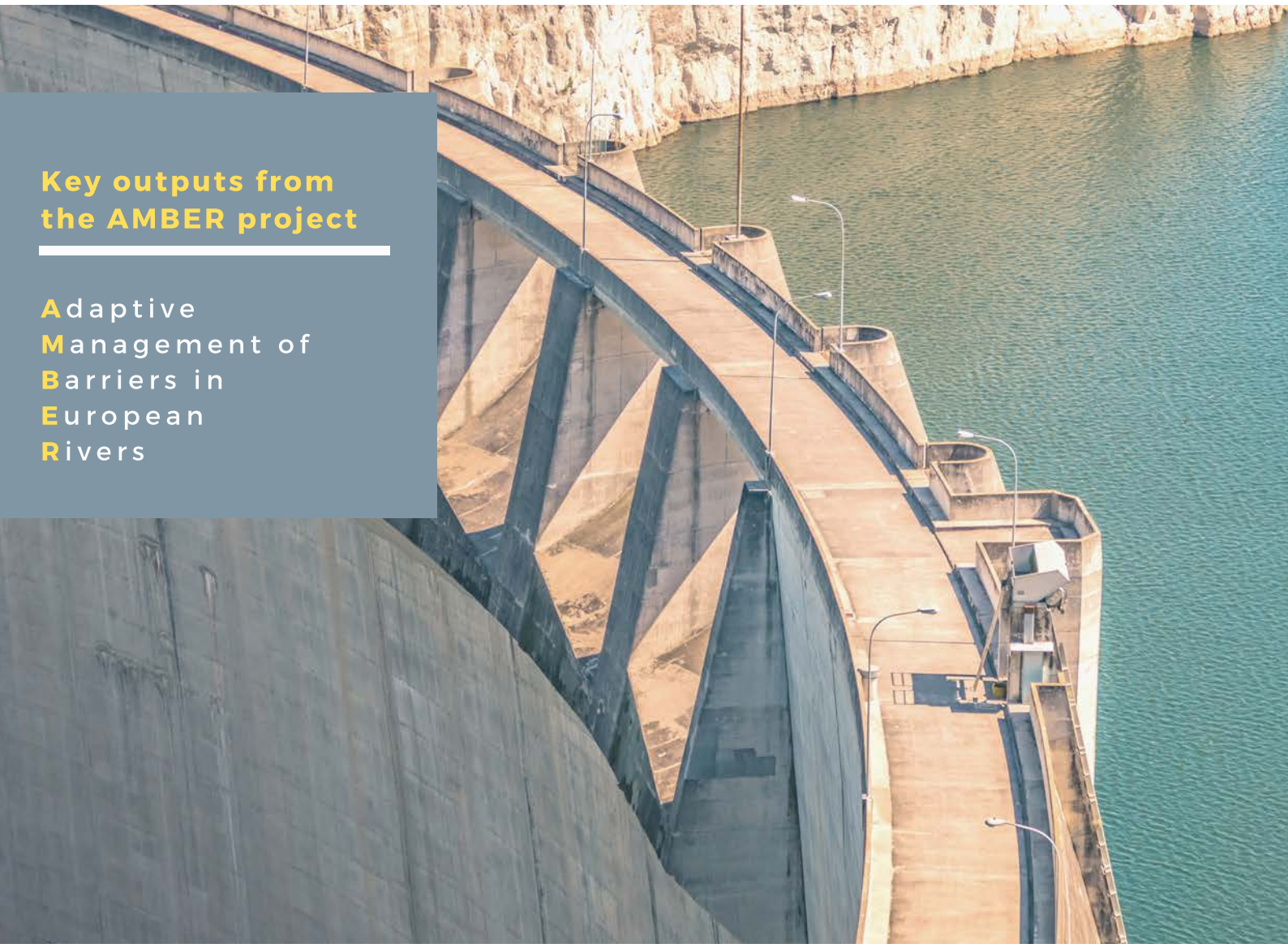
SEPTEMBER 2020

AMBER POLICY BRIEF 2



Key outputs from the AMBER project

Adaptive
Management of
Barriers in
European
Rivers

TOOLS FOR MANAGING AND RESTORING CONNECTIVITY IN EUROPEAN RIVERS

This policy brief outlines the tools developed in WP2 and WP3 as part of the H2020 AMBER project

