Habitat modelling using HABBY

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BASEMENT Users Meeting 2023

Outline

- Habitat modelling: motivation and approaches
- HABBY tool
- Workflow example
- Conclusion

Motivation

- The **alteration** and **loss** of habitats are among the biggest threats to river ecosystems (Reid et al., 2019)
- **Habitat analysis** is crucial for river protection, restoration and adaptation
- Habitat **modelling** enables testing/investigating alternative scenarios
  - broad range of flow conditions
  - new/alternative morphological setup
  - support for restoration projects


COMMENT

JOSE LUIS ROCA/AFP/GETTY

Dead fish on the banks of the Guadiaro River in southern Spain during severe drought.

Prepare river ecosystems for an uncertain future

As the climate warms, we can't restore waterways to pristine condition, but models can predict potential changes, argue **Jonathan D. Tonkin**, **N. LeRoy Poff** and colleagues.

Tonkin et al. (2019). *Nature*

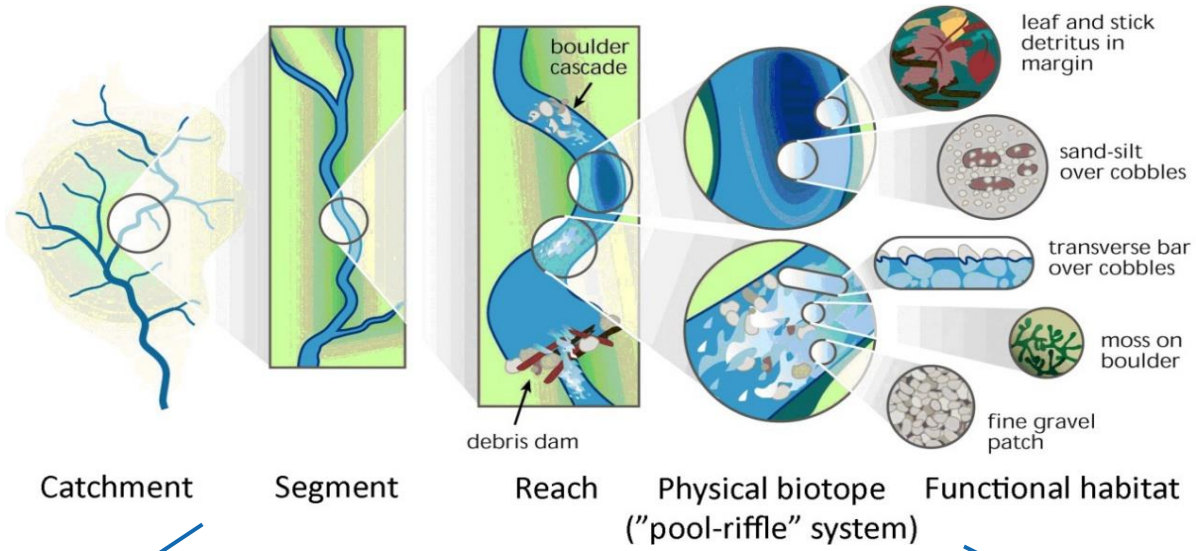
Motivation

Habitat analysis is required by national guidelines

- Merkblatt-Sammlung Wasserbau und Ökologie 2012
- Geschiebe- und Habitatsdynamik 2017
- Schwall-Sunk – Massnahmen 2017

Scale

After Frissell et al. (1986)



Catchment scale: several km

Temperature, main channel characteristics, flow regime

→ Species distribution, dispersion, migration

Meso-scale: meters to tens of m

River width, patch hydro-morphological features (e.g. riffle, pool)

→ Presence, movement and aggregation of motile species (fish)

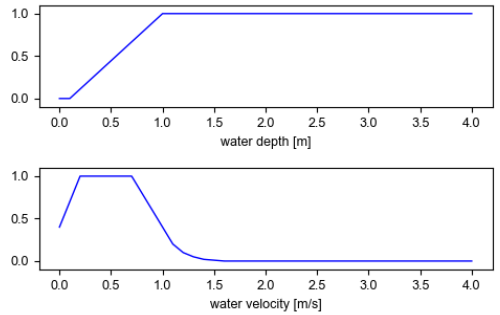
Micro-scale: cm to several m

Local water depth, velocity, substrate,…

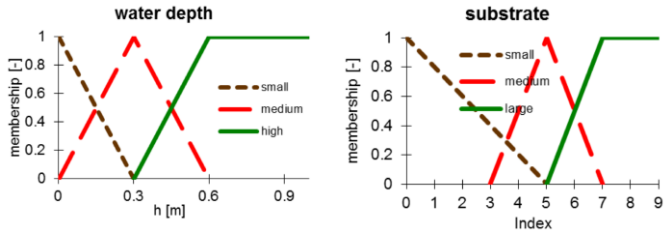
→ Presence of non-motile (or little) species: vegetation, macroinvertebrate, fish eggs and early stages

Approaches

Suitability curves

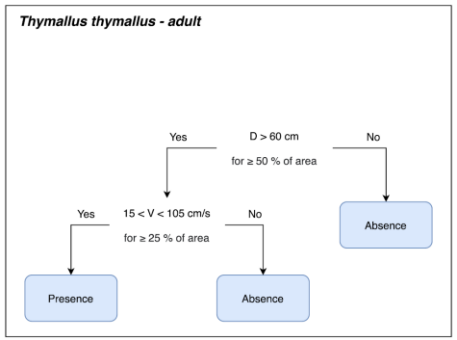


Fuzzy approaches



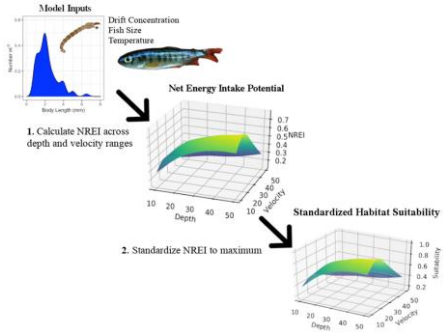
from Ecohydraulics lecture @ETH

Decision tree rules



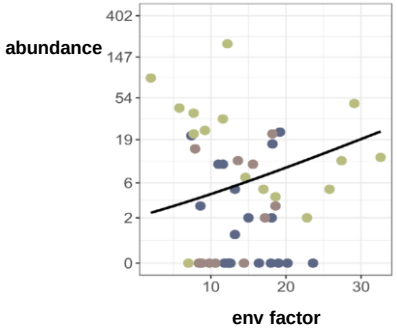
from Farò et al. (2022)

