Regional Stakeholder Feedback to FIThydro

How are we addressing it?

FIThydro

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Authors

Eleftheria Kampa, Ecologic Institute

Laurent David, Centre National de la recherche scientifique

Ismail Albayrak, ETH Zürich

Atle Harby, SINTEF

Antonio Pinheiro, Associação do Instituto Superior Técnico para a Investigacao e Desenvolvimento

Christian Wolter, IGB Leibniz-Institute of Freshwater Ecology and Inland Fisheries

Kordula Schwarzwälder, NTNU Trondheim

Peter Rutschmann, Technical University of Munich

Discussing fish-friendly hydropower across Europe

In 2018 the EU-funded research project FIThydro (https://fithydro.eu/) hosted regional stakeholder workshops in the four European regions of the project, France & Belgium, the Iberian Peninsula, Scandinavia, and the Alpine region.

The aim of these workshops was to offer a platform for consultation and exchange between FIThydro scientists and stakeholders, who are external to the project on the key open issues and "burning" questions relevant to the assessment and planning of fish-friendly hydropower plants (HPP). These events have been an opportunity to present the FIThydro work programme to stakeholders, discuss and receive feedback on the research agenda of the project. At the same time, external stakeholders (HPP operators, authorities, NGOs and scientists) could present their own regional activities related to hydropower and effects on fish.

The main target groups of these workshops were authorities involved in hydropower plant authorization processes, policy-makers in the water and energy sector, HPP operators, non-governmental organisations (NGOs), consultants/planners and the research community.

In total, four regional stakeholder workshops took place:

- France & Belgium: 24-25 January 2018, at the CNRS Meudon-Bellevue in Paris
- Iberian Peninsula: 20 March 2018, at the IST (Campus Alameda) in Lisbon, Portugal
- Scandinavia: 4-5 June 2018, at Energiforsk in Stockholm, Sweden
- Alpine region: 10-11 September 2018, at the Bavarian Environment Agency in Augsburg, Germany.

Approximately 30 to 40 participants, who were invited by FIThydro, attended each workshop (Figure 1). The regional stakeholder workshops were well received by the participants, giving the opportunity for fruitful discussions and good exchange between FIThydro scientists and stakeholders.

The workshops were particularly helpful in gaining the practitioners' perspective on the scientific works carried out within the FIThydro project and in showing the variety of approaches and solutions used in different regions in Europe.

The key problems identified by stakeholders and their main recommendations to FIThydro are being used in an ongoing way by the project to fine-tune the content of the upcoming technical deliverables of the project.

Overall participant makeup

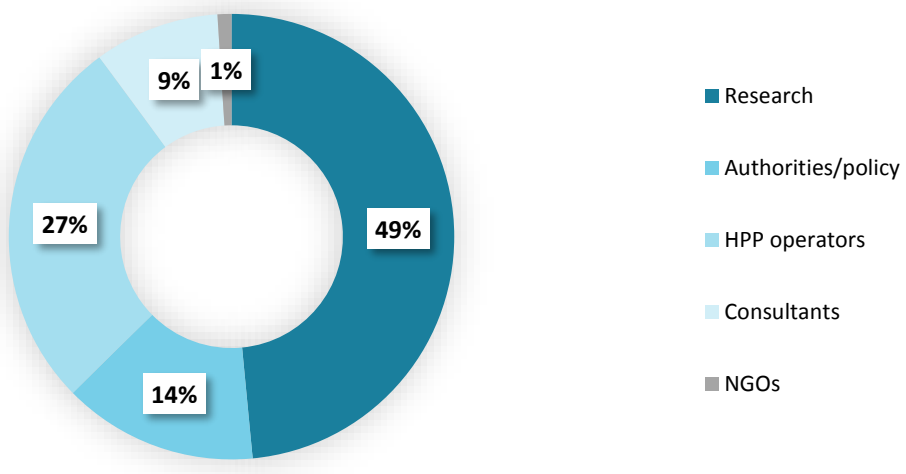

Figure 1: Share of participants by stakeholder group in the regional workshops

What issues were discussed?

Impression from 3rd FIThydro Regional Stakeholder Workshop for the Scandinavian region, @E.Kampa

Discussions at the regional workshops were structured around seven key topics (see Table 1) to reflect the main scientific content of FIThydro and issues of particular interest in the four regions.

Discussion topics	France & Belgium	Iberian Peninsula	Scandinavia	Alpine region
Ecology of fish species				
Fish migration				
Sediments and habitats				
(Environmental) flows and habitats				
Compensational habitats				
Hydropeaking & mitigation measures				
Combination of mitigation strategies				

Table 1: Discussion topics and coverage in the regional stakeholder workshops

For an interactive exchange with the stakeholders, the following set of guiding questions was developed.

Key guiding questions for discussion with stakeholders:

a) What do you consider as the **major issues (key problems, open questions)** relevant to the assessment and planning of ecologically compatible hydropower production in your region (specifically on the key topics of the workshop)?

b) What **approaches and solutions** are applied **to address the key problems and open issues** in your region?

c) What are **your recommendations or requests to the work-programme of FIThydro** (with specific relevance to the key topics of the workshop)?

Focus of this Report

This Report presents a selection of major issues on different topics identified by the stakeholders, who attended the workshops (see point (a) above). It also presents the stakeholder recommendations and requests to the work-programme of FIThydro (see point (c) above).