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AMBER

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No. 689682

1. OVERVIEW OF AMBER TOOLS

This policy brief outlines some of the tools developed during the AMBER project to help resource managers quantify stream fragmentation, assess barrier impacts and benefits, and make better, informed decisions on existing and future barriers based on what if scenarios. Three types of tools were developed, depending on the problems they help to solve:

1. Data Acquisition Tools (DATs)
   To collect and harmonize data, to fill gaps, and to make sense of disparate information

2. Mapping & Assessment Tools (MATs)
   To assess barrier effects, to predict changes, and to turn information into knowledge

3. Decision Support Tool (DSTs)
   To consider trade-offs, to inform decisions, and to turn knowledge into application based on *what if* scenarios

DAT1. BARRIER TRACKER APP

Author or Developer: Natural Apptitude for the AMBER consortium
Text: Carlos Garcia de Leaniz

The AMBER Barrier Tracker (Figure 1) is a smartphone app that enables users to locate barriers in the field, take a photograph and upload it into the cloud where it can be used to build a better map of stream fragmentation.

Figure 1. The Barrier Tracker app for recording barriers and filling data gaps developed as part of the AMBER citizen science programme in Europe https://portal.amber.international/.

Problems or needs addressed by this tool

Most barriers are grossly underreported in existing databases, as these tend to report medium to large size dams only. The Barrier Tracker harnesses the power of citizen science to provide a more complete picture of barrier abundance. It enables users to locate all types of barriers (classified into 6 main types), assess their main features, including height, current use and conservation status. The latter information is essential for identifying obsolete barriers and prioritize efforts for mitigation or removal.

References

Olivo, R. (2020). Let it Flow Magazine. https://amber.international/wp-content/uploads/2020/07/AMBER-magazine-Digital.pdf
page 30
AMBER deliverable url link:
https://amber.international/deliverables-2/

Source & availability

Available in 12 languages

Danish	German	Slovenian
Dutch	Italian	Spanish,
English	Polish	Ukrainian
French	Portuguese	Welsh

The app is free to use and download. It has no adverts. It is available for Android and IoS:

Download on the App Store | GET IT ON Google Play | AMBER

Examples of Use

Various videos have been made to demonstrate the use of the barrier tracker

- English
- Lithuanian
- Spanish

Updates

Requires Android 4.4 and higher
Requires iOS 9.0 or later. Compatible with iPhone, iPad and iPod touch.
Version 1.1.0 (15 March 2019)
Available in two new languages (Ukrainian and Slovenian) New translations added for all languages for updated functionality Export personal barrier records from app to email account via Account page Improvements made to mapping
New map data added
Various small amendments and bug fixes
Version 1.1.1 (27 February 2020)
Available for downloading all over the world
Version 1.1.2 (28 September 2020)
Essential Coreo and OS update
New translations added for updated functionality
Various small amendments and bug fixes

DAT2. GROUND TRUTHING OF STREAM BARRIERS

Author or developer: Jones, J., Belletti, B, Börger., L. Segura, G., Bizzi, van de Bund, W., Garcia de Leaniz, C.
Text: Carlos Garcia de Leaniz

This tool enables users to account for underreported barriers in existing databases and derive correction factors to get more accurate estimates of the abundance, location and type of barriers. A sampling strategy is developed to obtain *in-situ* information on barriers using the Barrier Tracker (Tool DAT1).

Problems or needs addressed by this tool

Existing barrier inventories are seldom complete and cannot easily be compared as they were built for different purposes, may record only a subset of barriers types, and differ also in spatial resolution, coverage, and accuracy. This tool makes use of standardised field surveys (i.e. river walkovers) to derive correction factors to obtain more precise estimates of barrier density via bootstrapping. This information is required to derive more realistic estimates of barrier density and hence of river fragmentation.

Training needs

Users must follow a standardised sampling protocol (detailed in Belletti et al., 2020; Jones et al., 2020) and agree on a common definition of barriers types, as shown below (Figure 2).

Examples of Use

Examples of use are given in Belletti et al. (2020) and Jones et al (2019, 2020).

References

- AMBER deliverable url link: https://amber.international/deliverables-2/
- Belletti, B., et al. (2020). Broken rivers: ground-truthing the world's most fragmented rivers. Authorea (pre-print) doi: 10.22541/au.159355955.53596231
- Jones, J. et al. (2019). A comprehensive assessment of stream fragmentation in Great Britain. Sci. Tot. Env. 673, 756-762 (2019).
- Jones, J., et al. (2020). Quantifying river fragmentation from local to continental scales: data management and modelling methods. Authorea (pre-print) doi: 10.22541/au.159612917.72148332.