Bioenergetic models



from Naman et al. (2020)

Statistical models



Modified from Becquet et al. (2022)

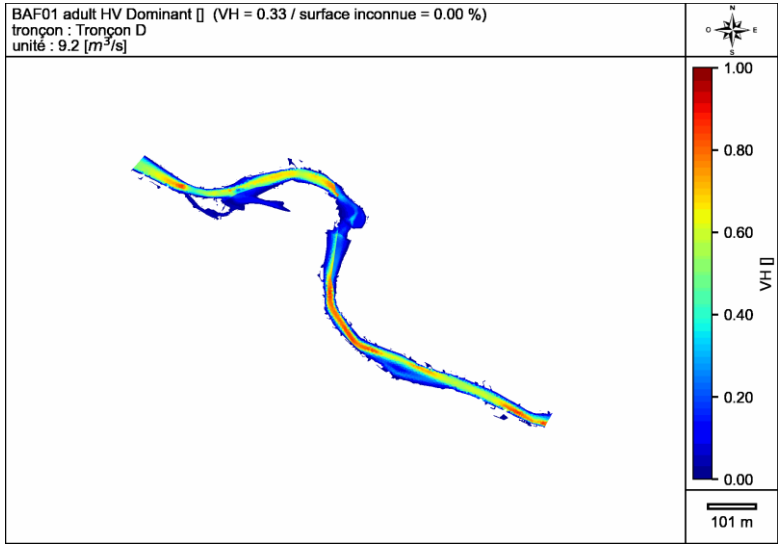
Becquet et al. "Macroinvertebrate distribution associated with environmental variables in alpine streams." *Freshwater Biology* 67.10 (2022): 1815-1831.
Farò et al. "A novel unsupervised method for assessing mesoscale river habitat structure and suitability from 2D hydraulic models in gravel-bed rivers." *Ecohydrology* 15.7 (2022).
Naman et al. "Bioenergetic habitat suitability curves for instream flow modeling: Introducing user-friendly software and its potential applications." *Fisheries* 45.11 (2020): 605-613.

HABBY: HABitat suitability tool

- Developed by:
  - **OFB**, the french office for biodiversity
  - **INRAE**, the national research institute
  - **EDF**, the french electricity group

- Main features:
  - Open-source, python-based, GUI
  - Multi-platform
  - Importer for different hydrodynamic tools
  - Different biological models available
  - Customized preference curves and statistical models

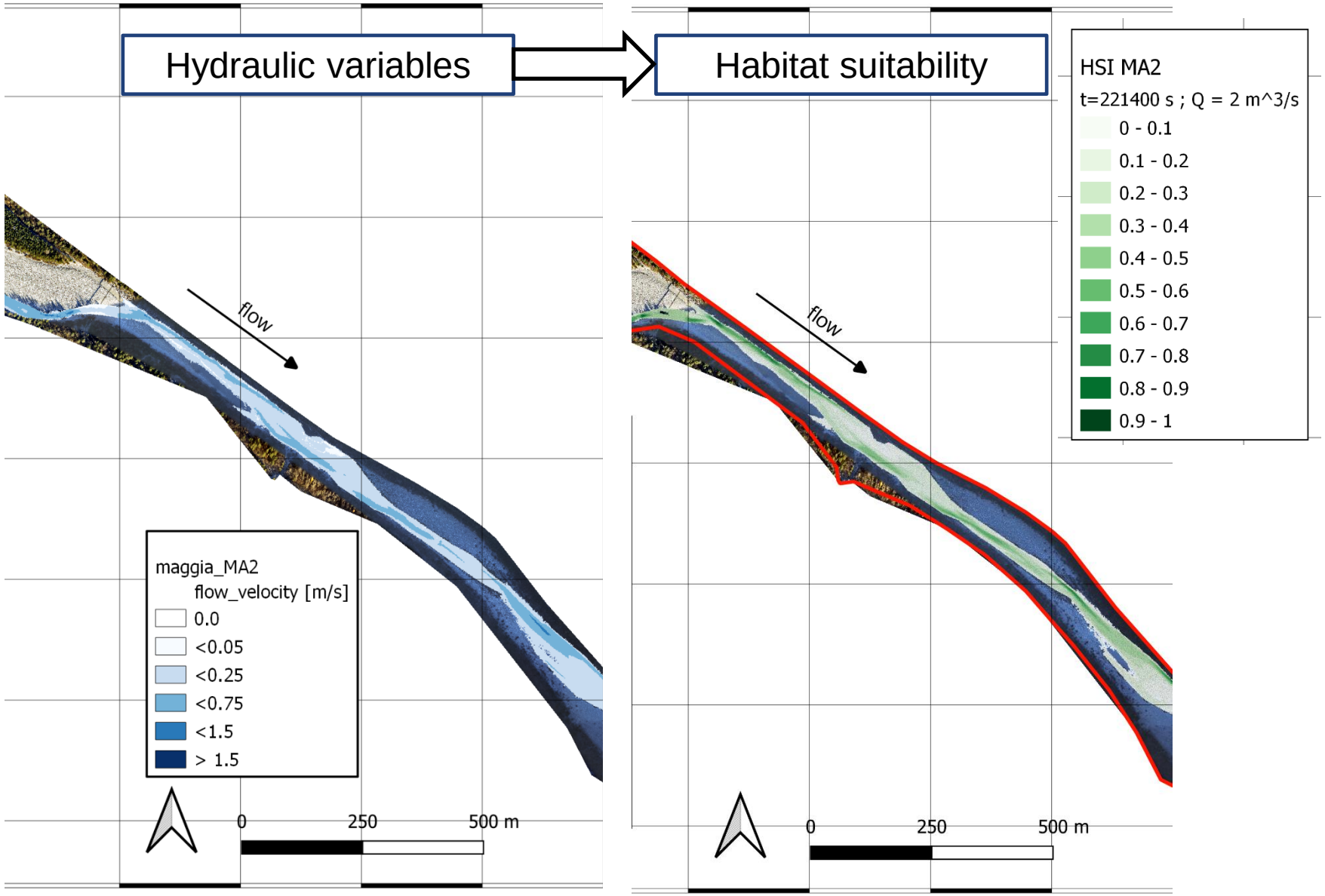
- Available at:
  - https://github.com/YannIrstea/habby
  - https://habby.wiki.inrae.fr/



