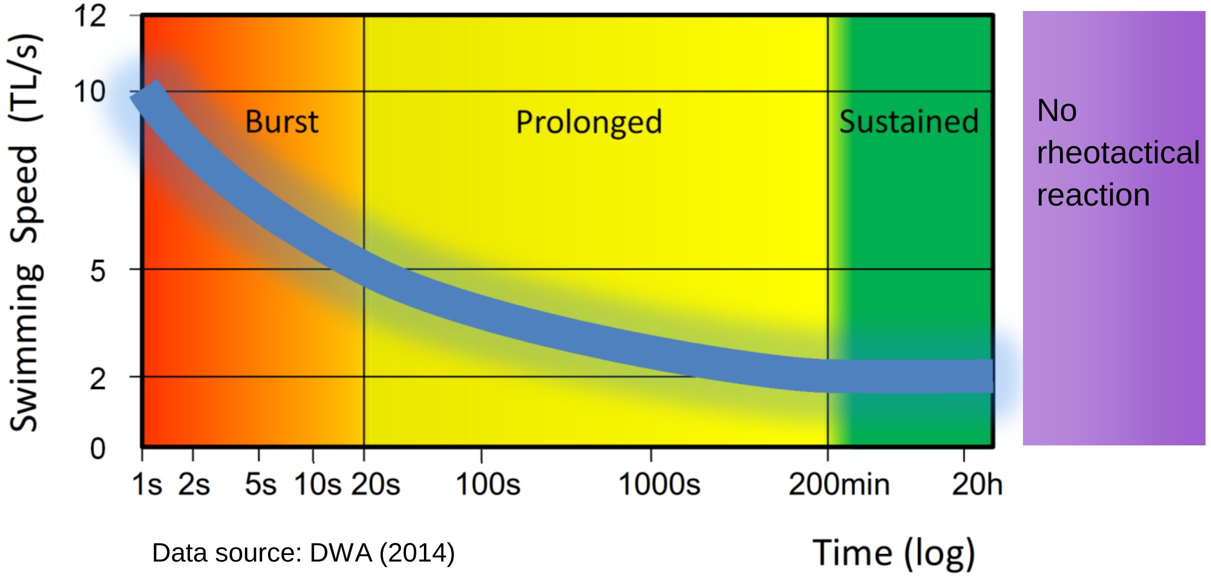
Adjacent turbine flow:
33.3 m^3/s (1,180 cfs)