Source & availability

The tool is fully described in AMBER deliverable D1.3, available at the AMBER website https://amber.international/. It is also described in Jones et al. (2019, 2020) and Belletti et al. (2020).

Improvements over state of the art

Most previous attempts to harmonise existing barrier databases have taken a common denominator approach and used only information from large dams that can sometimes be detected via remote sensing (e.g. Grill et al., 2019). The merits of *in situ* barrier ground truthing first proposed by AMBER (Jones et al., 2019) have recently been demonstrated (Atkinson et al., 2020; Sun et al., 2020).

Updates

NA

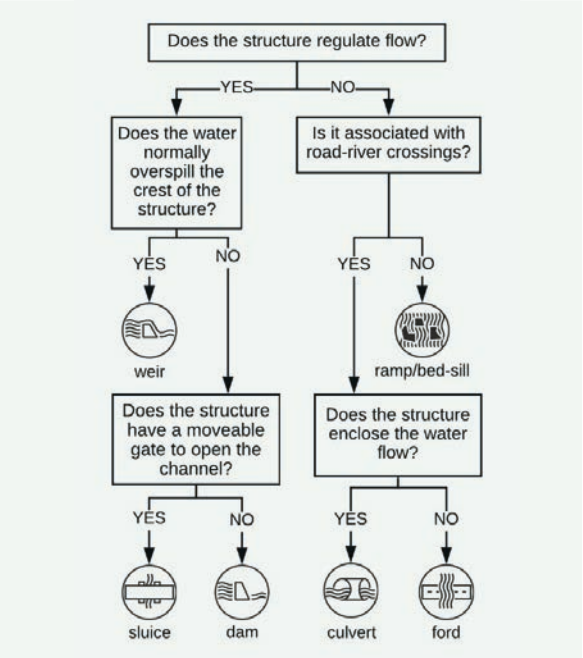

Figure 2. Decision tree used for classifying longitudinal stream barriers into six main functional types. Structures that do not meet these criteria are classified as "other" (from Jones et al., 2020).

DAT3. BARRIER DUPLICATE EXCLUDER

Author or developer: Jones, J., Belletti, B, Börger., L. Segura, G., Bizzi, van de Bund, W., Garcia de Leaniz, C.
Text: Carlos Garcia de Leaniz

This tool enables users to detect and exclude duplicates from barrier databases and get more accurate estimates of true barrier density.

Problems or needs addressed by this tool

Duplicate records are common in existing barrier inventories whenever more than one barrier database are merged. This introduces an upward bias in estimates of barrier density.

Training needs

No special training needs are required but the following workflow has been successfully used in AMBER (Figure 3).

Examples of use

See Jones et al. (2020)

Updates

NA

References

- AMBER deliverable url: link: https://amber.international/deliverables-2/
- Jones, J. et al. (2019). A comprehensive assessment of stream fragmentation in Great Britain. Sci. Tot. Env. 673, 756-762 (2019).
- Jones, J., et al. (2020). Quantifying river fragmentation from local to continental scales: data management and modelling methods. Authorea (pre-print) doi: 10.22541/au.159612917.72148332.

Source & availability

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It is also described in Jones et al. (2019, 2020) and Belletti et al (2020).

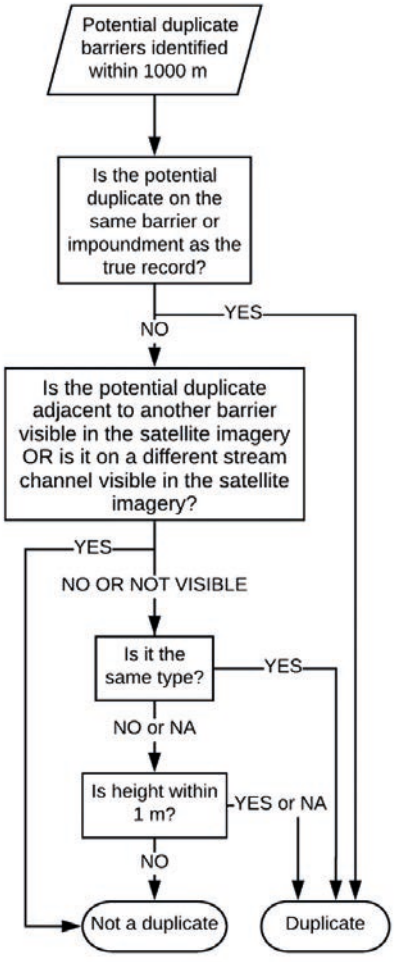

Figure 3. Decision tree used to identify duplicate barrier records (from Jones et al., 2020).