Important! Please be aware that the major issues identified by the stakeholders in this report are not to be interpreted as scientific facts or statements/evaluations on behalf of the FIThydro team. The major issues raised by stakeholders are presented but not commented by the FIThydro team.

However, the Report does outline the responses of the FIThydro Steering Committee to the recommendations of stakeholders made explicitly to the FIThydro work-programme. The Report explicitly indicates whether FIThydro can address the specific recommendations/ requests within its technical deliverables.

Full workshop summary reports including all stakeholder feedback received on problems, solutions and recommendations are available online:

- Iberian Peninsula: https://www.fithydro.eu/workshopiberia2/
- Scandinavia: https://www.fithydro.eu/workshop-scandinavia3/
- Alpine region: https://www.fithydro.eu/workshop-alpine4/
- France & Belgium: https://www.fithydro.eu/workshopfrancebelgium1/

Which stakeholder recommendations can be addressed by FIThydro and how?

Impression from the 4th FIThydro Regional Stakeholder Workshop for the Alpine region, @J.Reck

The detailed tables below provide feedback on whether FIThydro can address the stakeholder recommendations/ requests to the project and indicate the project deliverables, where stakeholders can find the relevant results. This should assist stakeholders in following up progress and relevant outcomes of the project.

All technical deliverables of the FIThydro project are made available on the FIThydro website https://www.fithydro.eu/ (Dissemination & Results > Deliverables > Technical Deliverables). At the time of publishing this Report, five technical deliverables were already made available online. The links to the five technical deliverables available online are:[1]

- D1.1 Metadata overview on fish response to hydropower: https://fithydro.eu/wp-content/uploads/2017/12/D1.1.pdf
- D1.2 Risk classification of European lampreys and fish species: https://syncandshare.lrz.de/dl/fiNCXf1nZeUtjaeqStUHAXa4/?inline
- D 2.1 A List of solutions, models, tools and devices, their application range on a regional and overall level, the identified knowledge gaps and the recommendations to fill these: https://syncandshare.lrz.de/dl/fiJfqVXVsawLyXRsC83HKg1t/?inline
- D 4.1 A classification system for methods, tools and devices for improvements measures: https://syncandshare.lrz.de/dl/fiPtwbn8Jsy25dvwaAJjdwHw/?inline
- D 5.1 Review of policy requirements & financing instruments: https://fithydro.eu/wp-content/uploads/2018/02/Fithydro_D5.1_V2final.pdf

[1] Some of the deliverable online links are preliminary as the deliverables are still in the approval process. However, all deliverables can be found on the project website, once approved.

In addition, FIThydro will develop an online WIKI which will provide structured information on mitigation measures and specific methods, tools and devices related to assessments of fish-friendly hydropower. The online WIKI will be made available in 2020.

Across the different topics, approximately 70% of the stakeholder recommendations and requests to the project can be addressed or partly addressed in the research work-programme of FIThydro. This confirms that FIThydro is, to a large extent, meeting expectations of regional stakeholders from the project.

Some recommendations and requests made by stakeholders cannot be addressed by FIThydro mainly because the topics they reflect are out of the research scope of the project. In particular, stakeholder requests in relation to the topic of sediments and habitats cannot be addressed to a large extent because only limited research is being carried within FIThydro on this subject.

Ecology of fish species

Discussions addressed fish population ecology, challenges which fish populations are exposed to in regulated rivers as well as fish response and resilience to river fragmentation and hydropower. From the FIThydro work-programme, first steps towards a fish population hazard index for hydropower were presented and discussed.

Some of the key problems identified by stakeholders are

- Small species (with similar size to juvenile of larger fish) are not sufficiently considered with respect to migration and mortality.
- Further research is needed on how individual fish mortality affects fish populations, and the role of compensation measures in this context.
- Need to define a “population”: How many individuals make a „good“ population? How large does the population have to be in order to be self-sustainable in the long-run?
- Turbine induced mortality of larvae (for different species) and relevance to population.
- Lack of scientific and technical knowledge on the biology of cyprinid species, their communities and their habitat requirements.
- Migration behaviour: Do all fish species migrate/need to migrate? How is corridor choice and corridor behavior at different sites?
- Lack of long-time quantitative studies on the effects of (restoration/mitigation) measures on fish population in impounded areas.
- Need for uniform biological indicators and links to hydrology to ensure better transferability of results and to measure mitigation measures efficiency more homogenously.
- Need for developing new models on the biological preference of certain species.
- Role of habitat loss/fragmentation.
- Hybridization and loss of genetic variability.
- Multiple pressure-setting: How to disentangle the effects of mitigation measures from other effects? How to isolate effects of HPP from the effects of other activities? In this context, monitoring is of high importance.
- Cumulative impacts have received little attention so far.

Recommendations/requests of stakeholders to FIThydro

The **recommendations/requests of stakeholders to FIThydro** mainly concerned the development of the fish hazard index by the project, the sensitivity of fish species and the development of tools and models to evaluate fish populations.

Ca. 60% of the stakeholder recommendations on issues related to the ecology of fish species can be followed up fully or to some extent in the FIThydro technical deliverables.