From https://github.com/YannIrstea/habby

Workflow example

- Maggia river, Ticino
- Impact of minimum flows on habitat suitability of fishes

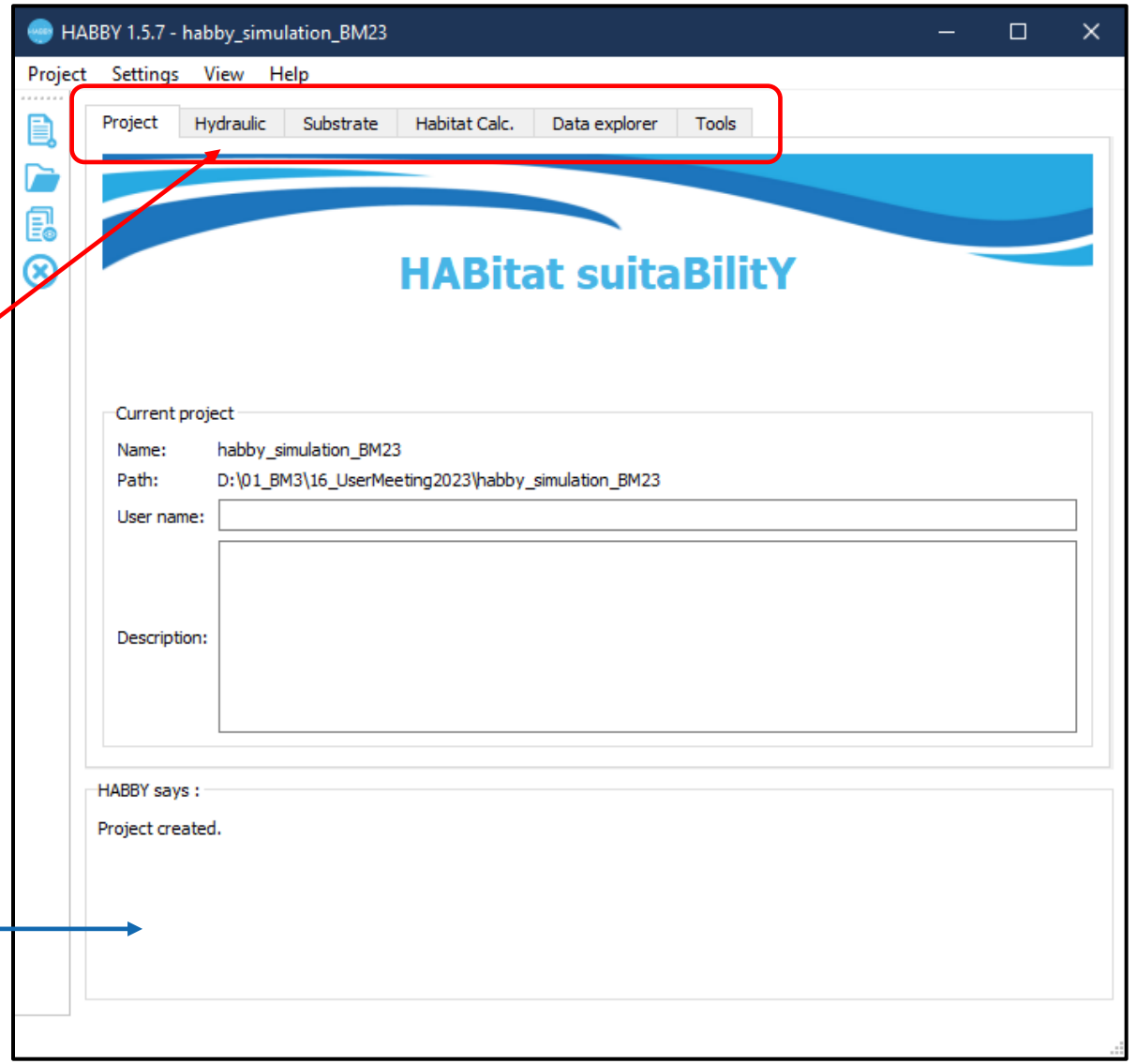


Workflow example

- Project definition
- Hydraulic step
- Substrate step
- Habitat calculation
- Data explorer
- Tools

