AMBER: Let it Flow

Piotr Parasiewicz et al

S. Sakowicz Inland Fisheries Institute

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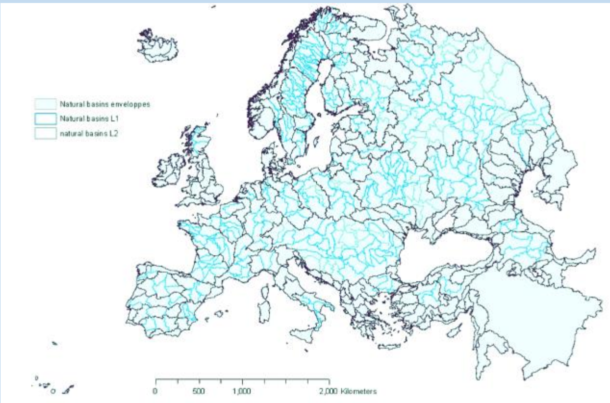
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 689682.

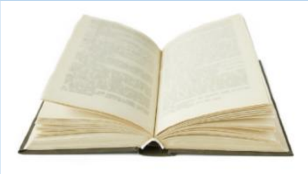
Adaptive Management of Barriers in European Rivers




1. European Barrier Atlas



2. Barrier guidance
- strategic
- adaptive
- practical



removal

Planning (location)

mitigation

Collaborative?

20 participant institutes:

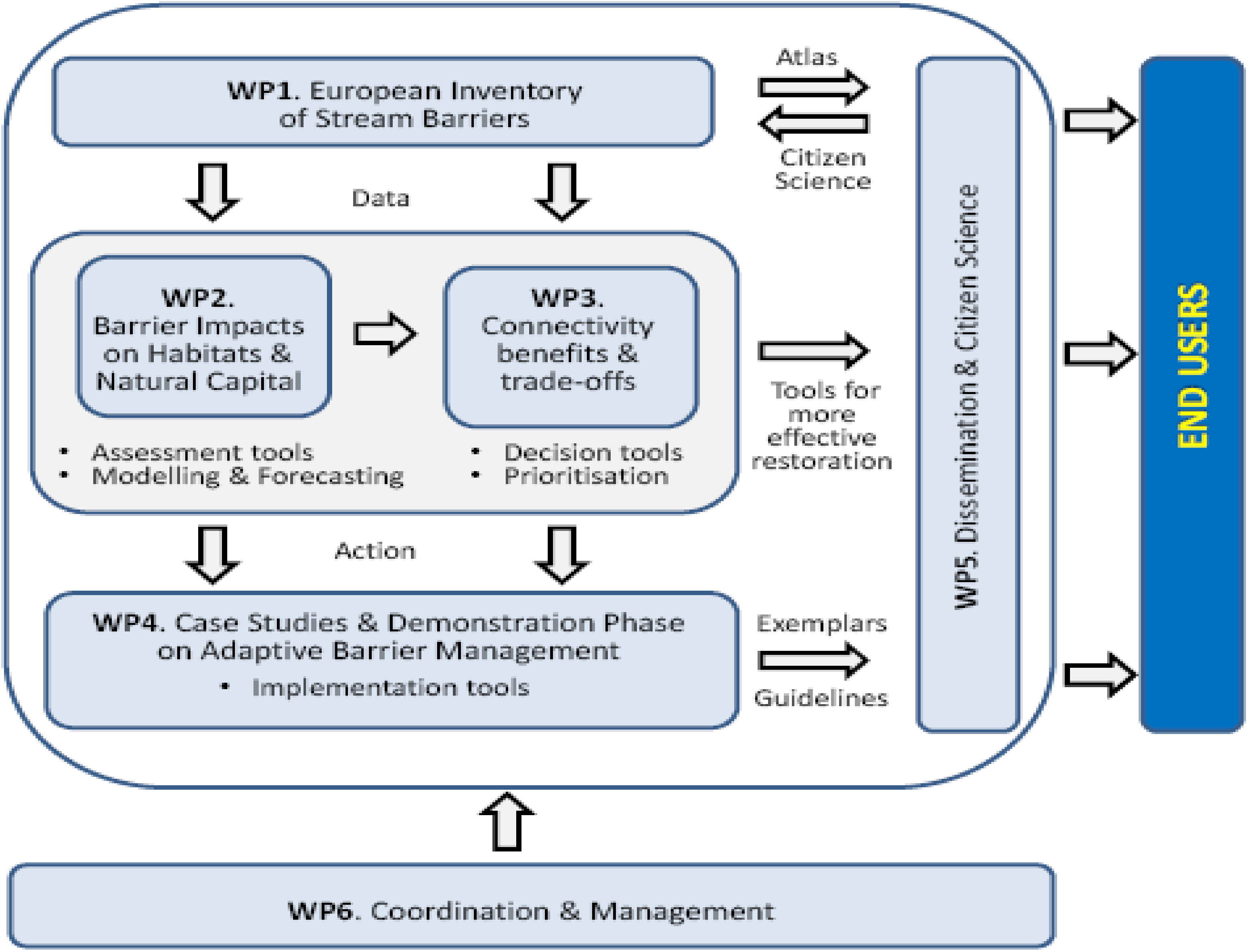
8 Universities - Swansea, Durham, Highlands & Islands, Southampton, Cork (Ireland), Oviedo (Spain), Milan (Italy), DTU (Denmark).