Ecology of fish species: Stakeholder Requests and FIThydro Steering Committee Response

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
The fish hazard index should reflect the **cumulative impacts** of several structures.	Iberian	The fish hazard index will be developed to serve the assessment of environmental impact as well as mitigation potential/need for single hydropower plants. As such the index can and will be used also for assessing the cumulative impacts resulting from a series of HPP while considering the specific risk of each single HPP. However, the detailed approach how to perform cumulative impact assessment is not ready yet, but in development. The cumulative impacts of several structures will be addressed in D1.4 "Cumulative Impact Assessment".	D1.3 (Oct-19) D1.4 (Feb-20)
It might be useful to consider also the **productivity of the system** in the fish hazard index developed by FIThydro.	Scandinavia	Productivity will not be considered as this is indirectly reflected by the type specific (reference) fish community and deviations from the latter due to e.g. eutrophication cannot be attributed to HPP	D1.3 (Oct-19)
Concerning the FIThydro work on mortality, it is important to use at least two different categories for **Kaplan turbines**: small and large, because the effects are different.	Alpine	This remark was taken up and will be considered in the fish hazard index	D1.3 (Oct-19)
Consider **other factors**: thermal, diseases/virus, plasticity of species	France & Belgium	This will not be considered, because these impacts do not usually result from HPP construction or operation. Thermal stratification and cold water release impacts regularly occur at large reservoirs, which are not in the scope of the FIThydro project.	-
Increase knowledge on ecology and biology (relevant for efficiency of mitigation measures)	Iberian	Deliverables are already available summarising knowledge on: Metadata overview on fish response to hydropower (D1.1) Risk classification of European lampreys and fish species (D1.2); this contains a compilation of habitat requirements of fish that are relevant for hydromorphological mitigation measures	D1.1 (Available online) D1.2 (Available online)
Compilation or construction of **preference (or suitability) curves** for different cyprinid species	Iberian	Habitat requirements and preferences of species have been compiled and analysed. The results are available already in deliverable D1.2 Risk classification of European lampreys and fish species	D1.2 (Available online)

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Assessed sensitivity of species should not take account only of the percentage of fish dying in the turbines but also the share of the **fish population**, which approach the turbines.	Alpine	This is a knock out request for all non-diadromous species, because no HPP operator is willing to assess the absolute number of fish in the catchment upstream of the HPP, which would cause tremendous mark – recapture efforts to achieve at best a qualified guess. In contrast, operators have to provide evidence that the rate of fish killed in the turbines constitute only a negligible share of the total population.	-
Develop tools to evaluate the **resilience of populations**	France & Belgium	This is already provided by deliverable D1.1 and further developed in D1.2. The resilience of a species/population is the opposite of its sensitivity against mortality.	D1.1 (Available online) D1.2 (Available online)
Contribute to the development of **models to assess fish habitat suitability** (at the scale of communities rather than at the species level) of the cyprinids, in order to identify the possible affectations in reaches influenced by hydropower	Iberian	The community level is framed by the river reach and the river type specific fish assemblage or in case of development targets fish reference. The type-specific communities usually consist of different ecological guilds or functional species. Habitat requirements will be assembled for each guild. The habitat modelling activities will be focused on target fish species, identified for each test case where that modelling will be developed. An agent-based model will also be developed. Regarding fish habitat at communities scale no specific development is foreseen.	D1.3 (Oct-19) D3.3 (Oct-20)
Provide **more automatized models**	France & Belgium	There is not a specific purpose of “more “automatized” for the models being developed within FIThydro. Regarding numerical modelling, the main ideas are providing guidelines for fish behavior assessment downstream of HPP and upgrading some existing models in order to make them more Europe-wide applicable. Regarding the automation, due to site specific aspects behind any modelling, it seems unlikely that significant advance may be made.	-
Pros and cons of **measurements and their statistical validation** should be examined; what can be extrapolated to other sites?	Alpine	General recommendation to be considered across deliverables dealing with the test cases	-
Long term observations on water catchment (and capitalize every data acquired on sites per biogeographical region)	France & Belgium	General recommendation without linkage to a specific deliverable	-

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Evaluate the combined role of **multiple anthropogenic pressures** (synergies, conflicts, neutral)	France & Belgium	Other pressures on fish populations than hydropower will only briefly be touched in FIThydro	-
The project does not focus specifically on the impact of **invasive species** to fish populations	Iberian	Flow and /or habitat alterations impacted the native communities and give room and anthropogenic license to new species to non-natives. The non-native species might delay the recovery of the native fish; however, the primary impact is not from invasive species but from habitat modification. Impact from habitat modification will be addressed in FIThydro but not impact from invasive species. Some connections might be made in the project, for example looking at how flow alterations act as a variable to introduced species success.	-
Use the results of the **European projects** MARS and REFORM	France & Belgium	Results of MARS and REFORM are being used where relevant	-
Looking for compilation, classification, standardization of approaches and existing data	France & Belgium	General recommendation; issues already taken into account in development of project tools and outputs	-

Fish migration

Discussions addressed fish migration and fish passage solutions (for upstream and downstream migration) and the workshops included presentations on how these issues are being assessed in the test cases of the FIThydro project. Technical solutions, methods, tools and devices (SMTDs) being developed by the project were illustrated

Some of the key problems identified by stakeholders are:

- Site-specific aspects are critical in the selection of technical solutions to support fish migration.
- More studies are needed on fish passage through turbines.
- More studies (field studies) are needed on solutions for short-distance migrators.
- Lack of monitoring of fish passes in order to assess their efficiency.
- Lack of detailed species-specific knowledge on fish behaviour and migration behaviour patterns. Especially for potamodromous species, their migration/movement behaviour and relation to habitat availability needs further research.
- Challenges associated with tracking the use of fish passages in rivers and possible fragmentation of populations.
- Reservoir effects: How to help fish face the reservoir while moving to suitable spawning grounds?
- Fishway entrance location and attraction flow which will compete with discharge and turbine flows.
- Solutions are still needed for migration across large HPP: How can more cost-effective solutions be developed? How can successful solutions from small-scale HPP be applied to large HPP?
- Downstream migration: Still open issues in relation to large rivers, safe fish passage and avoiding turbine mortality; further research is needed on large HPP in different river types, including etho-hydraulic experiments. Also the biological functioning of fine screens with bypass at large HPP requires further attention.
- Upstream migration: Existing fish passes for upstream migration are not state-of-the-art at several sites.
- Nature-like versus technical fishways: There are pros and cons for both solutions; decision which solution is better depends on the conditions at a specific site.
- Improvements are needed not only in migration routes but also in habitats.
- Problems related to invasive species at fish passes.

Recommendations/requests of stakeholders to FIThydro

The **recommendations/requests of stakeholders to FIThydro** concerned among others technical solutions for upstream and downstream migration, their efficiency, techniques to assess fish pass suitability and relationships between technical and habitat measures.

Ca. 65% of the stakeholder recommendations on issues related to fish migration can be followed up fully or to some extent in the FIThydro technical deliverables.

Fish migration: Stakeholder Requests and FIThydro Steering Committee Response:

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Find systems which work equally well for allowing fish **downstream migration and taking in the water** (trashracks reach their functional limit for flows above 60m³/s)	France & Belgium	Addressed only in the survey of solutions, models, tools and devices	D2.1 (Available online)
Quantify the gains brought by crossing structures on stocks of different species	France & Belgium	Efficiency of cross structures are evaluated	D2.2 (Apr-19)
Analyse **fish pass selectivity** (e.g. native versus exotic species)	Iberian	Range of the upstream fish pass is specified for different species	D2.2 (Apr-19)
Location and attraction ability of the fish passes need to be emphasized	Iberian	This will be addressed for different test cases but stays specific at each test case.	D2.2 (Apr-19)
Protocol to assess **fish passage suitability**	Iberian	Information about field measurements and operational tools will be delivered in the FIThydro workshop on “Lab and field measurement techniques” (25/1/2019, Lisbon). Workshop results will be integrated in Deliverable D2.2	D2.2 (Apr-19)
Study fish pass suitability concerning **seasonal Mediterranean flow variability**	Iberian	Within the development of guidelines for fish behaviour assessment downstream of HPP, the performance of fish passes with varying discharges will be considered	D3.3 (Oct-20)
Future research should look further into ways of **operating HPPs in a more flexible way** (operational measures to guide fish) combined with research on what happens in the water (e.g. are there fish that want to migrate?)	Scandinavia	Research on operational measures is being done at the HPP Bannwil, Switzerland Overall, this issue is relevant for a future research agenda (follow-up projects)	D2.2 (Apr-19)
It would be helpful if FITHydro could deliver experience and data on high-resolution **multi-beam techniques**	Scandinavia	This information is delivered with results of different test cases and also in the workshop on “Lab and field measurement techniques” (25/1/2019, Lisbon). Workshop results will be integrated in Deliverable D2.2	D2.2 (Apr-19)
“All” species and sizes should be considered	Alpine	Many species (but not all) are considered in the field and laboratory studies and the results will be published in D2.2 and D3.4	D2.2 (Apr-19) D3.4 (Oct-20)

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Habitat and technical measures should not be considered separately from each other	Alpine	We consider both together at Schiffmühle HPP (Switzerland) and in other test cases	D2.2 (Apr-19)
Understanding of why a solution works (or not), the **link between biological response and stimuli** created by the solution	France & Belgium	This topic is addressed for some of the solutions in D2.2 and D3.4	D2.2 (Apr-19) D3.4 (Oct-20)
Define best solutions for both **downstream and upstream migration**	Iberian	Various existing and new solutions are studied within the project.	D2.1 (Available online) D2.2 (Apr-19) D3.4 (Oct-20)
What could be a „technical“ and „economic“ solution for the **intakes (turbine circuits)** in order to decrease the mortality?	Iberian	FIThydro will develop new fish guidance structures to protect and guide fish from hydropower intakes. Simultaneously, a new model for assessing fish mortality due to turbine passage will be developed.	D3.1 (Oct-19) D3.4 (Oct-20)
Special study for **higher dams**	Iberian	This cannot be addressed as none of the FIThydro test sites is suitable for a study on high dams.	-
Analyse fishways built at **small-scale hydropower plants** that work badly and analyse solutions to improve them, if possible	Iberian	This is more a case by case analysis	-
It is important to link **connectivity measures for large HPP** to the ecological function being targeted, and possibly a fish guidance structure	Scandinavia	In FIThydro, it will be very difficult to link them. This is a bit far from the project objectives. We will provide technical solutions for downstream migration applicable to small and medium HPP. For the large HPP, other solutions will be proposed but not really tested inside the project.	-
Concerning the challenge of upscaling solutions implemented in smaller scale to large HPP, it would be helpful to set up a joint **pilot project at a large HPP**. There are ideas on this already by HPP operators in Sweden	Scandinavia	Cannot be addressed in FIThydro. Only possible in a follow-up pilot project.	-
Field **monitoring** of fish guidance screens **at large HPP** is needed	Alpine	In FIThydro (Swiss test cases), fish monitoring is done for the fish guidance screens at small HPPs. Furthermore, fish monitoring is done at large HPP without ‘fish guidance screens’.	-

Sediment and habitat

Discussions covered issues regarding sediment continuity around hydropower dams, challenges related to sediment management, conceptual and operational approaches to manage reservoir sedimentation and sediments in HPP.