Suitable	+
Unknown	o
Not Suitable	-

Data classification



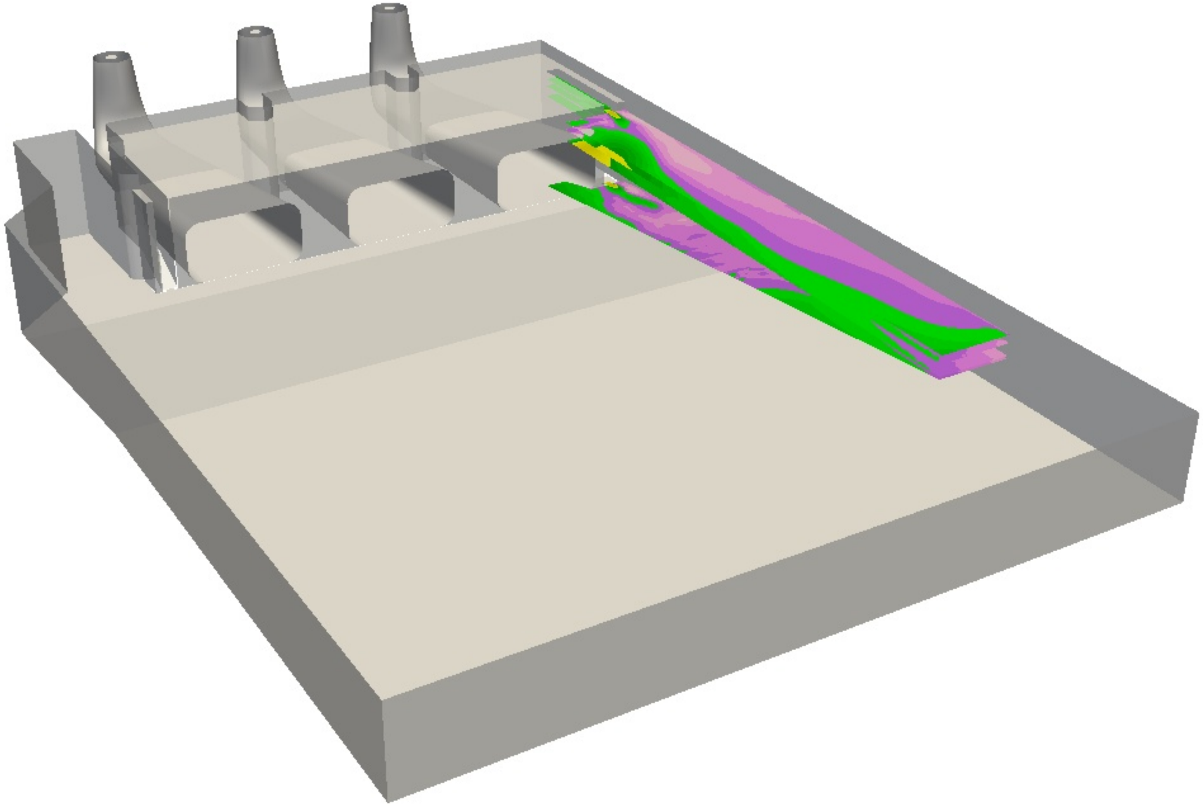
- Color = swimming speed



Data source: DWA (2014)