MAT1. RAPID BARRIER ASSESSMENT TOOL

Author or developer: Jim Kerr, Andrew Vowles, Paul Kemp
Text: Jim Kerr

The Rapid Barrier Assessment Tool automates the process of calculating barrier passability scores for multiple fish species based on barrier height, slope and depth. The tool is based on the French ICE (Informations sur la Continuité Ecologique) protocol (Baudoin et al., 2014) and produces barrier passability scores ranging from 0 – 1: 0 (total barrier), 0.33 (high-impact partial barrier), 0.66 (medium impact partial barrier), 1 (low-impact passable barrier). The tool also estimates the hydropower potential (Watts) at the site through a simple assessment of discharge and head drop.

Problems or needs addressed by this tool

Telemetry and other empirical studies provide valuable information on barrier passability, but they are generally very resource intensive and tend to focus on salmonids and/or large barriers. The Rapid Barrier Assessment Tool provides approximate passability scores quickly and effectively to facilitate prioritisation of restoration actions at various spatial scales.

Training needs

The tool is very simple to use and does not require any specific training. It is supplied with a guide to help users install the software and includes step-by-step instructions of how to assess a barrier and produce passability scores.

Updates

NA

Source & availability

The tool can be downloaded from the AMBER website, AMBER deliverable 2.3 https://amber.international/software/

It is currently available in English only.

Examples of use

We have critically reviewed and tested current methods of barrier impact assessments in the EU and elsewhere https://www.youtube.com/watch?v=419s98rvTIs.

The tool has been used to produce passability scores for hundreds of barriers in Ireland and England.

References

Baudoin, J-M., Burgun, V., Chanseau, M., Larinier, M., Ovidio, M., Sremski, W., Steinbach, P. and Voegtle, B. (2014). The ICE protocol for ecological continuity. Assessing the passage of obstacles by fish. Concepts, design and application. The National Agency for Water and Aquatic Environments (ONEMA). 200 pp. ISBN: 979-10-91047-29-6.

MAT2. eDNA TOOL KIT

Author or Developer: Laura Clusa, Sara Fernández, Eva García-Vázquez, Deiene Rodriguez-Barreto, Richard O'Rorke, Chloe Robinson, Sofia Consuegra
Text: Carlos Garcia de Leaniz

The eDNA Toolkit enables users to detect longitudinal discontinuities in river fauna and flora caused by barriers (Figure 4).

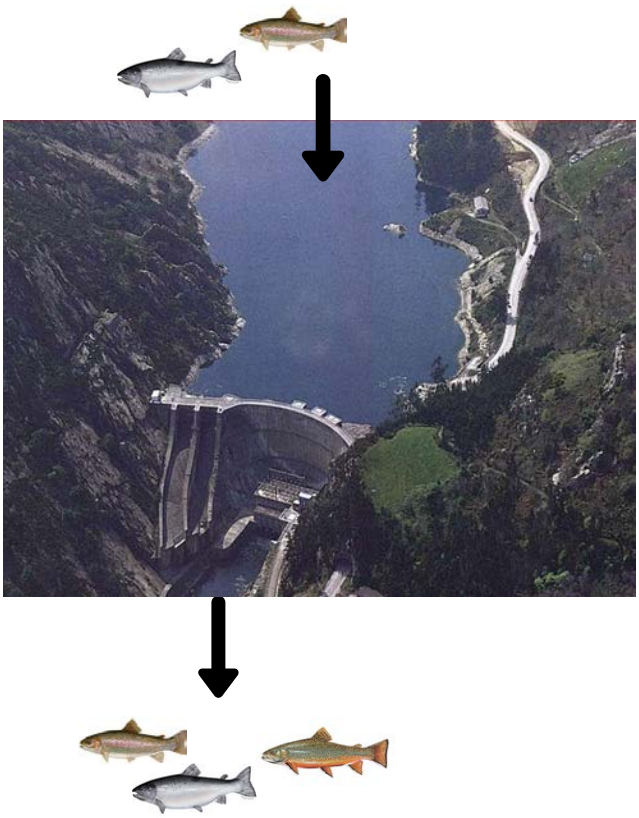

Figure 4. Example of application of eDNA to the assessment of the impact of five dams (D1-D5) on the distribution of salmonid fish in the River Nalón, Spain (adapted from Clusa et al., 2017a).