4 Industrial partners - hydropower – EDF (France), IBK (Germany), Innogy (Germany), Sydkraft (Sweden)

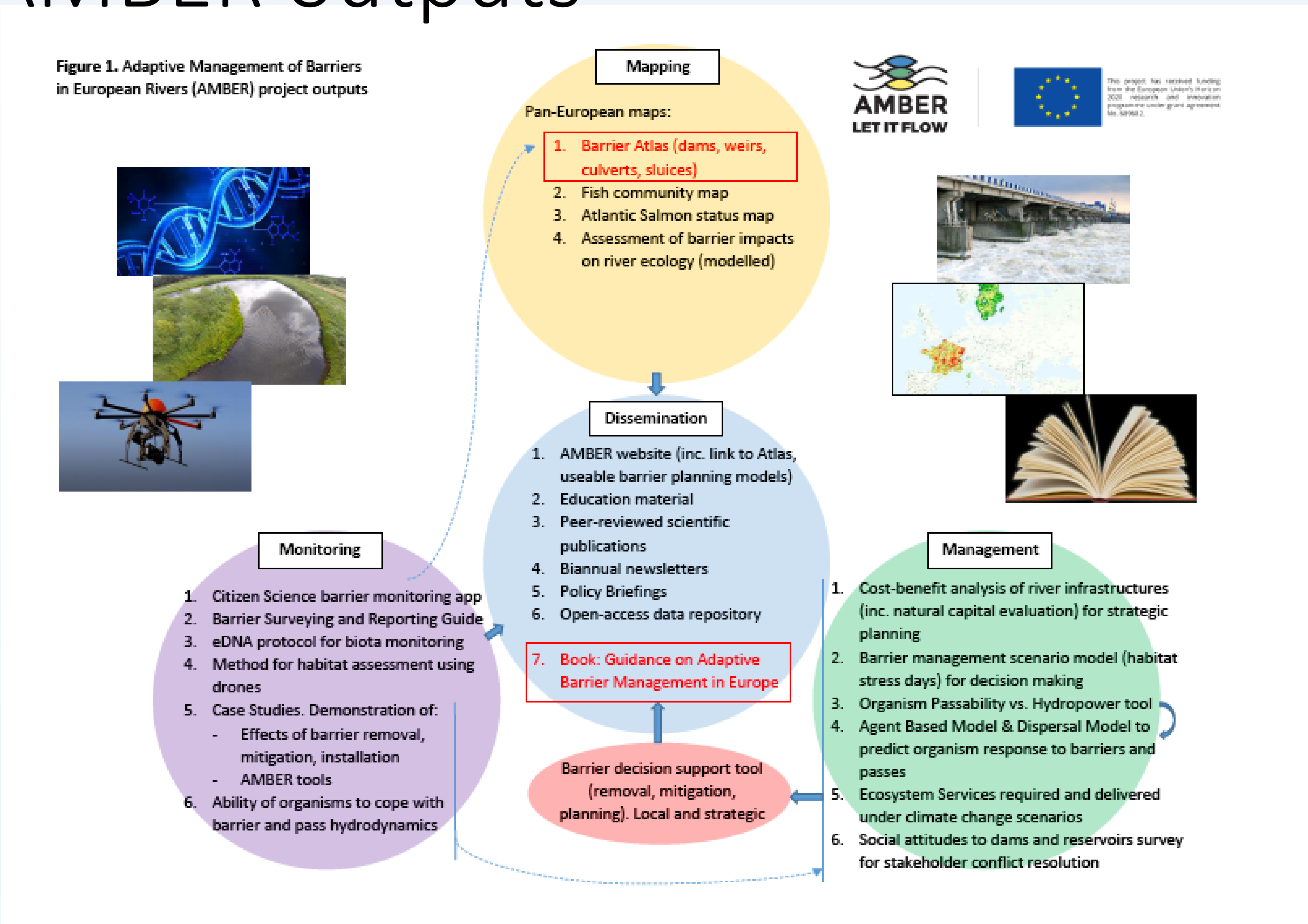
4 NGOs (WFMF (Netherlands), WWF (Switzerland), CNSS (France), AEMS (Spain)