Some of the key problems identified by stakeholders are:

- Sediment transport is now an issue more widely recognized by HPP operators.
- Lack of natural bed-forming floods is a key issue.
- Reducing spawning grounds from covered gravel due to impoundment and channelization.
- Challenges for sediment transport differ between large and small dams.
- Technical and biological challenges also differ for different sediment sizes; Need to evaluate and quantify the needs of different species in terms of large sediments and their resistance to fine sediment.
- Research so far concentrates on the hydromorphological issues related to sediment transport, while biological impacts are not yet (or little) considered.
- From an ecological perspective, we need to know what are the effects of suspended sediments on downstream ecology and fisheries, ideally by looking at reference river systems.
- Possibilities to work with measures like sediment replenishment, reservoir flushing and artificial floods depend on the legal context and involved stakeholders.

Recommendations/requests of stakeholders to FIThydro

The **recommendations/requests of stakeholders to FIThydro** on sediments and habitats are outlined in the table below.

Due to the limited scope of work carried out on sediments in FIThydro, only about one-third of these stakeholder recommendations can be followed up in the FIThydro technical deliverables.

Sediment and habitat: Stakeholder Requests and FIThydro Steering Committee Response

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Characterize the link between **fish species and large sediment**	France & Belgium	This aspect is addressed in different test cases of the Fithydro project We are trying to link sediment related habitat availability for different species	D2.2 (Apr-19) D3.3 (Oct-20)
Implement follow-up protocols at different sites characterizing **large sediments and functionality of patches** of large sediments	France & Belgium	Cannot be addressed in the FIThydro project	-
Characterize the difference of **hydrosedimentary regimes** (large scale)	France & Belgium	Cannot be addressed in the FIThydro project. This large scale approach is not part of FIThydro due to a lack of time and resources	-
Build on proven and existing hydraulic basis and **extrapolate in terms of biological interest**	France & Belgium	Cannot be addressed in the FIThydro project	-
FIThydro should provide **statistically robust** statements	Alpine	General recommendation taken into account in development of project tools and outputs	-
FIThydro should make clearer how it is going to **extrapolate conclusions,** which are based on test cases, to more general recommendations for other HPP in other rivers and other regions	Alpine	Sediment management is very broad and FIThydro only applies very specific solutions in its test cases. It will not be possible to give general solutions to every situation.	-

(Environmental) flows and habitat

This addressed activities related to environmental flows and downstream flows within FIThydro, methods for defining ecological flows and effects of minimum flow conditions on fish.

Some of the key problems identified by stakeholders are:

- Key open questions concern how e-flows are determined and what methods should be used.
- In some countries, legislation mixes different methodologies that are not compatible and uses criteria for e-flows which lack an ecological basis.
- It can take many years to determine if a new E-flow is effective, sometimes more than 5-10 years. As such, there is a need for indicators to measure short-term progress.
- Efficient measures are needed which lead to ecological improvements but have minimized impact on hydropower production and regulation.

Recommendations/requests of stakeholders to FIThydro

The **recommendations/requests of stakeholders to FIThydro** concerned the need for guidelines and indicators on the assessment of environmental flows, objective methods to calculate environmental flows, solutions for releasing environmental flows in existing dams and links to sediments.

Ca. 75% of the stakeholder recommendations on issues related to flows and habitats can be followed up fully or to some extent in the FIThydro technical deliverables.

(Environmental) flows and habitat: Stakeholder Requests and FIThydro Steering Committee Response

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Prepare a **guideline or „handbook“** to support decision making and to assess environmental flows efficacy (e.g. environmental goals, efficacy indicators)	Iberian	This will be addressed in the FIThydro WIKI	D4.1 (Available online) D4.5 (Oct-20)
Contribute to objectify the **methods of calculation** of environmental flows and develop indicators that allow to assess the ecological effectiveness of environmental flows once implemented	Iberian	FIThydro is not developing new e-flows methods, but rather takes advantage of the test case experiences and addresses existing e-flows regime effectiveness. This will be done on a scenario modelling basis included in the cost-effectiveness analysis Existing environmental flow methods will be described in the FIThydro WIKI	D4.1 (Available online) D4.5 (Oct-20) D4.7 (Oct-20)
Adapt **solutions and devices** to release these flows in existing dams	Iberian	FIThydro will not address the development of solutions or the adaptation of existing ones for releasing environmental flows. Within the characterization of the test cases, the existing solutions for releasing eflows will be described	-
The issue of **sediments in relation to flows** needs to be considered	Iberian	This issue will be considered in FIThydro, not in the context of large reservoirs, but rather for maintenance of downstream spawning grounds	Partly in: D2.1 (Available online) D2.2 (Apr-19) D3.3 (Oct-20)

Compensational habitats

This involved discussing experiences with compensation habitats and relevant typical measures related to hydropower plants (e.g. fish passages, minimum flow, gravel addition, vegetation addition and floodplain reconnection).

