Fishfriendly Innovative Technologies for Hydropower (FIThydro)

IEA Hydropower, Brussels, Belgium
29-30 May, 2017

Peter Rutschmann
Technical University Munich

Key Facts

- 26 partners (13 research, 13 industrial) in 10 European countries
- Total **Budget:** 7.2 Mio. Euro
- FIThydro addresses **decision support** in commissioning and operating hydropower plants (HPP) by use of existing and innovative **technologies**.
- The project investigates **mitigation** measures and strategies to develop cost-efficient environmental solutions for **sustainable** and **fish friendly hydropower.**
- **Case study regions:** France/Belgium, Portugal/Spain, Scandinavia and the Alpine Region.

Homepage: **www.fithydro.eu**

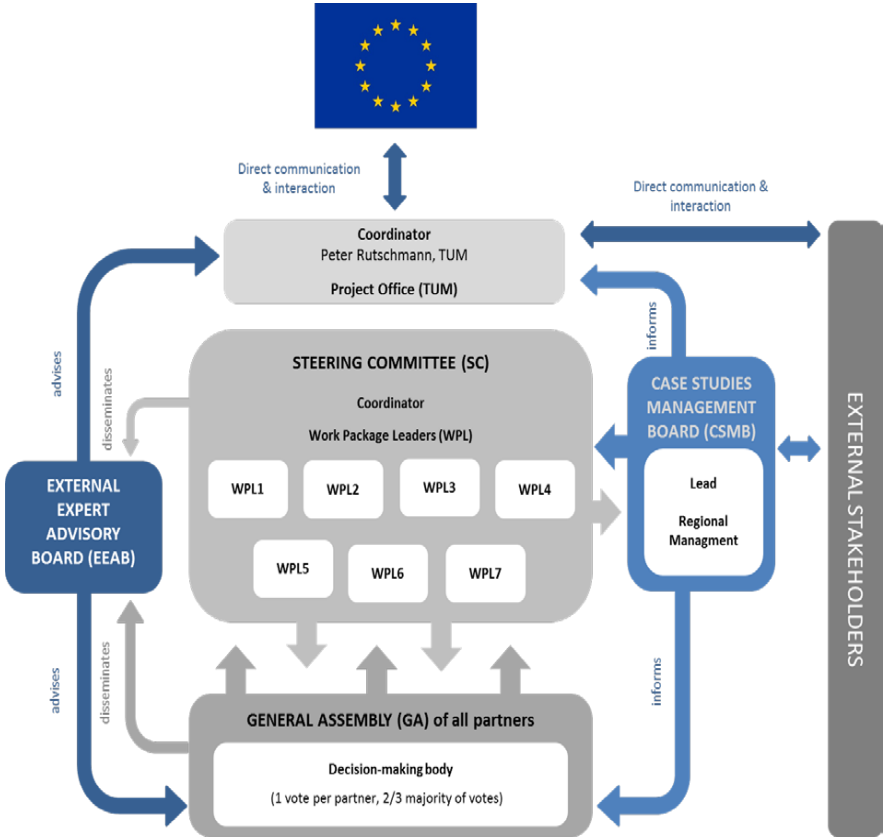
Partners

Objectives

1. Bringing together **all disciplines** related to hydropower.
2. Assessing the response and resilience of **fish populations** in HPP affected rivers.
3. **Environmental** impact assessment and species protection.
4. Improving fish and fisheries impact **mitigation strategies** using conventional and innovative **cost efficient** measures.
5. Enhancing methods models and tools to cope with EU obligation.
6. Identifying **bottlenecks of HPPs** and deriving cost efficient mitigation strategies.
7. Risk based Decision Support System (**DSS**) for planning, **commissioning and operating** of HPPs.
8. Enhancing problem awareness and objectiveness of **policy implementer**, NGOs and the public

Management Structure

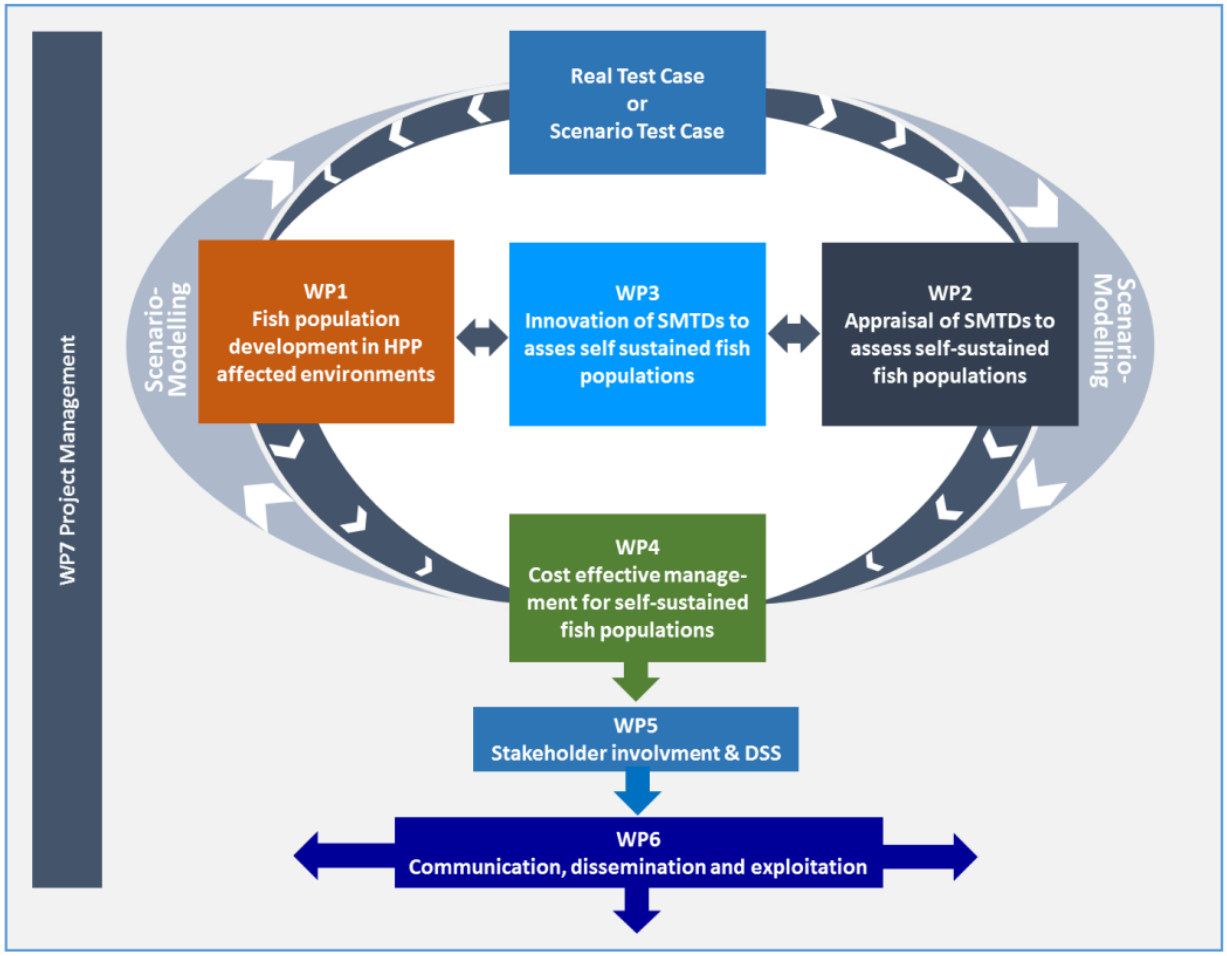
- **The Coordinator** (CO)
- **General Assembly** (GA)
- **Steering Committee** (SC)
- **The Case Studies Management Board** (CSMB) which is responsible for the management of the case studies.
- **The External Expert Advisory Board** (EEAB)