Source & availability

The toolkit is described in AMBER deliverable 2.5 on the AMBER website: https://amber.international/deliverables-2/

It is also described in Clusa et al. (2017a,b), Fernandez et al. (2018), and Robinson et al. (2019a,b).

Problems or needs addressed by this tool

The eDNA assays developed in AMBER allow users to infer presence/absence data for several targeted species from small water samples. Community-wide and species-specific markers were developed for the detection of native and invasive aquatic species using Next Generation Sequencing (metabarcoding) and real time PCR (qPCR).

Training needs

Standard Operational Procedures (SOPs) for collecting water samples are available from the AMBER Field Guide and Muha et al., 2019. Training in molecular techniques and appropriate equipment is required but a number of companies now offer eDNA analysis commercially.

MAT2. eDNA TOOL KIT

Author or Developer: Laura Clusa, Sara Fernández, Eva García-Vázquez, Deiene Rodriguez-Barreto, Richard O'Rorke, Chloe Robinson, Sofia Consuegra
Text: Carlos Garcia de Leaniz

Examples of use

The eDNA toolkit has been used to examine barrier effects in relation to Aquatic Invasive Species (AIS) in the Iberian Peninsula (Clusa et al., 2017a,b, Fernandez et al.,2018) and in Great Britain (Robinson et al, 2019a,b) and also in relation to fish community composition in the rivers Nalón and Guadalhorce (Spain), rivers Garry, Afan and Tawe (UK), and river Allier in France (Deliverable D2.5).

Studies have shown that sensitivity increases with volume of water and number of replicates. It is recommended that 1L is collected at each site in six independent replicates (i.e. 6L of water per site). This can be filtered on site with the help of 50 ml syringe and a filter capsule or brought to the laboratory (SOP in AMBER Field Guide).

Updates

NA

References

- Clusa, L., Ardura, A., Fernández, S., Roca, A.A. and García-Vázquez, E., (2017). An extremely sensitive nested PCR-RFLP mitochondrial marker for detection and identification of salmonids in eDNA from water samples. PeerJ, 5, p.e3045.
- Clusa, L., L. Miralles, A. Basanta, C. Escot, and E. Garcia-Vazquez. (2017). eDNA for detection of five highly invasive molluscs. A case study in urban rivers from the Iberian Peninsula. PLoS One 12:e0188126.
- Fernandez, S., M. M. Sandin, P. G. Beaulieu, L. Clusa, J. L. Martinez, A. Ardura, and E. Garcia-Vazquez. (2018). Environmental DNA for freshwater fish monitoring: insights for conservation within a protected area. PeerJ 6:e4486.
- Muha, T.P., Robinson, C.V., Garcia de Leaniz, C., and Consuegra, S. (2019). An optimised eDNA protocol for detecting fish in lentic and lotic freshwaters using a small water volume. PloS One 14(7), e0219218. doi: 10.1371/journal.pone.0219218.
- Robinson, C., C. Garcia de Leaniz, M. Rolla, and S. Consuegra. (2019). Monitoring the eradication of the highly invasive topmouth gudgeon (Pseudorasbora parva) using a novel eDNA assay. Environmental DNA 1:74–85.
- Robinson, C. V., C. Garcia de Leaniz, and S. Consuegra. (2019). Effect of artificial barriers on the distribution of the invasive signal crayfish and Chinese mitten crab. Sci. Rep. 9:7230.

MAT3. FISH HABITAT MODELLING AND MAPPING (MesoHABSIM)

Author or Developer: Piotr Parasiewicz, Katarzyna Suska, Janusz Ligięza, & Rushing Rivers Institute
Text: Piotr Parasiewicz

This tool enables users to assess the amount of habitat suitable for the fish community up and downstream of a barrier using the MesoHABSIM methodology (Figure 5). The accompanying SimStream software helps predict the impact of different fish habitat management scenarios under climate change.