Some of the key problems identified by stakeholders are:

- Habitats are very important for achieving self-sustainable fish populations. However, it is a key question whether habitat mitigation measures alone can support a population.
- Nature-like fish passes can be good habitats but not for all fish life stages. A lot of small fish and large fish can be detected in fish passes but not medium-size fish.
- In rivers with a series of impoundments, it is difficult to create compensational habitats and provide additional spawning grounds.

Recommendations/requests of stakeholders to FIThydro

Only few recommendations/requests of stakeholders concerned compensational habitats and these are outlined in the table below.

Compensation habitats: Stakeholder Requests and FIThydro Steering Committee Response

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Best practice examples should be collected **Success criteria** for compensational habitats should be defined	Alpine	Improving habitat conditions is an important mitigation measure Habitat quality and issues related to compensational habitats will be investigated and evaluated in case studies in the Alpine and the Scandinavian regions.	D4.1 (Available online) D4.5 (Oct-20)

Impacts of hydropeaking and mitigation measures

Discussions addressed the effects of hydropeaking on movement, behaviour, habitat and spawning of fish. Discussions also took place on the development of a hydropeaking tool to assess the impact of the operation regime, as well as the development of mitigation solutions.

Some of the key problems identified by stakeholders are:

- There are still few studies on the real effects of hydropeaking on fish; many impacts attributed to hydropeaking are theoretical. This makes it difficult to adopt adequate mitigation measures
- There is lack of good quality control data in the pre-operational stage.
- Operators should look at combinations of operational and technical measures to achieve good ecological status/potential.
- It is a challenge to design and assess the efficiency of measures to minimize the impacts of hydropeaking without affecting significantly electricity production and without changing the function in the market of each hydroelectric plant

Recommendations/requests of stakeholders to FIThydro

The recommendations/requests of stakeholders to FIThydro concerned the development of criteria and methods to assess the effects of hydropeaking on ecosystems, monitoring relevant modifications and the need for guidelines on relevant mitigation measures.

All of the stakeholder recommendations related to hydropeaking can be followed up fully or to some extent in the FIThydro technical deliverables

Impacts of hydropeaking and mitigation measures: Stakeholder Requests and FIThydro Steering Committee Response

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Developing **hydropeaking related criteria** would be useful in the Iberian region (e.g. flow reduction in the summer) Contribute to the development of **criteria, indexes and work methodologies** that allow identifying and quantifying objectively the effects of hydropeaking on fluvial ecosystems **Guidelines** to minimize impacts of hydropeaking, taking into account the complex market of energy Increase more detailed knowledge on hydropeaking **impacts on native Iberian fish** species	Iberian	Please refer to the hydropeaking tool which will also be applicable in the Iberian region. Within the development of the hydropeaking tool, expert rules will be proposed to characterize the behaviour of the Iberian barbel.	D3.3 (Oct-20)
A **handbook of mitigation measures** (on hydropeaking) should be created in order to be applied to all new projects	Iberian	Mitigation measures for hydropeaking will be included in the FIThydro WIKI. This is also documented in D2.1	D4.5 (Oct-20) D2.1 (Available online)
Monitor habitat modification, e.g. spawning grounds dewatering as a consequence of hydropeaking	Iberian	This is addressed in the hydropeaking tool and will also be studied in detail at some Test Cases	D3.3 (Oct-20)
Study of measures based on non-alteration of hydropower exploitation regime (e.g. improving downstream habitat)	Iberian	The FIThydro WIKI about mitigation measures will include habitat measures. This is also documented in D2.1	D4.5 (Oct-20) D2.1 (Available online)

Combination of mitigation strategies & socio-economic/policy challenges for decision-making

This topic included presentations of FIThydro's ongoing work on tools for a cost-effective combination of mitigation measures. It also addressed issues with regard to opportunities and challenges of the policy and socio-economic framework for taking decisions on the planning and operation of hydropower plants, including issues related to regulations and financial support mechanisms in the respective regions.

Some of the key problems identified by stakeholders are:

- Deciding what type of measures to implement in order to reach a certain goal is a challenge, e.g. maintaining 95% of the fish population.
- Implementation of measures should be based on a cost/benefit analysis: Necessary to have clear indicators on the efficiency/effectiveness and to quantify investments or production losses associated with measures. We need indicators of the goal we wish to achieve, in order to check functionality, e.g. of habitat measures or fish-friendly turbines, and to assess effectiveness against this goal.
- In the context of implementing the WFD, biotic components (and fish populations in specific) have not responded yet to measures. It was mentioned that a period of 5-15 years is needed to really get a response but the monitoring sites often do not match the restoration sites. Therefore, it is difficult to measure restoration success.
- It is important to have a method for quantifying benefits, e.g. in relation to the socio-economic importance of fish species preservation.
- A key question is how to define proportionate costs and how to select which measures are cost-effective and under which circumstances.
- An open question is often who is responsible for paying for mitigation measures (polluter-pays principle; grants and green labels based on consumer contributions; expropriation of property as an option?).
- Financing of mitigation measures remains a major open issue in many countries.

Recommendations/requests of stakeholders to FIThydro

The recommendations/requests of stakeholders to FIThydro concerned issues around an information platform on mitigation measures (including information on their efficiency), costs of measures and forecasting measures effectiveness, the analysis of cost-effectiveness and decision support tools.

Ca. 80% of the relevant stakeholder recommendations on these issues can be followed up fully or to some extent in the FIThydro technical deliverables.