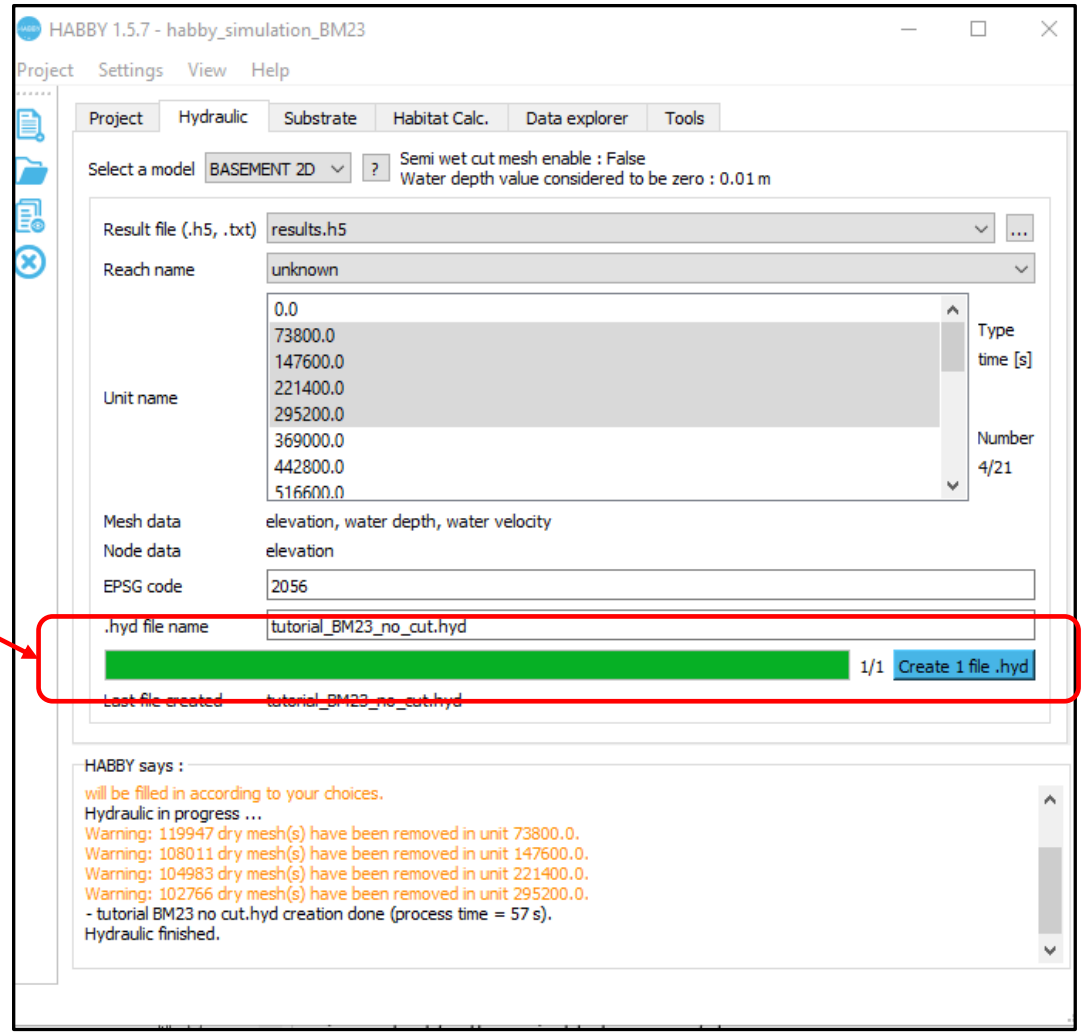
Tabs (modelling steps)

Information panel



Hydraulic step

- Choice of 2D hydraulic model -- BASEMENT
- Upload of results.h5
- Selection of output timestep (more than one)
- Creation of the **.hyd file**



