The FIThydro wiki

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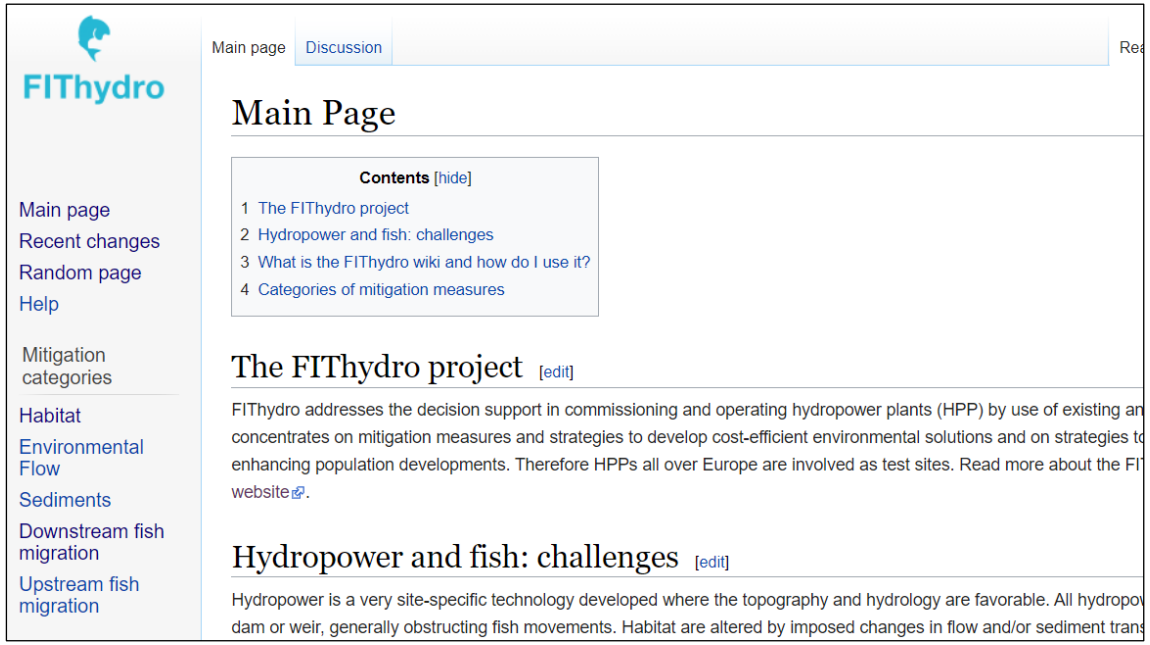

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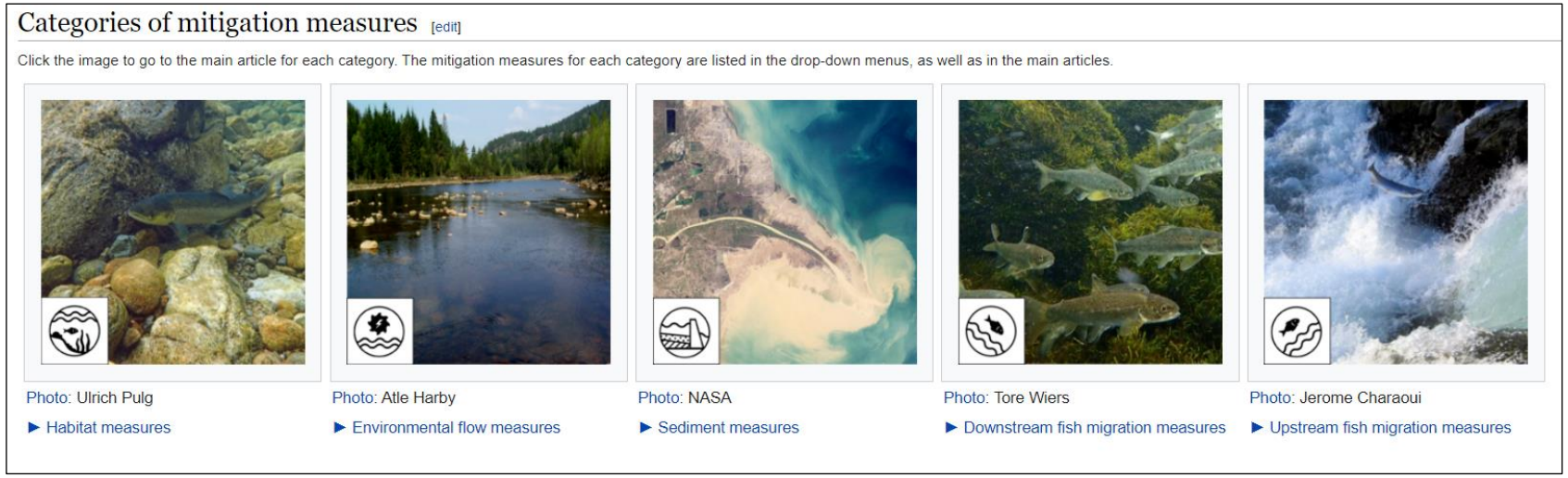
About the wiki