Work Packages

WP Number	WP Title	Start month
WP1	Fish population development in HP effected environments	6 - FVB.IGB
WP2	The appraisal of existing solutions, models, tools and devices to assess (the) self-sustained fish population(s) at the test case HPP in each of the four regions	3 - CNRS
WP3	The innovation of solutions, models, tools and devices to assess self-sustained fish population(s) at the test case HPP in each of the four regions	2 – IST
WP4	Cost effective management strategies to improve the development of self- sustained fish populations at existing and new HPPs	8 - SER
WP5	Stakeholder involvement & decision- support system	11 - EI
WP6	Communication, Dissemination and Exploitation	1 - TUM
WP7	Management of the Project	1 - TUM
WP8	Ethics requirements	1 - TUM

Work Packages

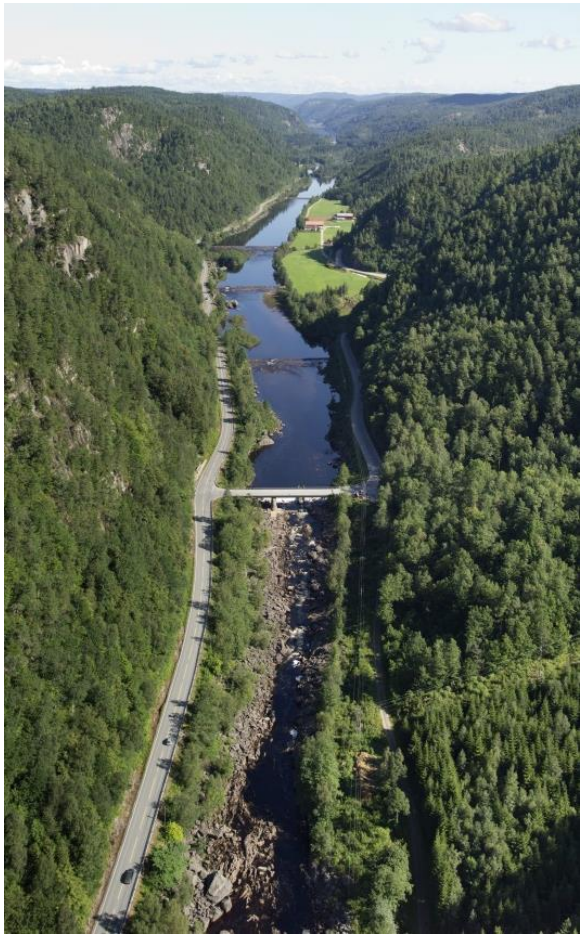


Test Cases

HPP	River / Country	HPP Data	Fish species / species at risk	Test case topics: Hydraulics:	Test case topics: Population / Habitat:	Innovative SMTDs	Main Partners	Comments	Picture
Freudenau	Danube	**Discharge [m³/s]**	Barbel, Nase	Fish migration	Habitat impovement	Methods		Operation and mantainence optimization, beaver management	
		3000.0							
Operator		**Head [m]**							
Verbund	Austria	8.6							
Budget		**Capacity [MW]**							
ca. 150000€		172.0					WP1, WP2, WP3, WP4		
HPP Ham	Albert canal	**Discharge [m³/s]**	Bream, Roach, Perch, Pike, Pikeperch	Fish migration Innov. Devicies Turbine mortality	Species at risk Self sustained populations	Methods Tools	VLAGEW INBO SJE	Innovative Archimedes screw HPP	
		15.0							
Operator		**Head [m]**							
NV de Scheepvaart	Belgium	10.0	Atlantic Salmon, Eel						
Budget		**Capacity [MW]**					WP1, WP2, WP3, WP4		
65 000 €		1.2							
Gotein	Saison	**Discharge [m³/s]**	Brown Trout, Cyprinids, Salmon	Fish migration Attraction flows	Self sustained populations	Solutions Devices	CNRS VLAGEW INBO	Test of bypass efficiency for salmon smolts. Low bar spacing (20mm) and low bar inclination (26%)	
		6.6							
Operator		**Head [m]**							
provided by ONEMA	France	5.0	Salmon						
Budget		**Capacity [MW]**					WP1, WP2, WP3, WP4		
ca. 75 000€		0.32							
Trois-Ville	Saison	**Discharge [m³/s]**	Brown Trout, Cyprinids, Salmon	Fish migration Attraction flows	Self sustained populations	Solutions Devices	CNRS VLAGEW INBO VOITH	Test of bypass efficiency for salmon smolts. Low bar spacing (20mm) and low bar inclination (26%)	
		5.0							
Operator		**Head [m]**							
provided by ONEMA	France	5.0	Salmon						
Budget		**Capacity [MW]**					WP1, WP2, WP3, WP4		
ca.80 000€		0.24							