Combination of mitigation strategies & socio-economic/policy challenges for decision making: Stakeholder Requests and FIThydro Steering Committee Response

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Tools and recommendations: Adaptable to different contexts, pragmatic, taking into account the economic aspects (cost-effective aspects)	France & Belgium	General recommendation; issues already taken into account in development of project tools and recommendations	-
It is important to **clarify some of the concepts** used with regard to mitigation measures in the surroundings of hydroelectric plants (e.g. ecological flows, fishways); the inherent perspective is the remediation or rehabilitation, not restoration (return to the original ecosystem)	Iberian	General introduction to concept of mitigation measures will be provided in the FIThydro WIKI	D4.5 (Oct-20)
Handbooks for the smart combination of solutions **Mitigation measures toolbox and guidelines** needed to select best measures based on a cost-benefit analysis To describe mitigation measures, a **web-based information platform** is preferred, compared to a handbook format. A web-based information platform helps spread the information to more people. However, the guidance needs to be citable, which is a weakness of a web-based system	France & Belgium Scandinavian	A handbook will not be produced but web-based tools to facilitate this (WIKI and Decision-Support System in development)	D4.5 (Oct-20) D5.4 (Feb-20)
Contribute to knowledge on the real state of the situation in order to identify the key points and contribute, through knowledge and information, to solving the main problems **European benchmark** for electricity production companies concerning environmental obligations, implementation, funding, assessment and success of measures	Iberian	Will be addressed by developing a decision matrix for assessing alternative mitigation measures for identified problems (bottlenecks)	D4.2 (Oct-19)

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
Facilitate **cost-effectiveness analysis** of mitigation measures, giving visibility to the advantages/disadvantages offered by different methods (avoided costs, CBA, CEA) Provide guidance on how to **forecast the effectiveness** of recommended measures	France & Belgium Alpine	An approach for cost-effectiveness analysis will be developed and illustrated on the FIThydro WIKI	D4.5 (Oct-20)
Feedback, synthesis of the **efficiency of mitigation measures** (increased instream flow, hydropeaking)	France & Belgium	The FIThydro WIKI will include information on the efficiency of these mitigation measures as well as examples. They will also be tested in scenario modelling. In addition, the REFORM WIKI (http://wiki.reformrivers.eu) also offers state of the art information on hydromorphological river rehabilitation and measures efficiency	D4.5 D4.6 D4.7 (All in Oct-20)
Operating costs of mitigation measures should not be neglected	France & Belgium	Operating costs will be considered in the cost estimates and be provided for different types of mitigation measures	D4.3 (Apr-20)
A system to **check quality of data collected on effects and costs** by FIThydro is needed, for data to be credible. E.g. information on effectiveness of measures should be based on monitoring	Alpine	We will gather information from many sources and do a quality check as far as possible	-
Impact of mitigation measures on the **output and availability of power plants** should be considered	France & Belgium	Will be addressed and conclusions will be made available in reports and the FIThydro WIKI	D4.4 (Aug-20) D4.5 (Oct-20)
A „**handbook of criteria**“ (design, operation, post-evaluation, monitoring) unified in Europe is required. FIThydro should have as main objective to fix that in order to be transferred into regulation laws	Iberian	A web-based Decision-Support System will address these issues	D5.4 (Feb-20)
FIThydro decision-support tool could address also **bottlenecks not related to hydropower**, e.g. lack of fish due to acidification	Scandinavian	This is outside the scope of FIThydro and will not be addressed	-
Make a cross-analysis of good/bad practices on the approach of **regulatory and**	France & Belgium	Partly addressed in terms of differences in regulatory regimes and financing support tools in different countries.	D5.1 (Available online)

Stakeholder recommendation/request	Region	Response of FIThydro Steering Committee	Deliverable
socio-economic issues of different Member States			

List of FITHydro deliverables for interested stakeholders

The following tables gives an overview of the status of the outputs by FIThydro until the end of the project in October 2020

#	Description of deliverable	Date	Status	Short description
D1.1	Metadata overview on fish response to hydropower	Oct-17	Available[2]	This aimed at developing a fish species classification system according to species-specific sensitivity against mortality. Another objective was providing the biological and autecological baseline for developing a fish population hazard index for the European fish fauna.
D5.1	Review of policy requirements & financing instruments	Oct-17	Available[3]	This investigates the regulatory landscape for planning and operating hydropower plants on EU and country level. The report also looks at the use of financing instruments especially in the countries where FIThydro test sites are located.
D1.2	Risk classification of European lampreys and fish species	Oct-18	Available[4]	This study aimed to characterise the potential impacts of hydropower on fish and identify species most at risk. The results provide the operation related component or baseline for developing a fish population hazard index for the European fish fauna.
D2.1	A List of solutions, models, tools and devices, their application range on a regional and overall level, the identified knowledge gaps and the recommendations to fill these	Oct-18	Available[5]	This identifies knowledge gaps and existing solutions, methods, tools and devices for a comprehensive assessment of self-sustained fish populations affected by hydropower on the following topics: (1)Upstream and downstream migration, (2)Turbines, (3) Hydromorphology, (4) Hydropeaking, (5) E-flows, (6) Fish characterization and habitat, (7) Presentation of the Test cases.
D4.1	A classification system for methods, tools and devices for improvements measures	Oct-18	Available[6]	This report aims to describe the main types of mitigation measures that can be used to solve challenges related to: Environmental flows, Habitat, Sediment management, Downstream fish migration, Upstream fish migration. For each type of mitigation measures, several solutions are described.
D2.2	Working basis of solutions, models, tools and devices and identification of their application range on a regional and overall level to attain self-sustained fish populations	Apr-19	In prep	Report of solutions based on the analysis of the present solutions and the potential solutions. Definition of tools and devices which could be test in the WP3 in collaboration with the providers of the different regions.
D1.3	Fish Population Hazard Index	Oct-19	In prep	Referenced, index-based assessment scheme for fish hazards at hydropower including an application guideline