- **Open-access online platform www.fithydro.wiki**
- **Systematic presentation of project outputs, including:**
  - Solutions, methods, tools and devices
  - FIThydro test case applications
  - Overview of other FIThydro outputs, such as Policy and Public Acceptance, DSS



EXAMPLE

Example from "Placement of spawning gravel in the river"

Placement of spawning gravel in the river

Note that this measure is included in both the habitat and sediment categories.

Contents [hide]

Introduction [edit]

River regulations often change the natural flow regime and the sediment connectivity, introducing changes to the substrate composition both in the bypass section and downstream the outlet of the hydropower plant. This is often leading to a reduction in magnitude, frequency and duration of floods that impact the substrate composition, typically leading to fine materials clogging the substrate and possibly creating an armoured layer. An armoured layer will inhibit the spawning of fish species laying their eggs in the substrate, potentially reducing the number of eggs deposited in the substrate, increasing the predation and possibly also reducing the survival of eggs, e.g. due to low oxygen levels in the hyporheic zone. As such, the areas supporting spawning can be reduced due to regulation and hence represent a limiting factor ('bottleneck') for the fish population. The grain size distribution of the spawning gravel to be placed in the river must be correct for the species of concern. The spawning fish should be able to dig and lay their egg in the added gravel. Fine sediments should not be able to clog the gravel. The shape of the stones should be similar to the natural conditions in the river, and sharp-edged stones from blasting, often available close to a hydropower projects, should only be used if considered appropriate for the species of concern. If the gravel is not sufficiently 'clean', it should be washed prior to deposition in the river to avoid particle pollution and possibly increased clogging downstream. Before placement of spawning gravel in the river is made, the hydraulic conditions where the spawning gravel is placed must be investigated. The gravel must be located in a part of the river that does not dry out during low flow conditions, in areas with sufficient through-flow of fresh, oxygen-rich water to the eggs, and in areas that are not exposed to out-wash/flushing during high flow and flood events. This measure has been implemented in several rivers in Norway (Pulg et al 2017). It is a fairly inexpensive measure to introduce, it stimulates the natural population and seems to achieve very good results in all rivers it has been used.

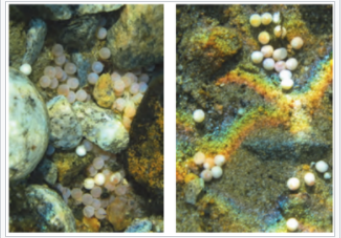


Figure 1: Salmon eggs in gravel. The picture on the left shows high egg survival (transparent = alive) in placed spawning gravel. The picture on the right shows low survival rate in natural spawning gravel where sand has filled in much of the substrate

Methods, tools, and devices [edit]

During planning [edit]

A first step in considering placement of spawning gravel as a measure would be to assess if the total and distribution of spawning areas are limiting the development of fish population, i.e. diagnosis in the environmental design terminology. The spawning areas are often assessed by visual inspection of the river, i.e. by foot beside the river, by wading or from boat. Aerial photos can also in some cases assist this step. When the spawning areas are identified, they can be mapped in a GIS and the total area and their distribution assessed. For Atlantic salmon, spawning areas are considered being large if more than 10% of the total river has suitable spawning conditions, moderate if between 1-10% and small if less than 1% (Forseth and Harby 2013). The distribution/spread is considered large if more than 500 meters between identified spawning areas, medium if between 200-500 meters, and small if less than 200 meters. These threshold values are considered indicative for Atlantic salmon, but they may be different for other fish species.