Test Case Challenges

1. Flow and habitat
   - Lack of wetted area
   - Lack of or distribution of spawning habitat
   - Lack of or distribution of rearing habitat
   - Downstream or attraction flow
   - Environmental flow in bypassed reach
   - Hydropeaking
2. Sediments
   - Deficit of sediments
   - Surplus of sediments
   - Clogging of substrate

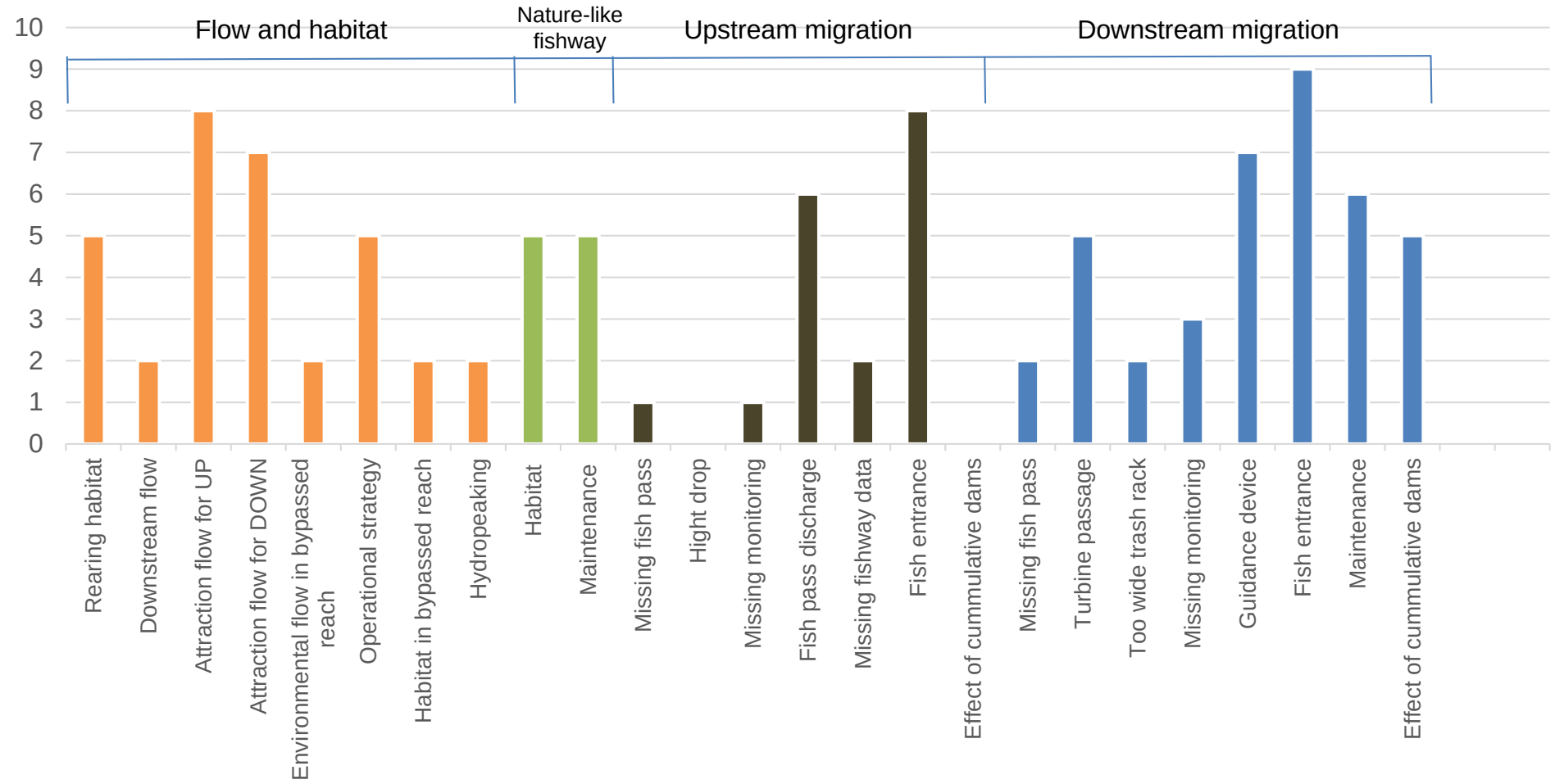


Test Case Challenges

3. Upstream migration
   - Missing fish pass
   - Hight drop
   - Missing monitoring
   - Fish pass discharge
   - Missing fishway data
   - Fish entrance
   - Other

4. Downstream migration
   - Missing fish pass
   - Turbine passage
   - Too wide trash rack
   - Missing monitoring
   - Missing fishway data
   - Fish entrance

Test Case Challenges



FIThydro and AMBER

AMBER:

Adaptive Management of Barriers in European Rivers

More effective ecosystem restoration in the EU

FIThydro:

Fishfriendly Innovative Technologies for Hydropower

Developing the next generation technologies of renewable electricity and heating/cooling

Cooperation: FIThydro and AMBER

Technical Cooperation:

- The EU barrier atlas on hydroelectric dams
- Effect of hydropower plants/barriers on the upstream and downstream reach
- Habitat Assessment (Telemtry, Drones)

Cooperation: FIThydro and AMBER

Project Management:

1. Regular communication through their PM's
2. FIThydro and AMBER: Participation in meetings and workshops of the other projects
3. Aim to host a joint meeting in 2020 in Brussels
4. Cooperate to organize additional event. (e.g: WFM)
5. Cooperate to organize Conference sessions

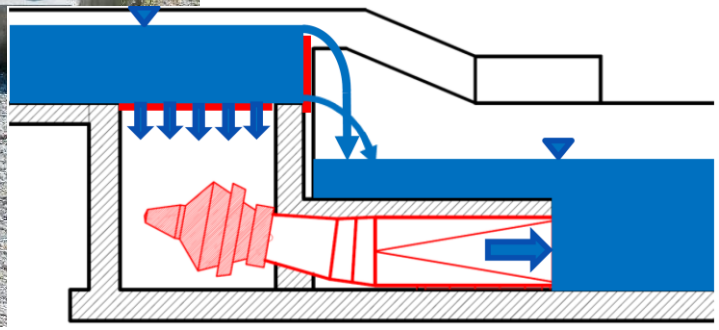
Cooperation: FIThydro and AMBER

Dissemination:

1. Website visibility as “related Project”
2. Exchange user networks and subscribe to newsletters to maximize reach and impact.