[2] https://fithydro.eu/wp-content/uploads/2017/12/D1.1.pdf
[3] https://fithydro.eu/wp-content/uploads/2018/02/Fithydro_D5.1_V2final.pdf
[4] https://syncandshare.lrz.de/dl/fiNCXf1nZeUtjaeqStUHAXa4/?inline
[5] https://syncandshare.lrz.de/dl/fiJfqVXVsawLyXRsC83HKg1t/?inline
[6] https://syncandshare.lrz.de/dl/fiPtwbn8Jsy25dvwaAJjdwHw/?inline

D1.4	Cumulative Impact Assessment	Feb-20	In prep	Evidence based guidance on assessment of, and management strategies for, the potential for cumulative effects from hydropower developments.
D3.1	Guidelines for mortality modelling	Oct-19	In prep	Report on extending the turbine fish mortality model BioPA to European species.
D3.2	Tools for fish behaviour assessment	Oct-19	In prep	This report will include - Development of an agent based model incorporated in the fish habitat simulation system CASiMiR. - Development of a software tool for hydropeaking impact assessment on fish habitats. - A new system for 3D fish-tracking - Artificial Lateral Line Probe for Turbulent Flow Assessment - Barotrauma Detection System for Turbine Passage
D3.3	Guidelines for fish behaviour assessment at HPPs	Oct-20	In prep	This report will include - Application of an agent based model incorporated in the fish habitat simulation system CASiMiR - Application of software tool for hydropeaking impact assessment on fish habitats - Guidelines for structural improvement measures - Hydro-morphodynamic investigations and resulting improvement measures - Modelling fish passage facilities and hydro-morphodynamic improvement measures for hydropeaking
D3.4	Enhancing and customizing technical solutions for fish migration	Oct-20	In prep	This report will include results on: - Downstream fish guidance systems with horizontal bars (FGS-Type I) and low bar spacing - Downstream fish guidance systems for large run-of-river hydropower plants (FGS-Type II) - Downstream fish guidance systems for perforated inclined plate - Downstream fish protection system using electro shock technique - Vertical slot fishways with macro-roughnesses or flexible cylinders
D4.2	Functional application matrix for identification of potential combinations of improvements measures	Oct-19	In prep	A decision matrix for assessing alternative mitigation measures for each identified bottleneck will be developed
D4.3	General cost figures for relevant solution, methods and tools	Apr-20	In prep	A set of cost-effectiveness measures and cost estimates will be provided at different levels for various solutions and combinations.
D4.4	General strategies to optimize production under given environmental restrictions or measures that influences production schedules	Aug-20		Adapting and running power production planning models with alternative environmental restrictions, documenting the results in peer-reviewed article and report.

D4.5	A set of general applicable effectiveness measures for solutions, methods and tools implemented to improve fish sustainability in regulated rivers and a cost/effectiveness matrix for a set of combined solutions, methods and tools	Oct-20	In prep	Based on D4.1, D4.2 and D4.3 a web-based tool showing the matrix of combined solutions, methods and tools to achieve improved fish sustainability will be developed **(WIKI of FIThydro)**
D4.6	Overview of relevant information on cost/effectiveness in regard implemented and possible measures to maintain or improve sustainability of fish population in the selected case studies	Oct-20	In prep	A report and a database with systematic background information from the Test Cases will be made, including cost/effectiveness for each potential measure
D4.7	A cost effectiveness matrix for the selected case study rivers and a similar matrix for potential new hydro power schemes of different characteristics	Oct-20	In prep	The matrix and tools delivered in D4.1 and D4.2 will be applied to Test Cases and reported in article and reports.
D5.3	Public acceptance of alternative hydropower solutions	Oct-19	In prep	Report on the results of the social acceptance analysis aiming to identify the perceptions and preferences of the wider public vis-à-vis the construction or conversion of hydropower plants in the four case study regions.
D5.4	Decision support system integrating technical solutions and guidelines from WP2 and 3, cost-effectiveness from WP4 and social/political aspects from WP5	Feb-20	In prep	Because of the potential high levels of impact of hydropower schemes, there is a need to develop a robust decision support system that is easy for developers to use but also maintains a high level of environmental protection. This task will develop such a protocol based on a risk assessment framework.

About FIThydro

The EU Horizon2020 project Fishfriendly Innovative Technologies for Hydropower (FIThydro) investigates cost effective environmentally friendly solutions and mitigation measures for improving fish protection in hydropower plant affected rivers. FIThydro develops decision support tools for the planning, commissioning and operation of hydropower plants, using existing and innovative technologies. Within the project, 26 partners from science and industry across Europe are work together to find the best solutions for different hydropower scenarios and support an ecologically friendly electricity production.

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Project coordinator:
Prof. Peter Rutschmann
Technical University of Munich
Germany

Contact information:
info@fithydro.eu

Partner contact for the document:
Eleftheria.kampa@ecologic.eu

Further information
Twitter: @FIThydroproject
www.fithydro.eu

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Responsible for content: See list of authors

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