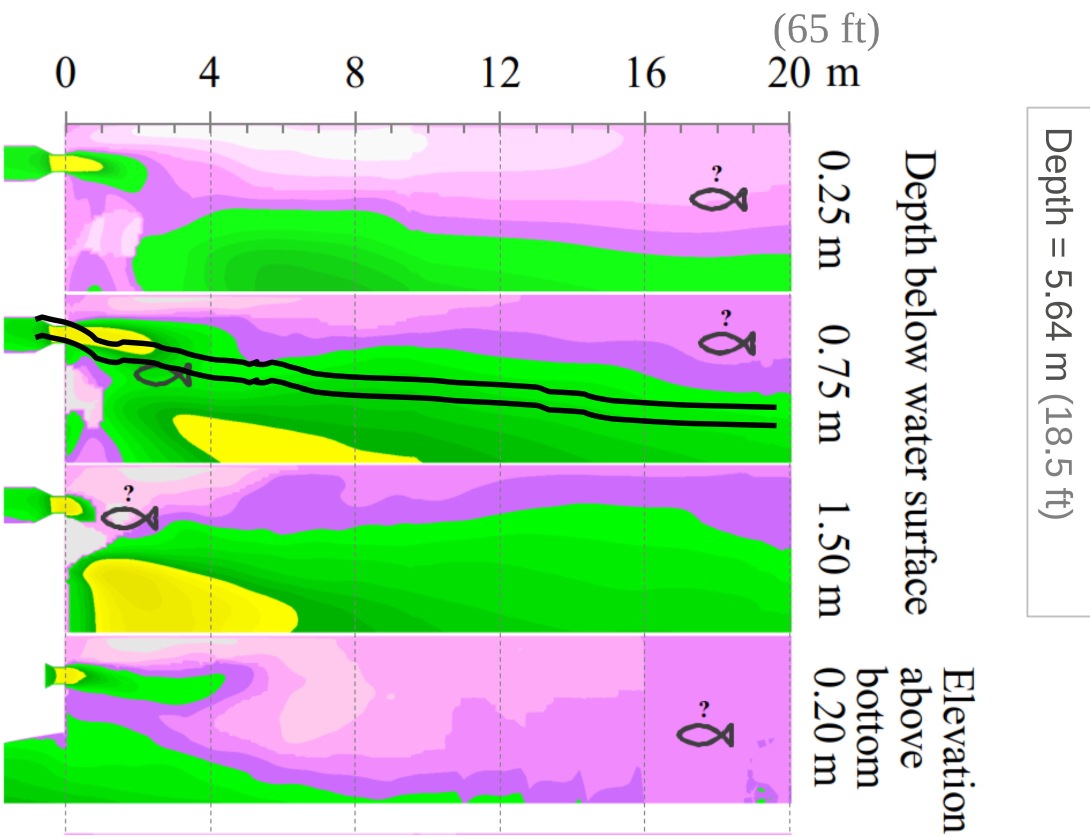
Example application

#1: Continuous migration corridor



#1: Continuous migration corridor

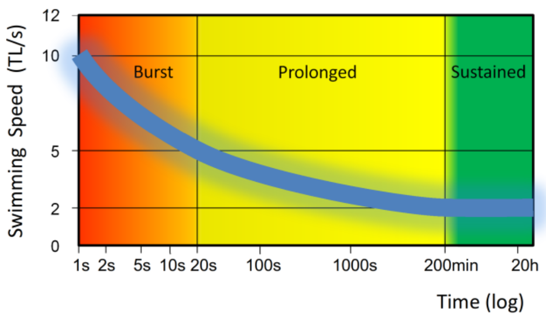
- Entrance pool → Tailrace
- > 0.2 m/s (Positive rheotaxis)