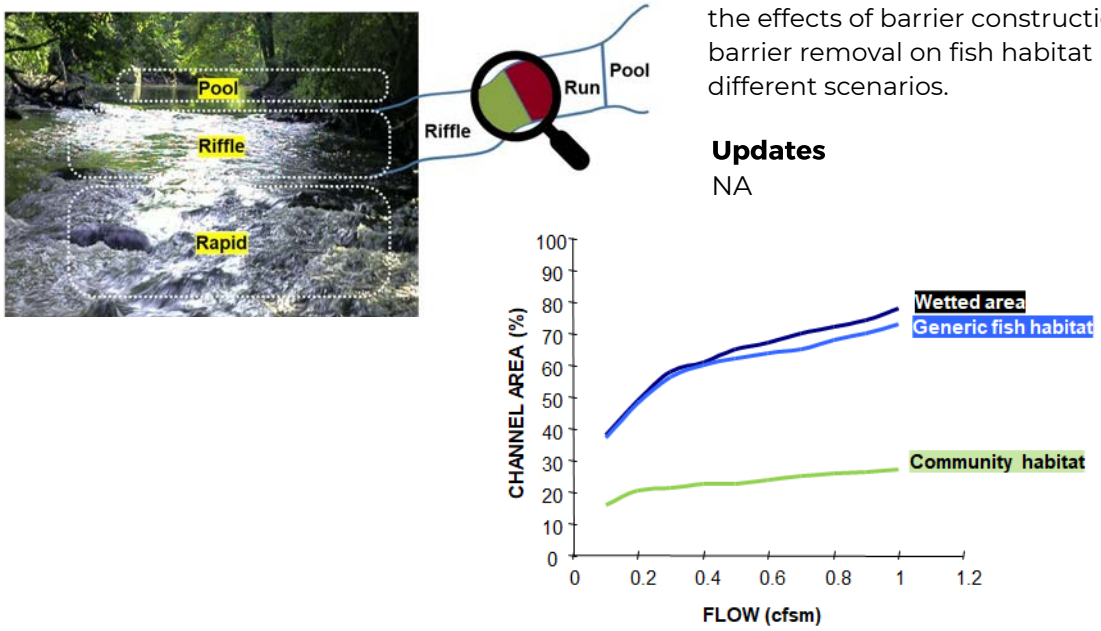

Figure 5. Schematics of the MesoHABSIM method. The distribution of hydromorphic units is mapped in the river (upper left), suitability filters are developed from fish observations to distinguish suitable (green) and non suitable (red) habitat areas (upper right). Suitable proportions of channel area observed at number of flows are expressed as rating curves. Generic fish habitat is suitable area available for all fish. Community habitat curves represent suitable area weighted by expected species ratio in the community. Rating curve of wetted area demonstrates proportion of entire (suitable and unsuitable) area available (bottom panel).

Source & availability

The tool is fully described in AMBER deliverable D2.6, available at the AMBER website https://portal.amber.international/ and at MesoHABSIM.org

Problems or needs addressed by this tool

Barriers impact on fish communities not only by impeding fish movements, but also by altering fish habitat upstream and downstream of the barrier. The MesoHABSIM tool allows users to predict the effects of barrier construction and barrier removal on fish habitat under different scenarios.

Updates

NA

Training needs

Training on the use of this tool is available in the form of a video-course, tutorials and manuals at MesoHABSIM.org.

Examples of use

Examples of use are described in Deliverable D4.2 and at http://mesohabsim.org/

References

Let it Flow Magazine
https://amber.international/wp-content/uploads/2020/07/AMBER-magazine-Digital.pdf Page 13
Deliverable D4.2
https://amber.international/deliverables-2/

DST1. RIVER INFRASTRUCTURE PLANNING TOOL (RIP)

Author or Developer: Jesse O'Hanley, Tim Feierfeil, Klemens Kauppert
Text: Jesse O'Hanley

The AMBER River Infrastructure Planning (RIP) helps environmental planners and river managers balance environmental and socioeconomic trade-offs associated with river infrastructure by selecting the best combination of barrier removal, construction and mitigation actions. The tool considers four Key Performance Indicators: (1) longitudinal connectivity, (2) project implementation costs, (3) hydropower generation potential, and (4) water storage capacity. It has an easy-to-use Microsoft Excel based graphical user interface for data input and result generation (Figure 6).

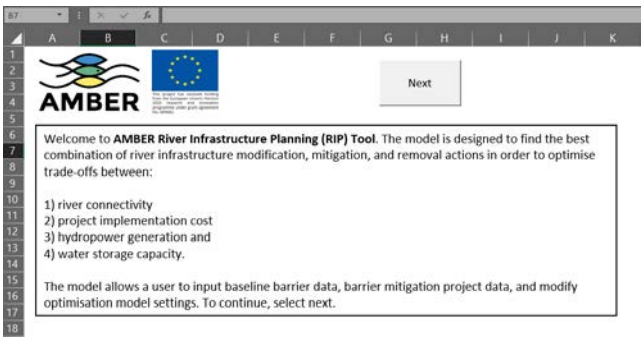

Figure 6. Screens-shot of the Microsoft Excel based graphical user interface for the AMBER River Infrastructure Planning (RIP) tool

Training needs

No specific training is required. Data formatting guidelines and help support prompts are integrated into the tool.