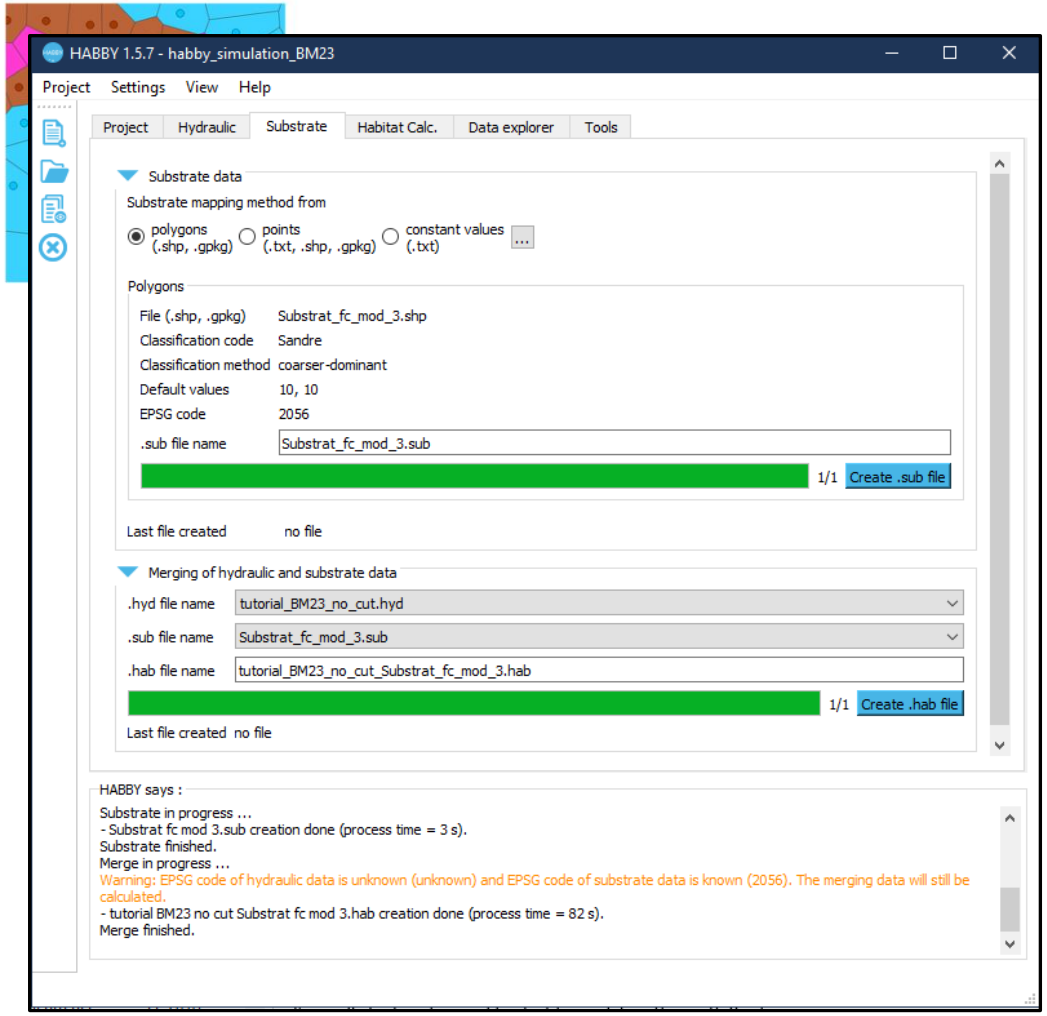
Substrate step

- Choice of input types & upload
  - Constant value (or no substrate)
  - Node-based (.shp file)
  - Polygon-based (.shp file)

Polygons

- Creation of **.sub file**

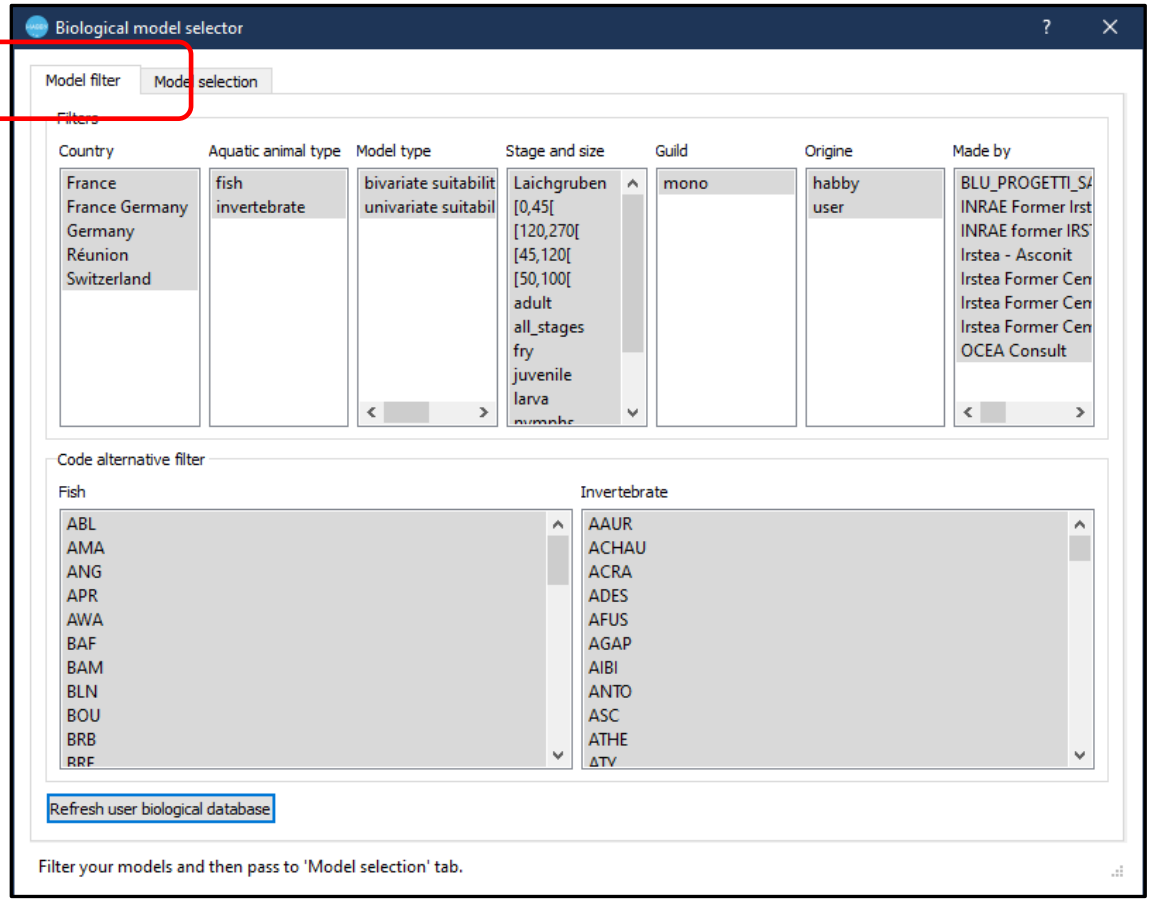
- Merging of .hyd and .sub files into .**hab**