#1: Corridor existence	
Yes	✓
No	✗

#2: Velocity barriers

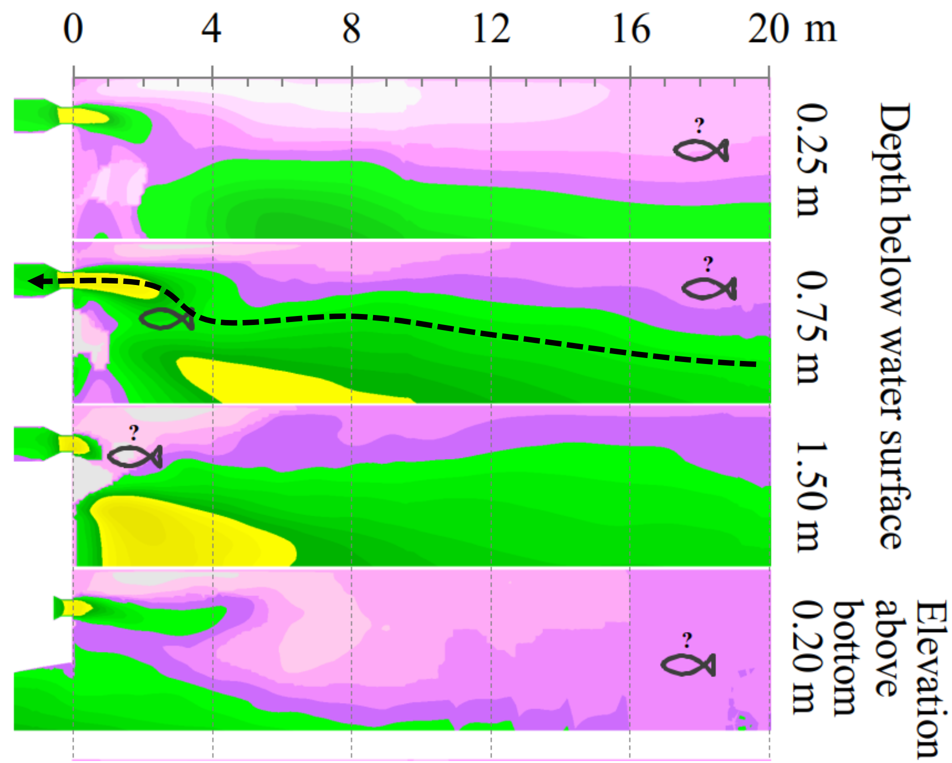
- Desktop suitable estimation



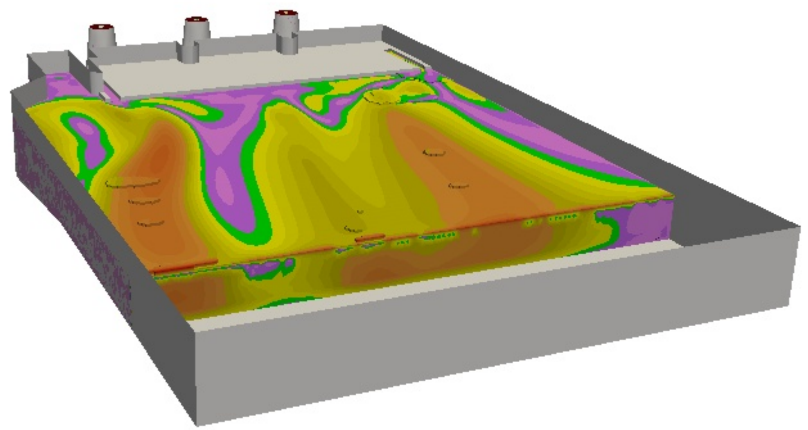
- L(prolonged) – L(barrier) > 10 TL
- 18.0 – 3.0 = 15.0 m > 4.0 m ✓

- L(prlgd) = [5 TL/s – v(water)] * t
- L(prlgd) = [2.0 m/s – 1.1 m/s] * 20s = 18m

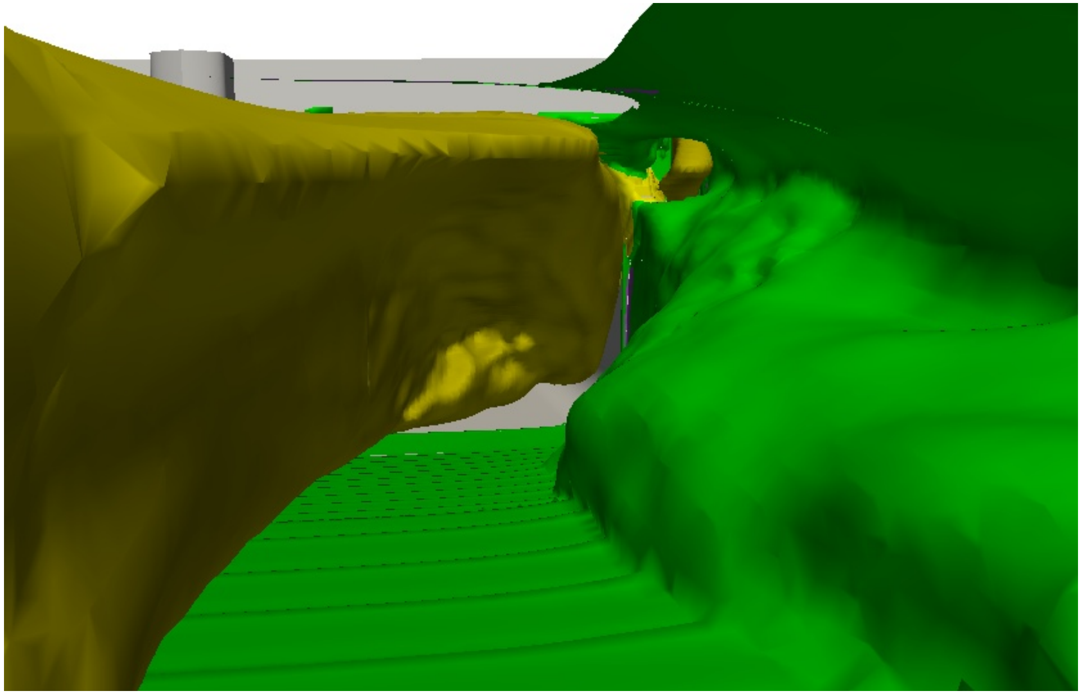
#2: L(prlgd) − L(barrier)	
> 10 TL	+
0–10 TL	o
< 0	-