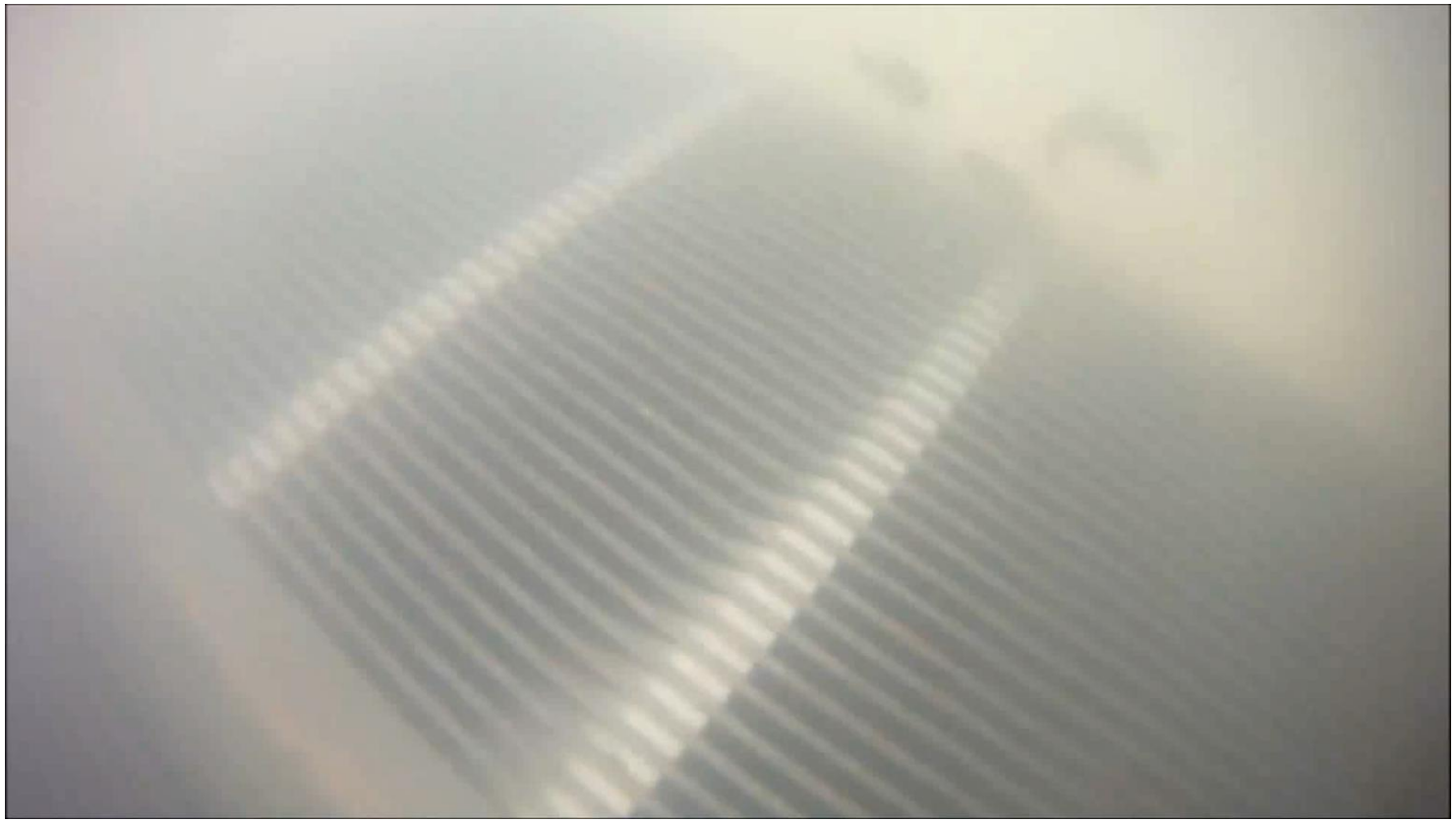
Hydro Shaft Powerplant – Eco Friendly Hydro

Eco-friendly HPP with testing of fish behavior and bypass use and turbine mortality probabilities. The powerplant is not visible and not audible.



Hydro Shaft Powerplant – Eco Friendly Hydro

Eco-friendly HPP with testing of fish behavior and bypass use and turbine mortality probabilities. The powerplant is not visible and not audible.

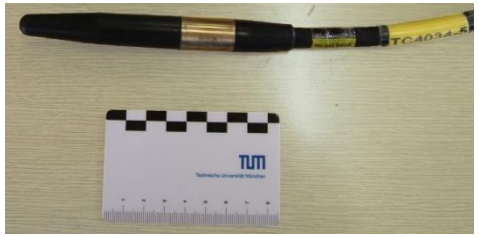


Hydro Acoustic Fish Tracking Concept

- *Pros*
- High range of sound waves in water
- Mobile and flexible measurement setup
- Contactless monitoring
- Chance for continuous monitoring

Equipment

Hydrophones (transmitter and receiver)

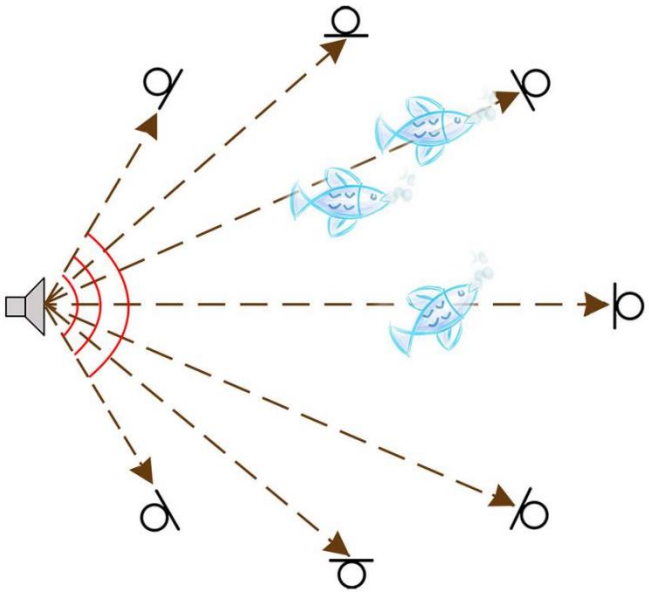


Electric generator

Amplifier (transmitter and receiver)