Habitat calculation – biological model selector

- **Model filter**
  - Search for model to compute

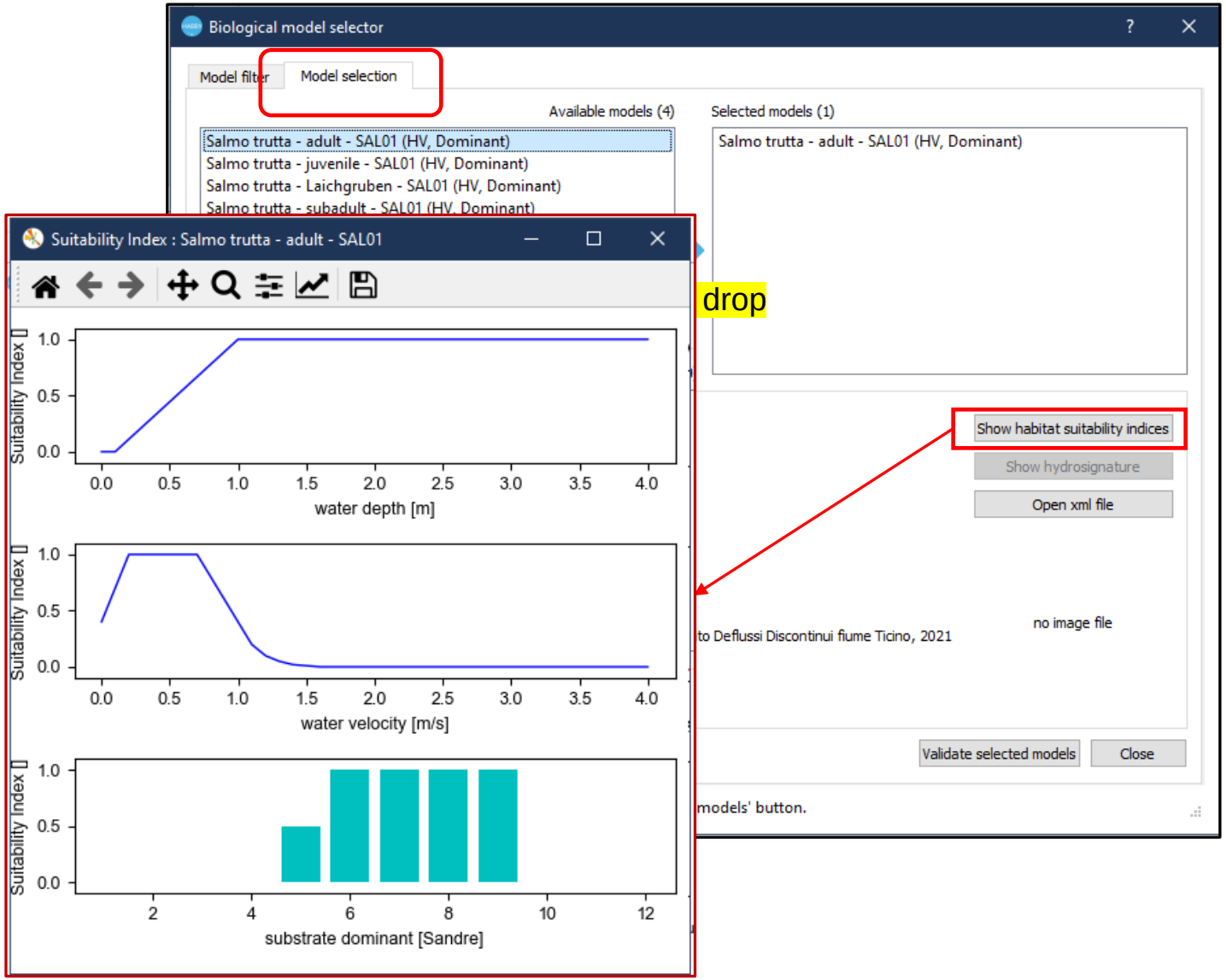
- Large database (country, species, life stages, etc.)
- Easy to inlcude more species (.xml)



Habitat calculation – biological model selector

- **Model selection**
  - Select model to compute

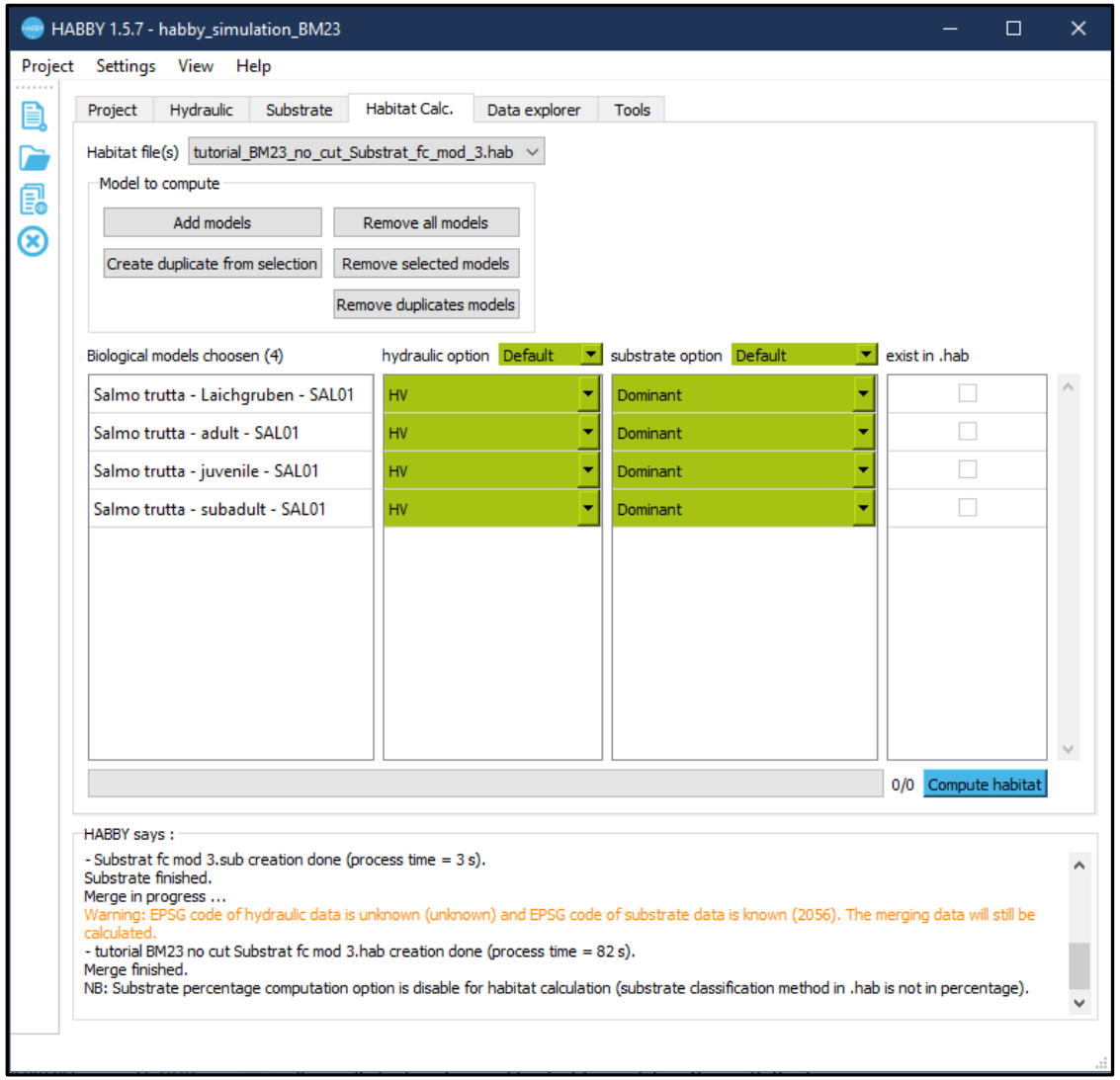
- Summary information
- Display of preference curves