Source & availability

The simpler, Excel based version of the RIP tool can be downloaded from the AMBER website
https://amber.international/software/

It is currently available in English only. Users need to download and install SolverStudio first before running AMBER RIP
https://solverstudio.org/

Problems or needs addressed by this tool

Determination of how best to manage river infrastructure in the context of river connectivity restoration not only requires consideration of the interactive effects of barrier removal, construction and mitigation actions on river connectivity as well as assessment of multiple, potentially competing environmental and socioeconomic benefits and costs derived from river infrastructure. The AMBER RIP tool addresses this need through the development and application of advanced mathematical optimisation techniques to systematically target barrier removal, construction and mitigation in order to find the most efficient balance between competing goals.

DST1. RIVER INFRASTRUCTURE PLANNING TOOL (RIP)

Author or Developer: Jesse O'Hanley, Tim Feierfeil, Klemens Kauppert
Text: Jesse O'Hanley

Examples of use

The applicability of an advanced version of this has been tried in the River Neckar catchment (Germany; Figure 7) where there are more than 1,000 river barriers. Hydropower and shipping are two of the main human uses and were selected as the primary socioeconomic KPIs. The planning tool was tested across ten scenarios for adaptive barrier management, including the current situation and 9 possible future development scenarios.

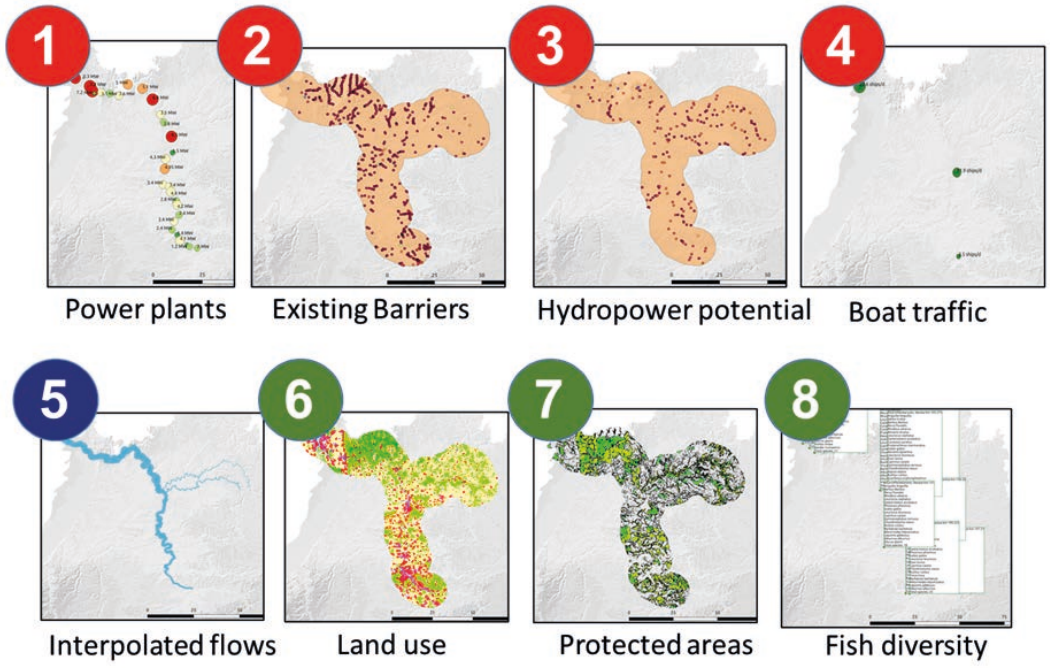

Figure 7. Some of the competing goals and constraints considered by the AMBER RIP tool to manage barriers in the Neckar catchment (Germany).