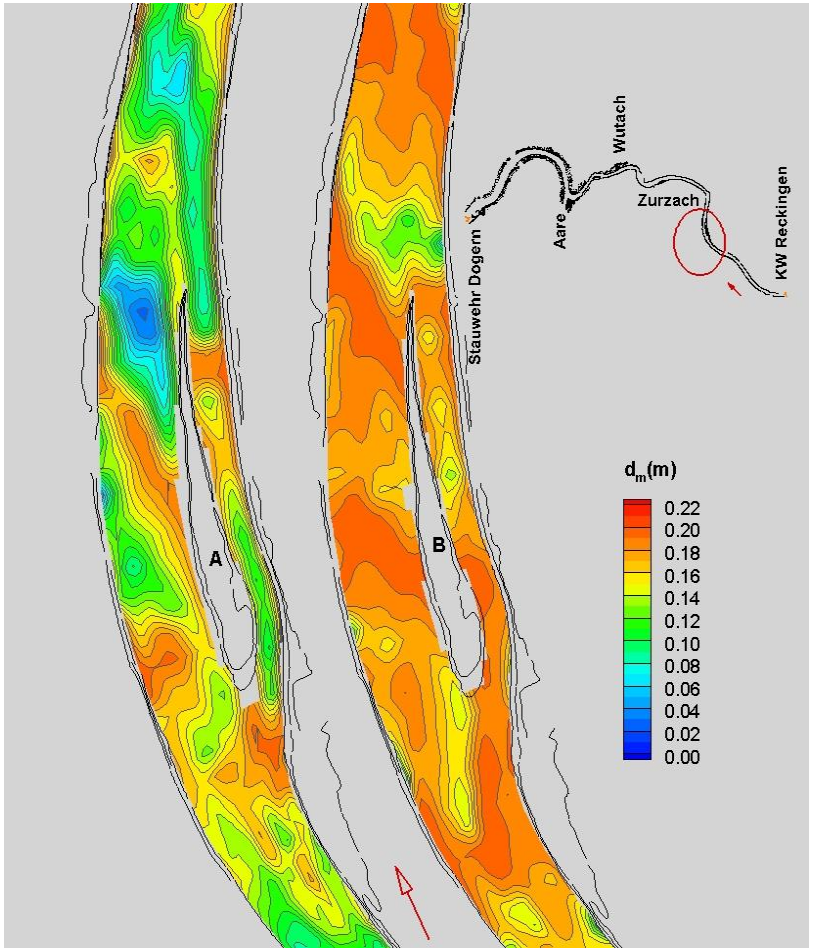
Digital oscilloscope

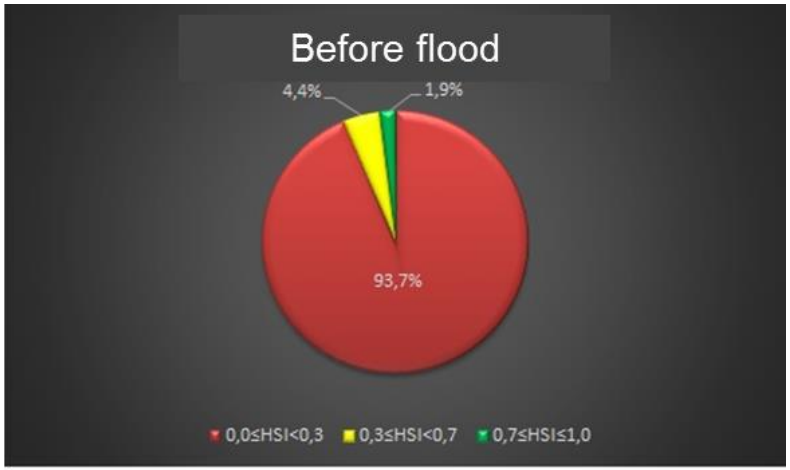
patent pending

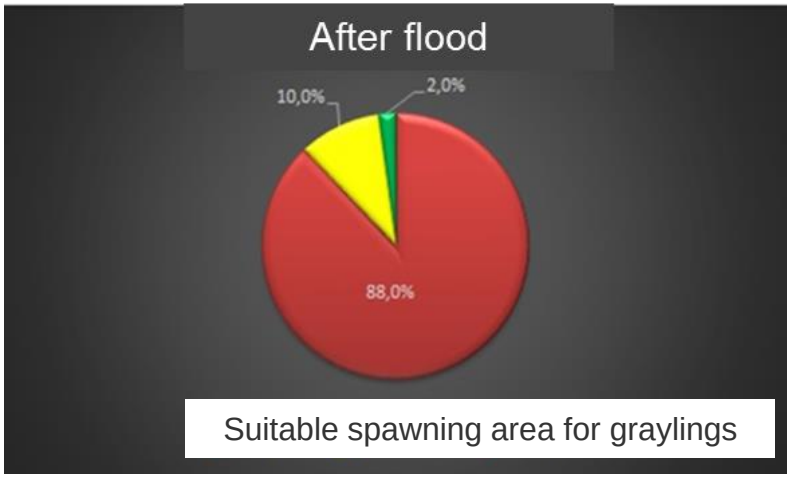


Flexible Hydro Acoustic Measurement Concept

Fish Habitat and Population Modeling







Fish Habitat and Population Modeling

$$[Ni^{t+1}] = [M] \times [Ni^{t}]$$

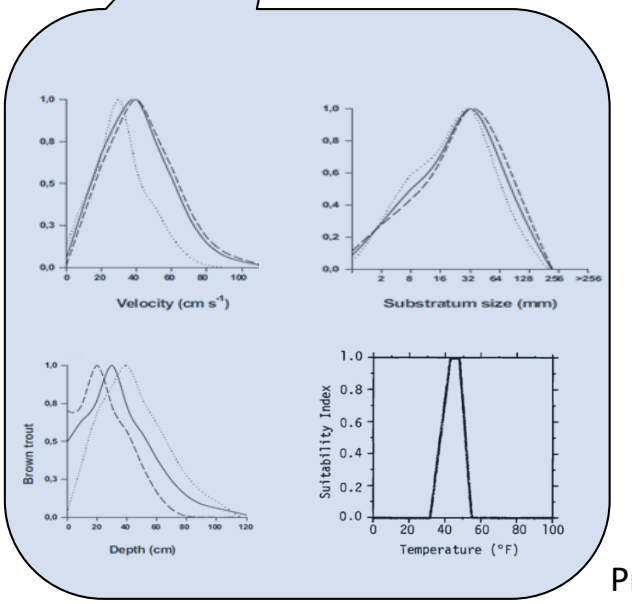
Matrix M changes with time

Changes in time

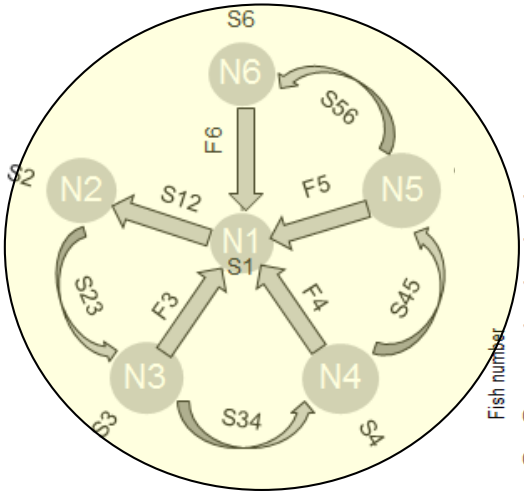
Spawning

No spawning

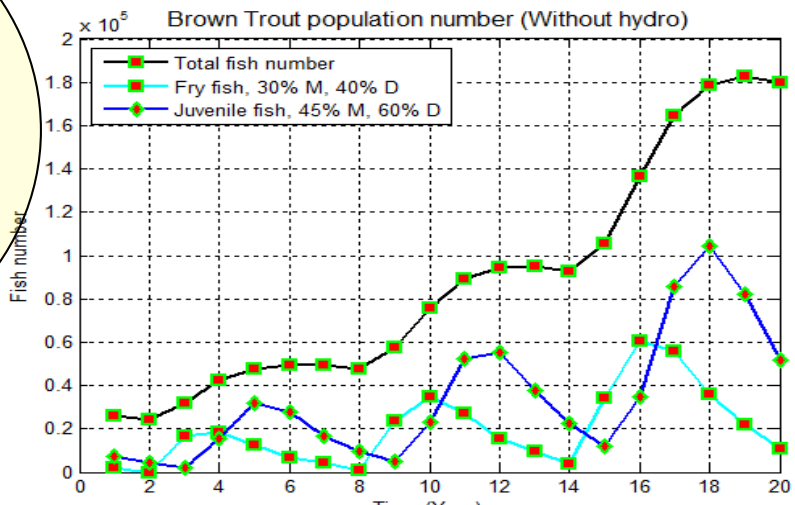
$$\begin{bmatrix} N1_{t+1} \\ N2_{t+1} \\ N3_{t+1} \\ N4_{t+1} \\ N5_{t+1} \\ N6_{t+1} \end{bmatrix} = \begin{bmatrix} 0 & 0 & \cdots & F_5 & F_6 \\ S_{12} & 0 & 0 & 0 & 0 & 0 \\ 0 & S_{23} & 0 & 0 & 0 & 0 \\ 0 & 0 & S_{34} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{45} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{56} & 0 \end{bmatrix} \times \begin{bmatrix} N1_t \\ N2_t \\ N3_t \\ N4_t \\ N5_t \\ N6_t \end{bmatrix} \quad \begin{bmatrix} N1_{t+1} \\ N2_{t+1} \\ N3_{t+1} \\ N4_{t+1} \\ N5_{t+1} \\ N6_{t+1} \end{bmatrix} = \begin{bmatrix} S_1 & 0 & F_3 & F_4 & F_5 & F_6 \\ 0 & S_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & S_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & S_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & S_5 & 0 \\ 0 & 0 & 0 & 0 & 0 & S_6 \end{bmatrix} \times \begin{bmatrix} N1_t \\ N2_t \\ N3_t \\ N4_t \\ N5_t \\ N6_t \end{bmatrix} \quad \begin{bmatrix} N1_{t+1} \\ N2_{t+1} \\ N3_{t+1} \\ N4_{t+1} \\ N5_{t+1} \\ N6_{t+1} \end{bmatrix} = \begin{bmatrix} S_1 & 0 & 0 & 0 & \cdots \\ 0 & S_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & S_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & S_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & S_5 & 0 \\ 0 & 0 & 0 & 0 & 0 & S_6 \end{bmatrix} \times \begin{bmatrix} N1_t \\ N2_t \\ N3_t \\ N4_t \\ N5_t \\ N6_t \end{bmatrix}$$