Habitat calculation

- Calculation of **habitat suitability**
  - Summary of all species selected and already calculated
  - Hydraulic option (water depth and/or velocity)
  - Substrate (on/off, type of classification)

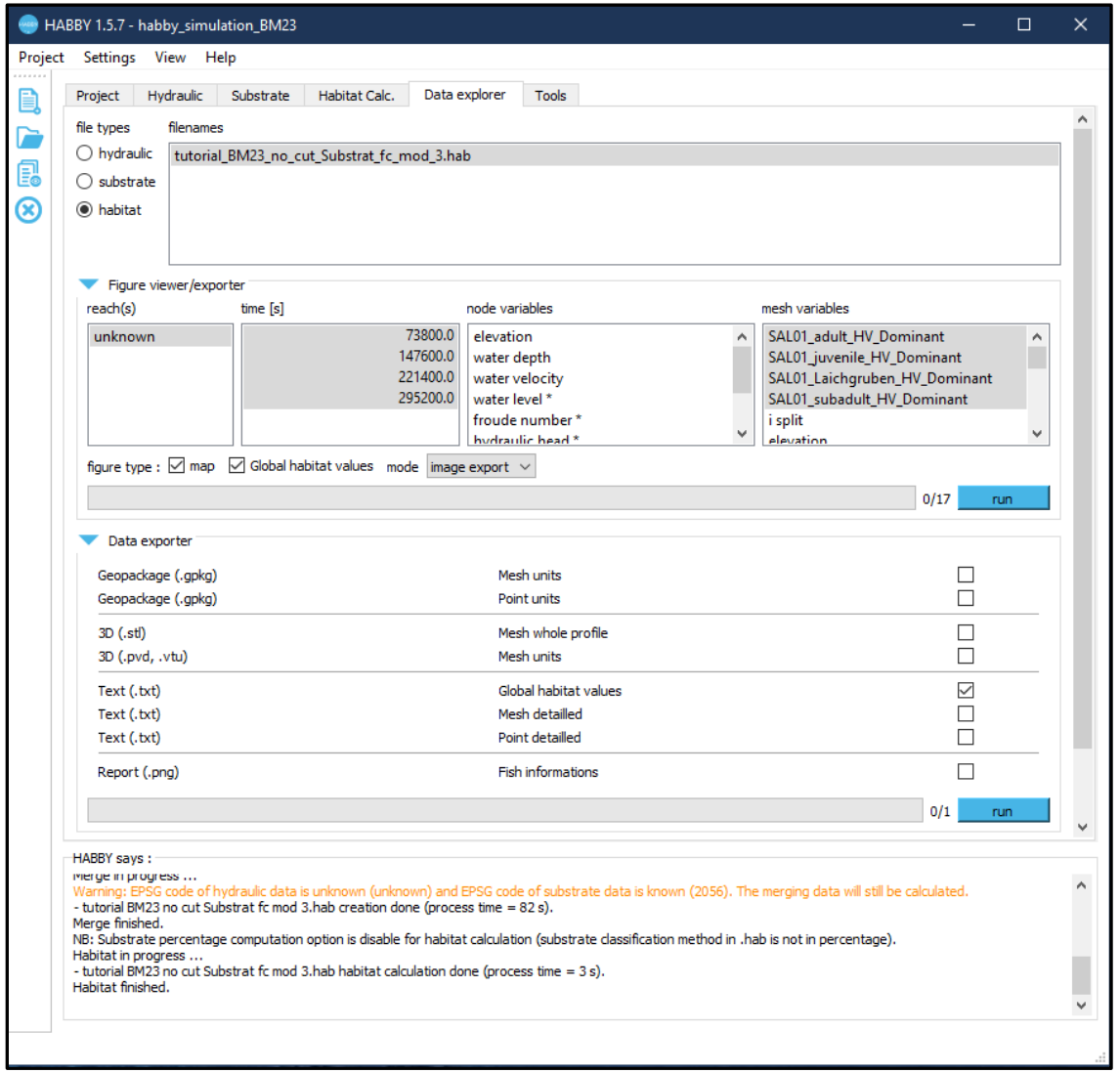
- Add models to the **.hab file**



Data explorer and output types

- **Figure exporter**
  - Live-figure available
  - Choice of single or mutiple variables to display
  - Save figures

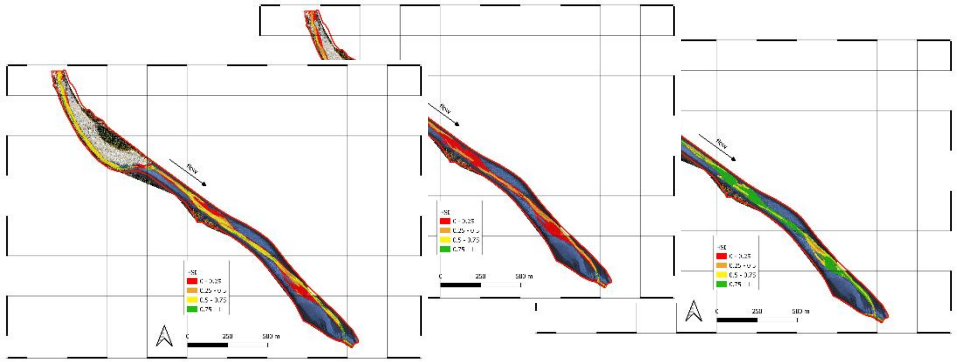
- **Data exporter**
  - Txt files
  - GIS supported files (e.g. shape)
  - Organized in an ouput folder