4 Government organisations - IFI (Ireland), ERCE (Poland), SSIFI (Poland), Joint Research Centre (Italy)

AMBER Pert diagram



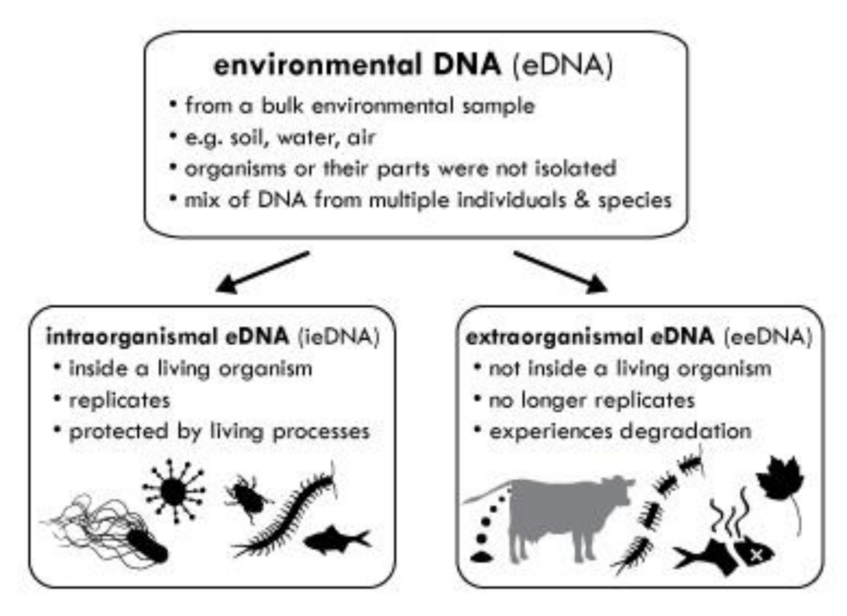
AMBER outputs



New opportunities for restoring river connectivity

1. New technologies

- eDNA/meta-barcoding



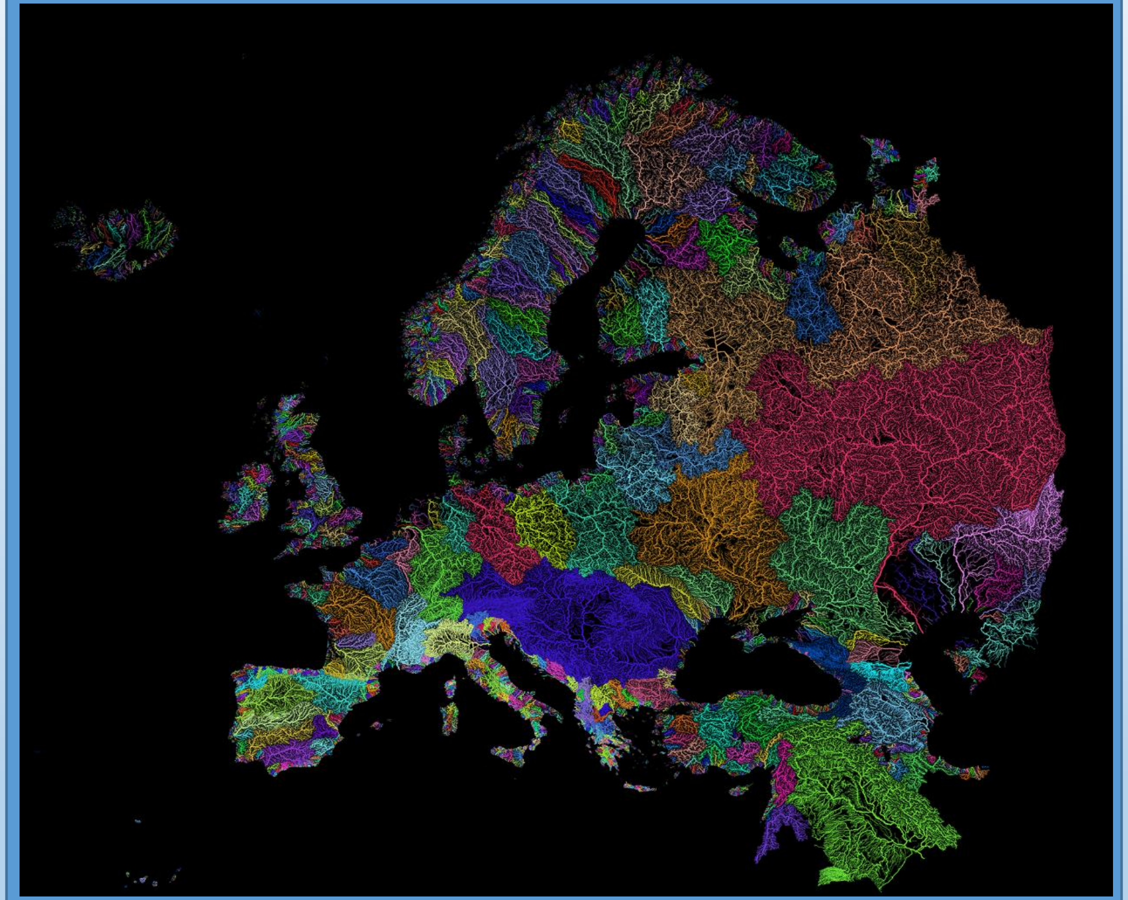
- Drones for quick surveying & remote sensing