Preference curves

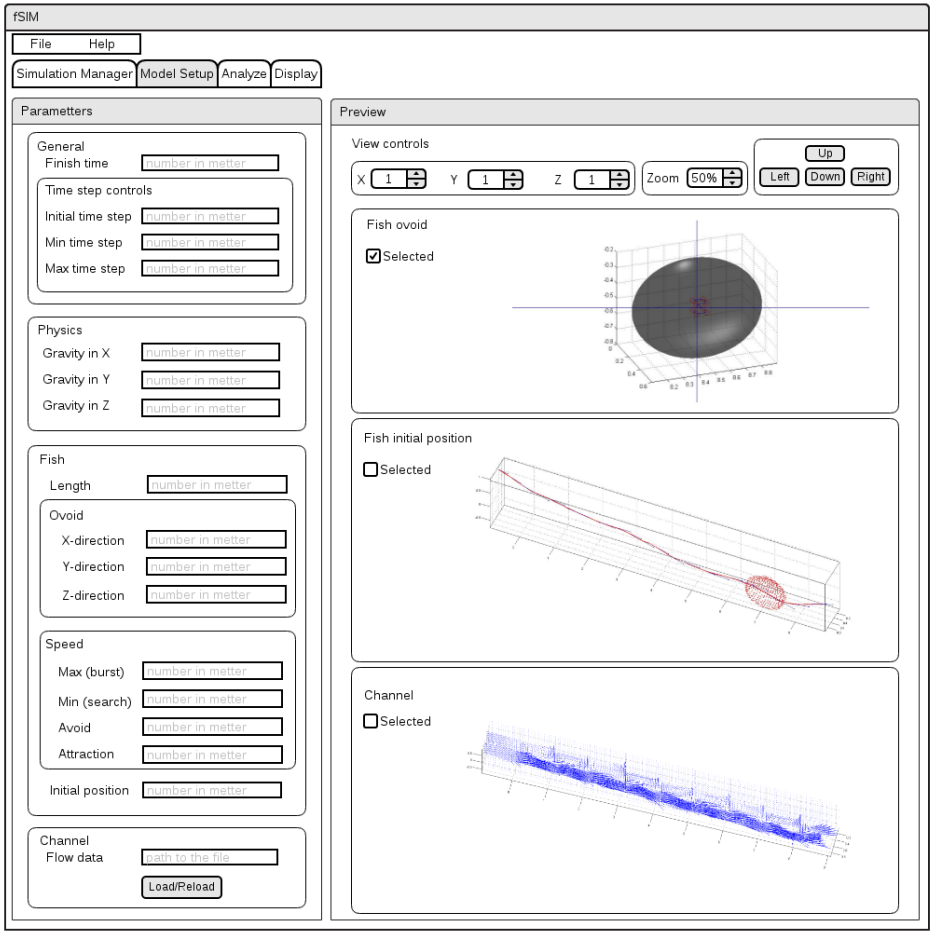


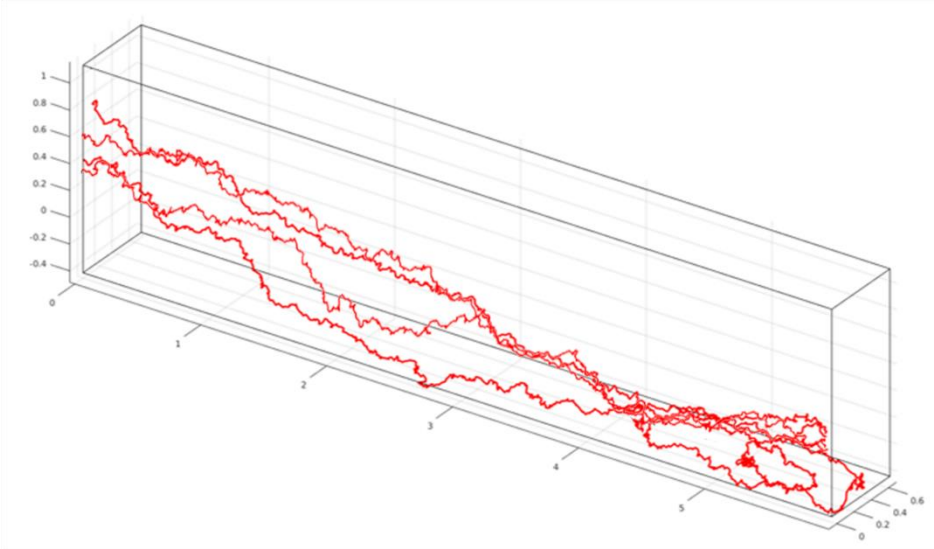
Life cycles of a population

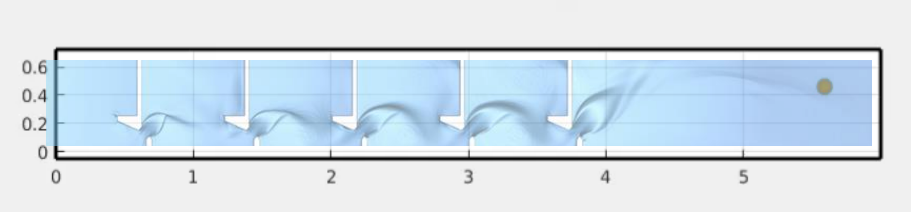


PhD thesis Yao Weiwei (TUM)

Fish Motion in the Flow







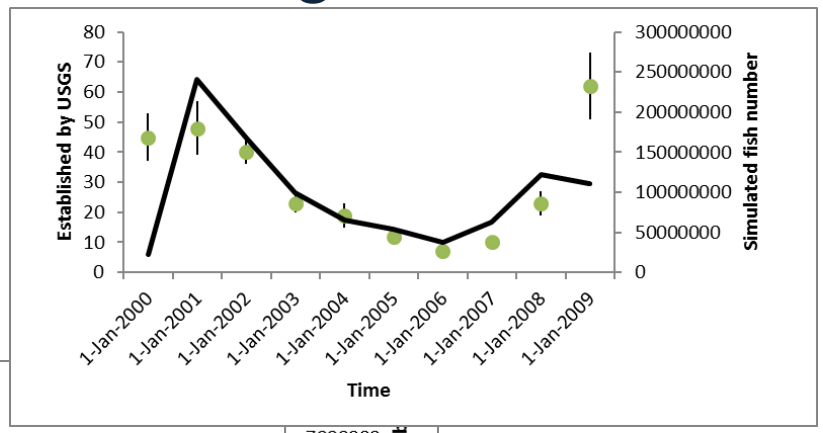
PhD thesis Dzung Nguyen (TUM)

Fish Habitat and Population Modeling - Colorado

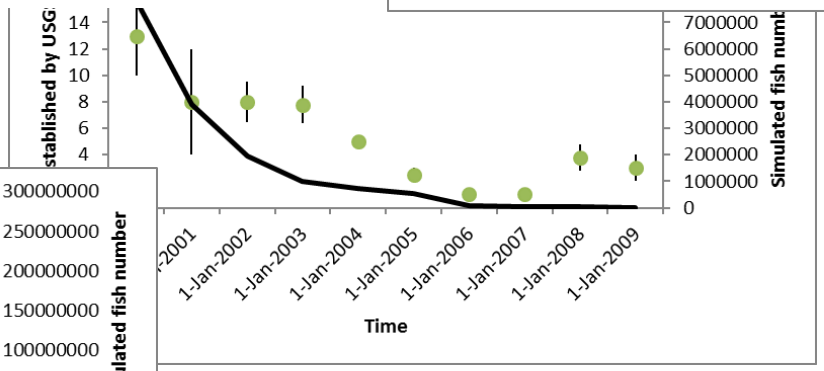
Brown trout
(*Salmo trutta*)