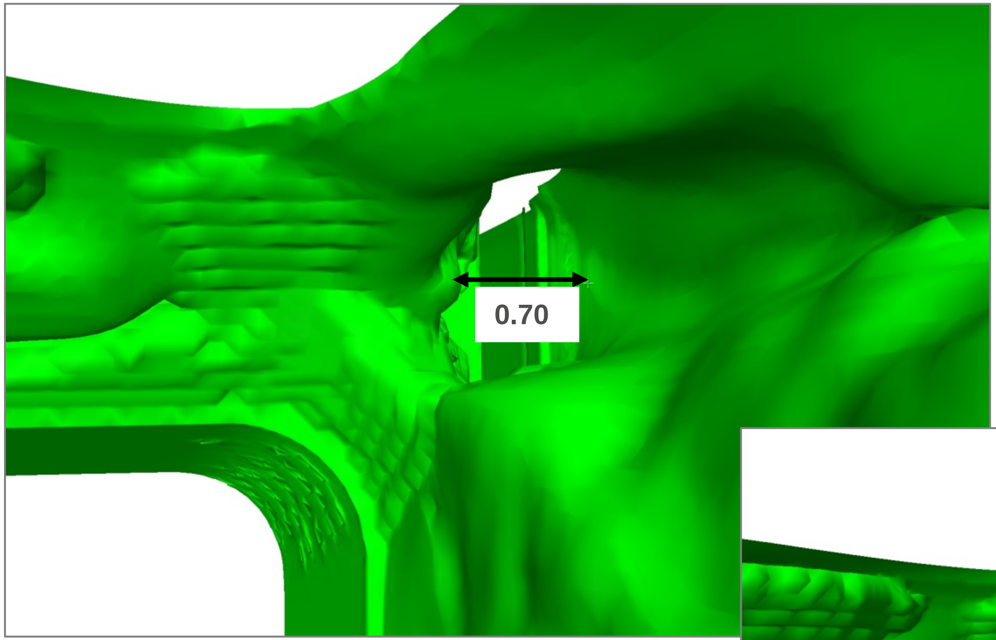
#3a + b: Corridor dimensions



#3a + b: Corridor dimensions



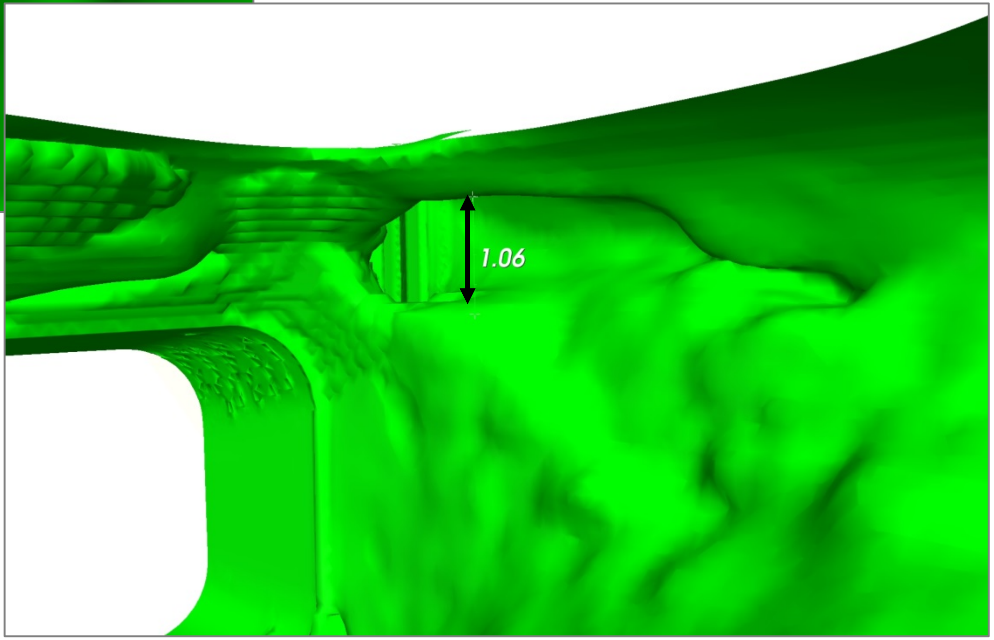
#3a + b: Corridor dimensions



- Min width > 9 W(fish)?
- 0.70 m ≯ 0.81 m

#3a: Min width	
> 9 W(Fish)	+
9–3 W(Fish)	o
< 3 W(Fish)	-

←



- Min height > 2.5 H(fish)?
- 1.06 m > 0.375 m ✓

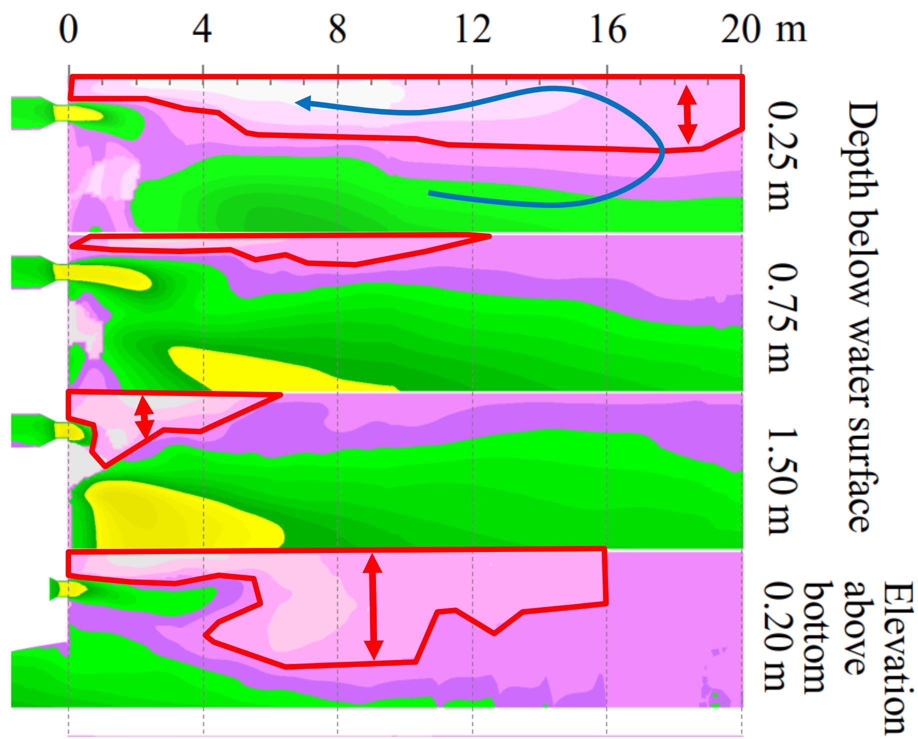