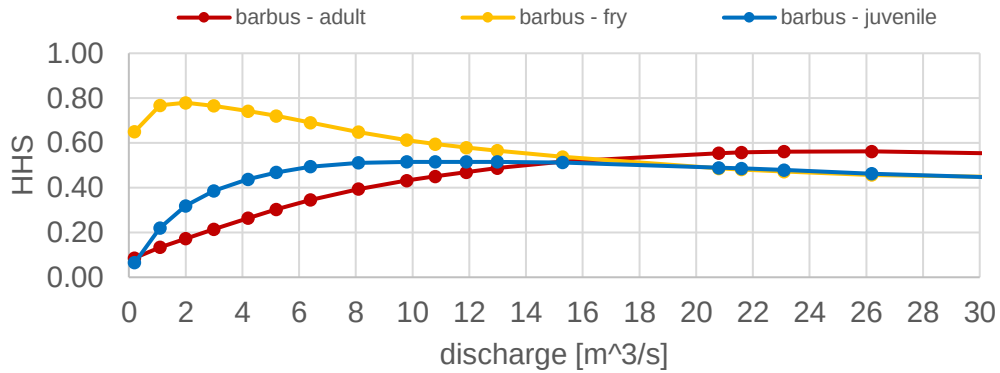


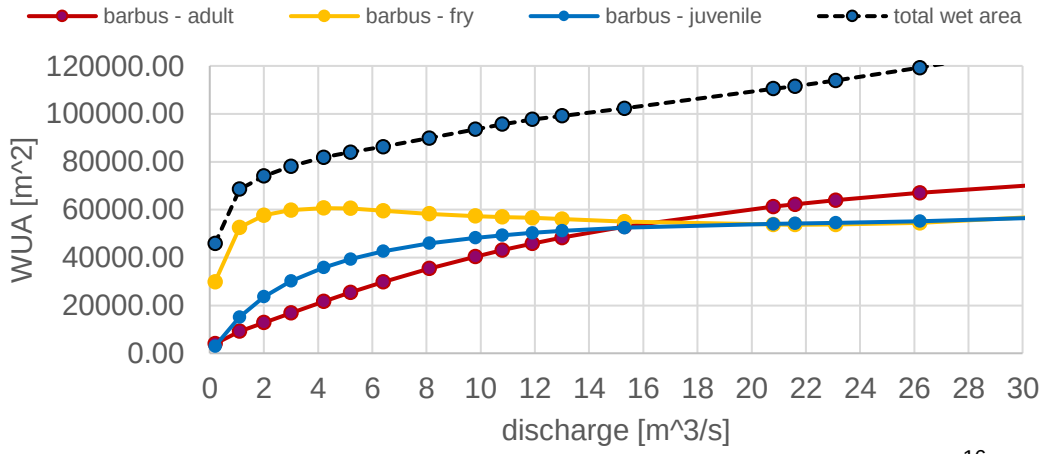
Results

- Modelling steady flow discharges with **BASEMENT**
- Calculating HSI for different species and life stages with **HABBY**
- Display HSI (or WUA) as a function of the discharge

HIS per each species*/lifestage



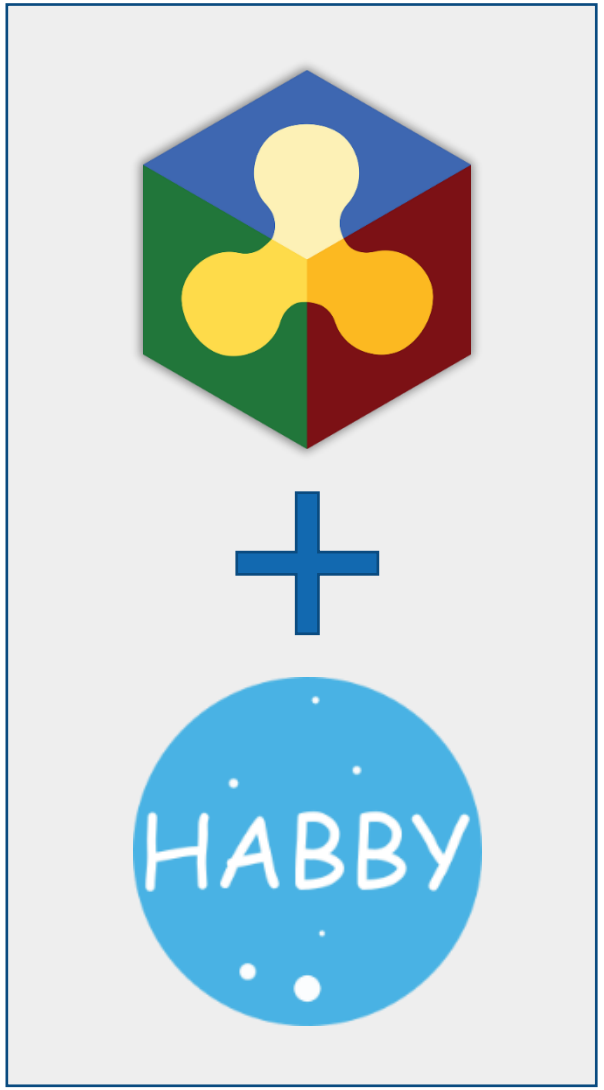




**Barbus, Cottus, Telestes for Maggia River*

Summary and key (useful) features

- **Flexible**
  - It can be re-run (also only partly)
  - Run by command line
- **Easy to use GUI**
  - drag&drop features
  - Win. Installer provided
- **Formatted output**
- Continuous development and documentation
- Bug report



Thank you for your attention!

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