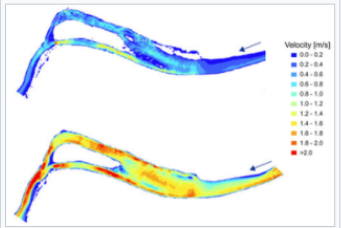


Figure 2: Example of simulation results from a hydrodynamic model. Flow velocity map for flow rate of 15.4 m^3/s is shown at the top and for 100 m^3/s at the bottom.

Table 1: A system for an overall classification of spawning habitat for Atlantic salmon (Forseth and Harby 2013).

		Extent of spawning habitat as a percentage of river area

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COSTS

Library of possible measures			Min [Euro]	Max [Euro]	Unit	Reference
Habitat	Instream habitat adjustments	Placement of spawning gravel in the river	10	100	per cubic meter	1,2
		Placement of stones in the river	50	150	per cubic meter	3
		Cleaning of substrate - ripping, ploughing and flushing	1	50	per square meter	3
		Fish refuge under hydropeaking conditions	NA			
		Placement of dead wood and debris	10	150	per meter	4
	Restoring habitat	Removal of weirs	2,000	1,000,000	per weir	5,6
		Construction of a 'river-in-the-river'	50	5,000	per meter	7
		Construction of off-channel habitats	1	100	per square meter	8
	Shoreline habitat	Environmental design of embankments and erosion protection	10	150	per meter	3
		Restoration of the riparian zone vegetation	1	50	per square meter	8
Fish migration	Downstream	Migration barrier removal	2,000	1,000,000	per project	5,6
		Operational measures (turbine operations, spillway passage)	NA			
		Sensory, behavioural barriers (electricity, light, sound, air-water curtains)	800	4,000	per m3/second	9
		Fish-friendly turbines	500,000		per turbine	10
		Skimming walls (fixed or floating)	3,000		per m3/second	11
		Bypass combined with other solutions	10,000	25,000	per m3/second	12
		Fish guidance structures with narrow bar spacing	2000	40000	per m3/second	11
		Fish guidance structures with wide bar spacing	2000	40000	per m3/second	11
		Bottom-type intakes (Coanda screen, Lepine water intake, etc)	17,000		per m3/second	9
		Other types of fine screens	NA			
	Upstream	Complete or partial migration barrier removal	2,000	1,000,000	per project	5,6
		Nature-like fishways	5,000	20,000	per vertical meter	13
		Pool-type fishways	10,000	100,000	per vertical meter	19
		Baffle fishways	5,000	100,000	per vertical meter	5,11,14
		Fishways for eels and lampreys	600		per meter length	16
		Fish lifts, screws, locks, and others	10000	500000	per project	11
		Truck transport	NA			
		Vertical slot fishways	5,000	20,000	per vertical meter	13

Use and application

- The wiki provides knowledge on solutions, methods, tools, and devices, and can be used for rough screening of appropriate measures.
- Linked to the **Decision Support System**
- The wiki allows for:
  - Easy navigation between relevant topics
  - Living document which can be updated and expanded
  - Any approved user can make their own edits
  - Ease of access (easy look-up, easy to link to, access on any device that can browse the internet, familiar interface)
  - Easier communication to the general public

Contact

- Please contact Bendik Hansen at bendik.hansen@sintef.no for questions or comments!

- The wiki is available at www.fithydro.wiki, and visiting the website is the best way to learn more about it

www.fithydro.wiki

Thank you

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