#3b: Min heigth	
> 2.5 H(fish)	+
2.5–2 H(fish)	o
< 2 H(fish)	-

←

#4: Back flow @ shore

- Assumption: Orientation along structure (shore)
- “Sensory distance” ~1.5 – 2.0 TL (Gao et al., 2016; Goodwin et al., 2006)
- Mean back flow width < 1.5 TL
- ~3.0 m ~~<~~ 0.6 m

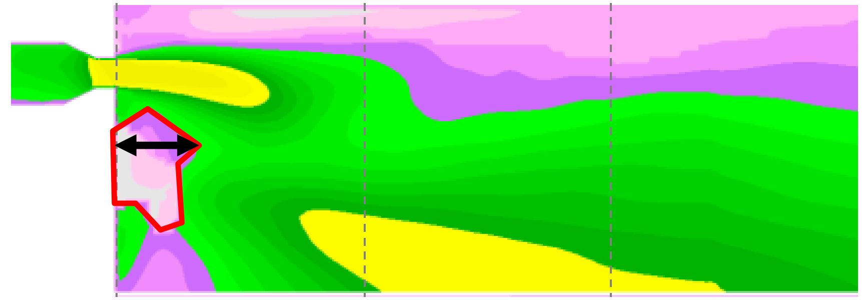
#4b: Still-water @ shore	
< 1.5 TL	+
1.5–4 TL	o
> 4 TL	-