Rainbow trout
(*Oncorhynchus mykiss*)

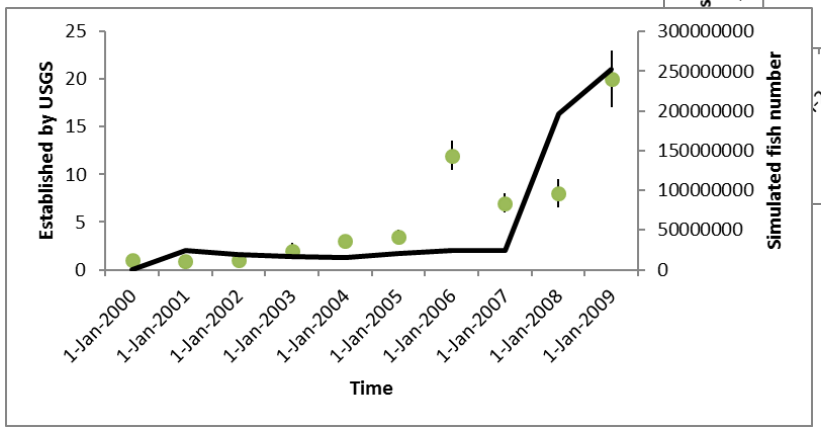
flannelmouth sucker
(*Catostomus latipinnis*)



Brown trout



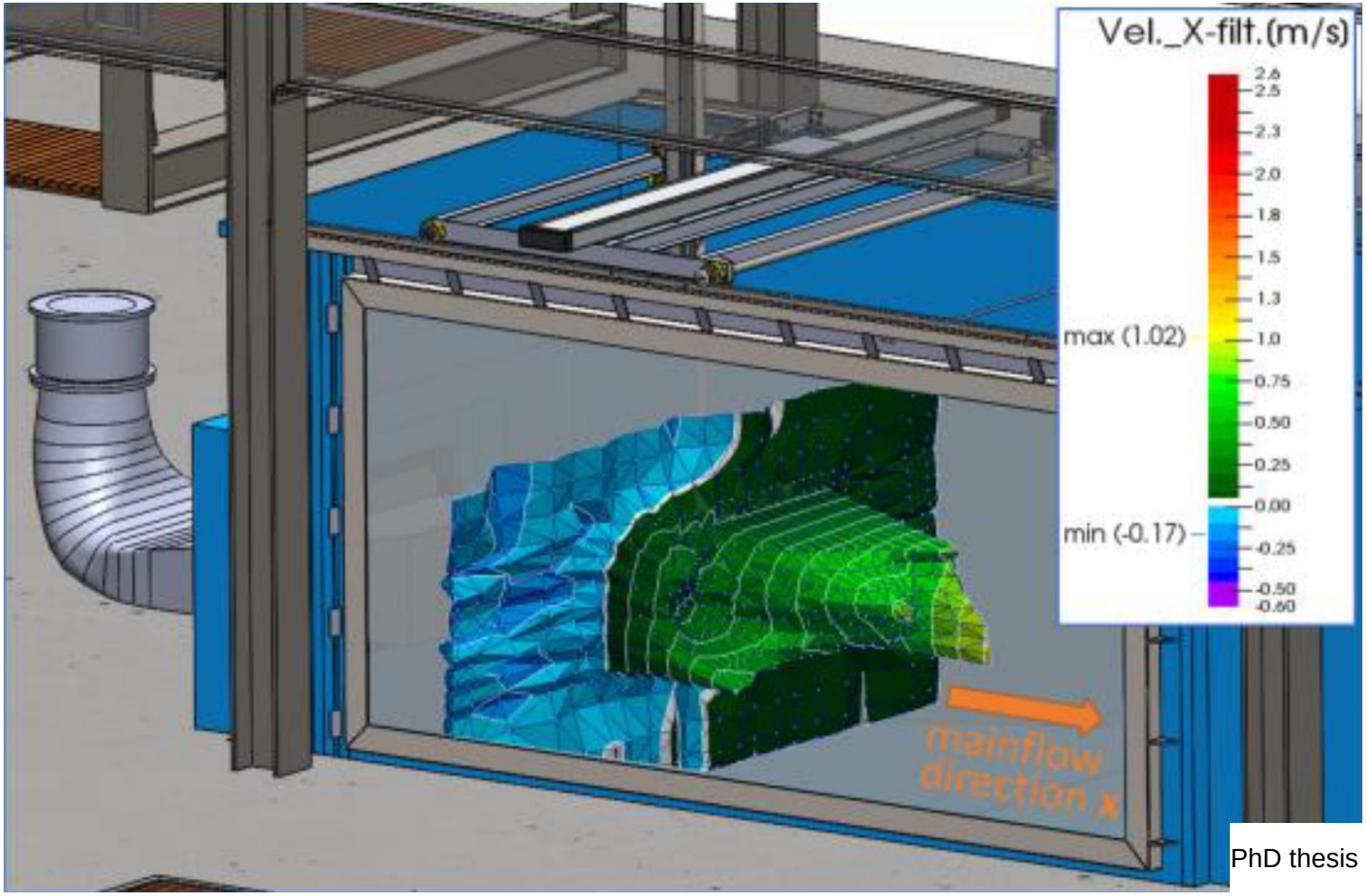
Rainbow trout



Flannelmouth sucker

PhD thesis Yao Weiwei (TUM)

Slight off-peak mode operation of turbines (BAW)



PhD thesis S. Roenneberg (TUM)

Contact Information

Technical University Munich
Department of Civil, Geo and Environmental Engineering
Chair of Hydraulic and Water Resources Engineering
Arcisstr. 21
80333 München

Coordinator: Prof. Peter Rutschmann
Tel. +49 89 289 23161
Fax +49 89 289 23172
E-Mail peter.rutschmann@tum.de

Project manager: Hany Abo El Wafa
Tel. +49 89 289 23167
Fax +49 89 289 23172
E-Mail hany.wafa@tum.de

www.fithydro.eu

Please subscribe to FIThydro‘s newsletter

Thank you

This project is Funded by the Horizon 2020
Framework Programme of the European Union
Grant Agreement number 727830