Updates
v 1.0 September 2020

References

Let it Flow Magazine. https://amber.international/wp-content/uploads/2020/07/AMBER-magazine-Digital.pdf page 59
AMBER deliverable link: https://amber.international/deliverables-2/

2. CRITICAL GAPS IN KNOWLEDGE & FEEDBACK FROM RIVER MANAGERS & ECOSTAT

On 11th March 2020 AMBER organised a webinar with the ECOSTAT group on Tools for Restoring Connectivity to inform this Policy Brief. We collected information via a questionnaire on the main challenges and critical gaps in knowledge for restoring river connectivity. The questionnaire consisted of three open-ended questions:

Q1	What are the main challenges for quantifying river connectivity?
Q2	What are the main challenges for assessing impacts of fragmentation?
Q3	What are the main challenges for restoring connectivity?

Responses were collected from 92 respondents from three stakeholder groups: EU River Basin Managers from 14 EU countries (n = 54), AMBER partners (n = 19) and participants from the ECOSTAT group (n = 19). Although some differences were found between stakeholder groups these are small and responses have been aggregated for analysis below.

Q1. What are the main challenges for quantifying river connectivity?

Most participants highlighted the lack of a comprehensive barrier database (29%), lack of sufficient resources (15%), and methodological challenges (15%) as the main practical impediments for quantify river connectivity (Figure 8).

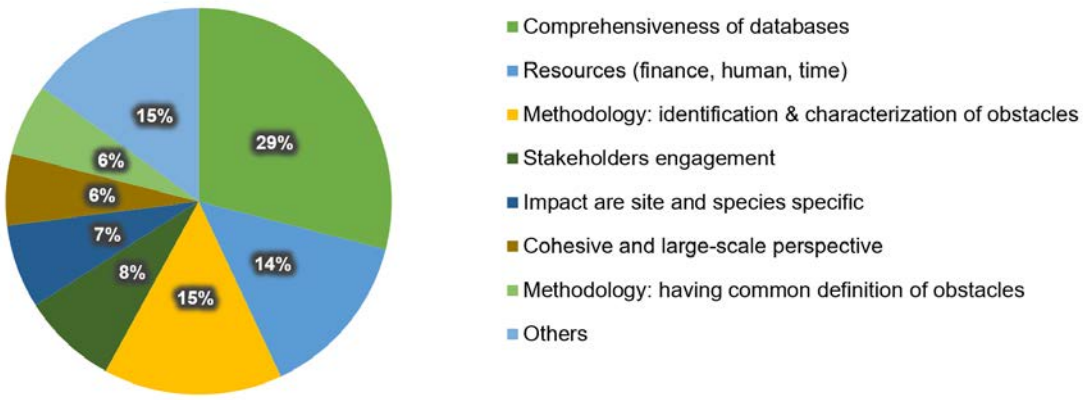

Figure 8. Main practical impediments for quantifying river connectivity.

Q2. What are the main challenges for assessing impacts of fragmentation?

Most participants highlighted the lack of data (21%), limited ecological understanding of barrier impacts (18%), and lack of resources (16%) as the main practical impediments for quantifying the impacts of river fragmentation (Figure 9).

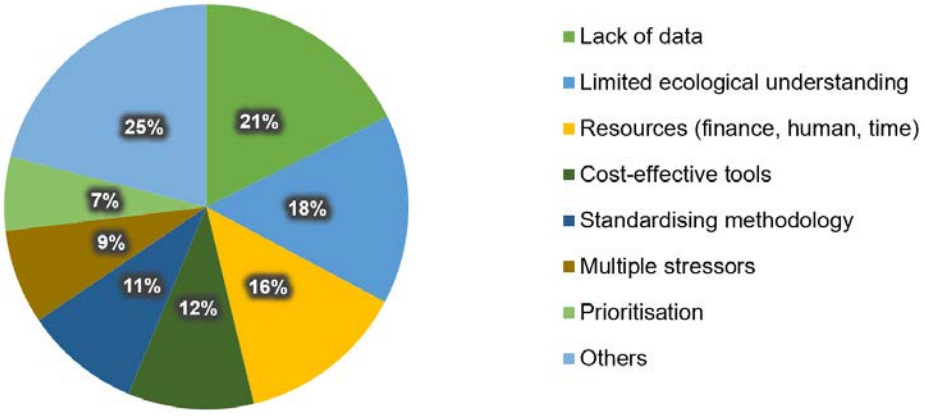

Figure 9. Main practical impediments for assessing the impact of river fragmentation.

Q3. What are the main challenges for restoring connectivity?

Most participants highlighted the lack of resources (40%) and involvement of stakeholders (39%) as the main practical impediments for restoring river connectivity (Figure 10).

Figure 10. Main practical impediments for restoring connectivity.

AMBER partners

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