- Modelling P/A (PREDICTS approach)

European Rivers systems

- Connecting continents with oceans
- Biological distribution pahtways
  - transportation
  - communication
  - processess

Rivers: Arteries of life



www.dailymail.co.uk/sciencetech/article-6511869/Fascinating-new-map-shows-river-basin-globe-different-colour.html

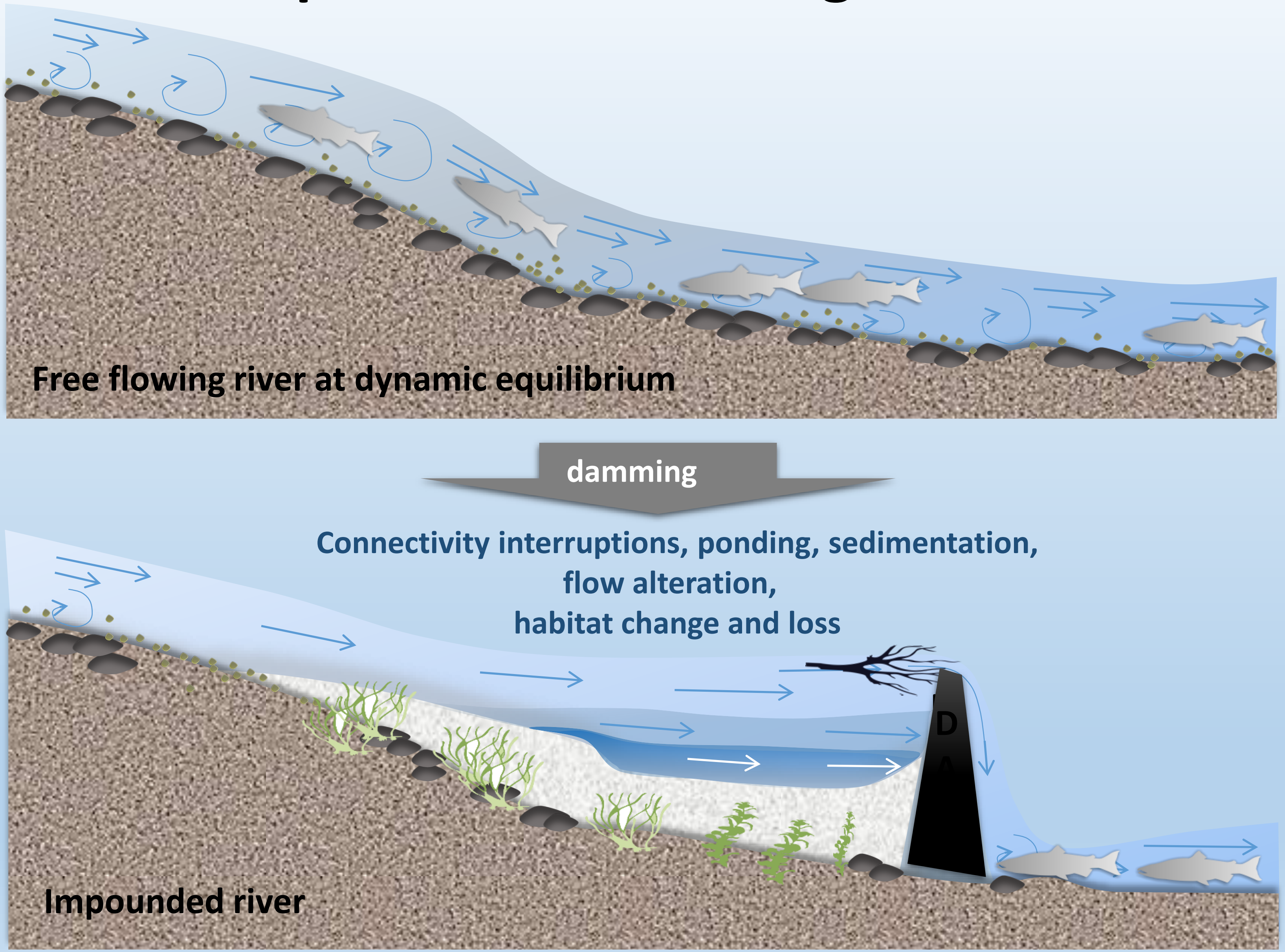
Impacts of dams

- altered or stopped fish upstream migration

- fish mortality:
  - dewatering
  - turbines