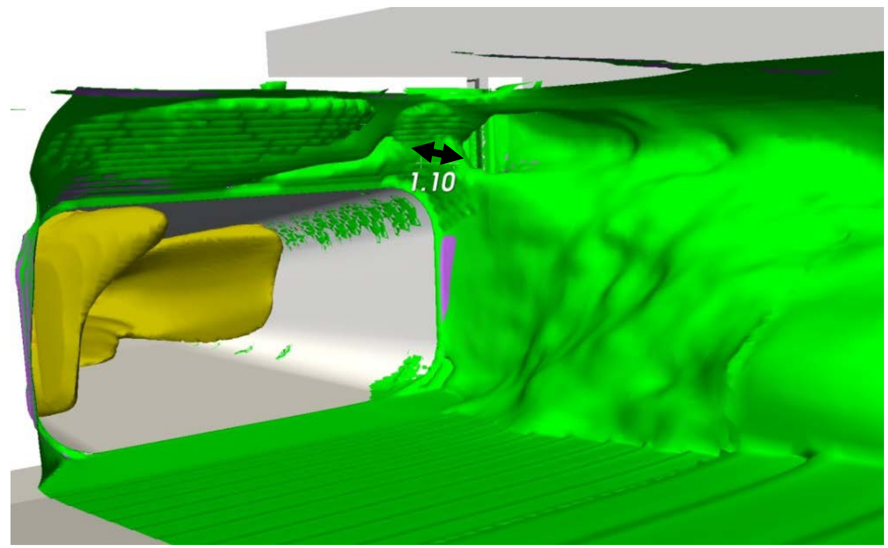


#5: Still-water @ entrance

- Off-shore migrants:
  - “Hydraulic dead end”
- Still water area length < 3.0 m
- 1.10 m < 3.0 m ✓

#4b: Still-water @ entrance	
< 3 m	+
3–10 m	o
> 10 m	-





Final matrix

	Q_attr (m^3/s)	1.0		1.7	
	Q_attr (cfs)	(35.3)		(60.0)	
	TL (m)	0.40	0.15	0.40	0.15
1	Corridor existence	✓	✓	✓	✓
2	L(barrier)	+	+	+	o
3a	Min width	o	+	o	+
3b	Min heigth	+	+	+	+
4	Back flow @ shore	-	-	+	+
5	Still water @ entrance	+	+	+	+
	Sum	+2	+3	+4	+4

+5 +8

Likely…	
Suitable	+
Unknown	o
Not Suitable	-

- Expert decision (cost-benefit)

Advantages & Limitations

Advantages & Limitations

- Simple
  - Requirements OK for planners
  - Omits e.g. temperature

- Transparent
  - Highlights pros & cons
  - Focus discussion

- Outlook
  - Velocity barrier
  - Specific fish investigations
  - Include knowledge

References

- DWA, 2014. Merkblatt DWA-M 509: Fischaufstiegsanlagen und fischpassierbare Bauwerke - Gestaltung, Bemessung, Qualitätssicherung. DWA-Regelwerk, Hennef.
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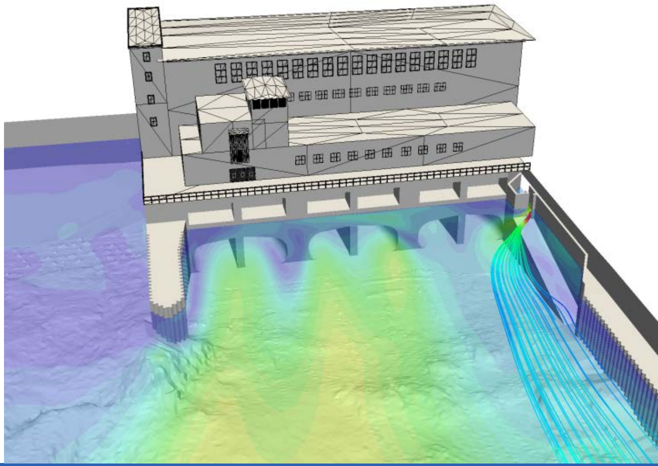

Thank you!

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