Phot. P. Prus, M. Adamczyk SSIFI

Dam impact on free flowing river



Modified from L. Wildman - The Effects of Dams on Floodplain Function

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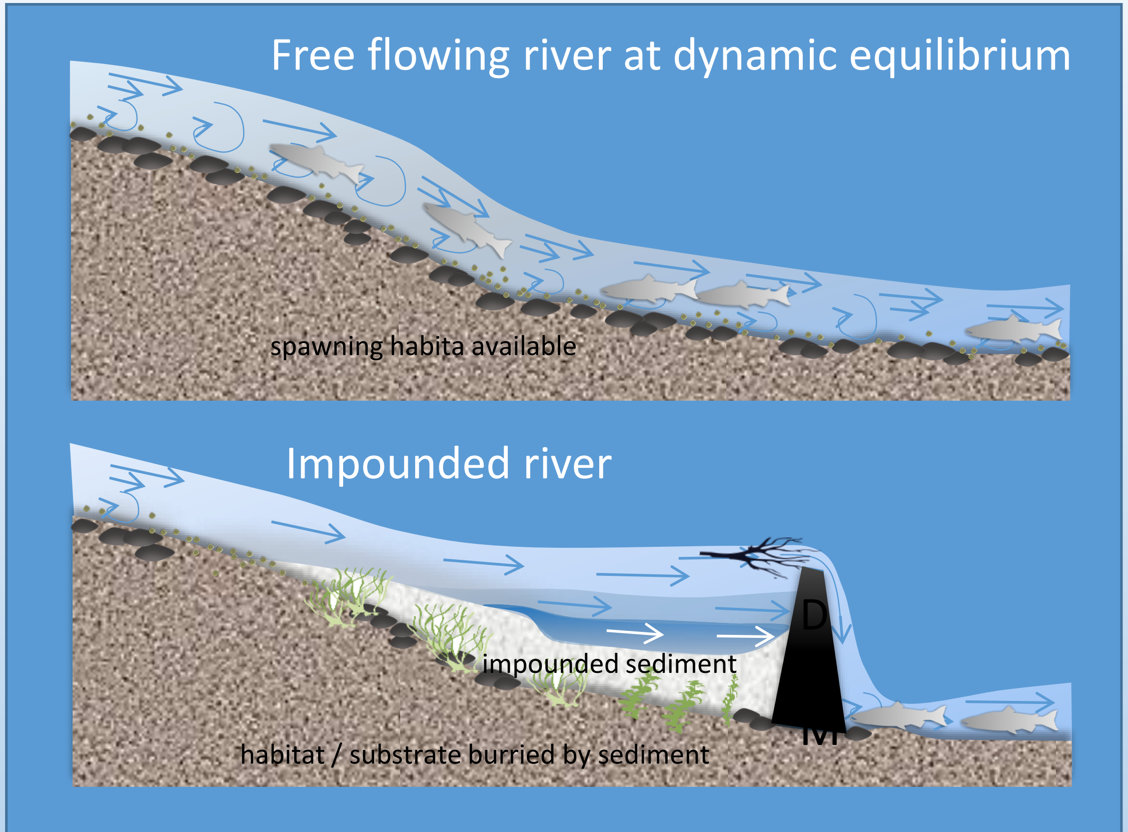
Dam impact on upstream habitat

- higher depth
- low velocity
- substrate siltation
- high temperature
- low oxygen
- eutrophication
- vegetation shift
- benthos shift



Phot. P. Parasiewicz SSIFI

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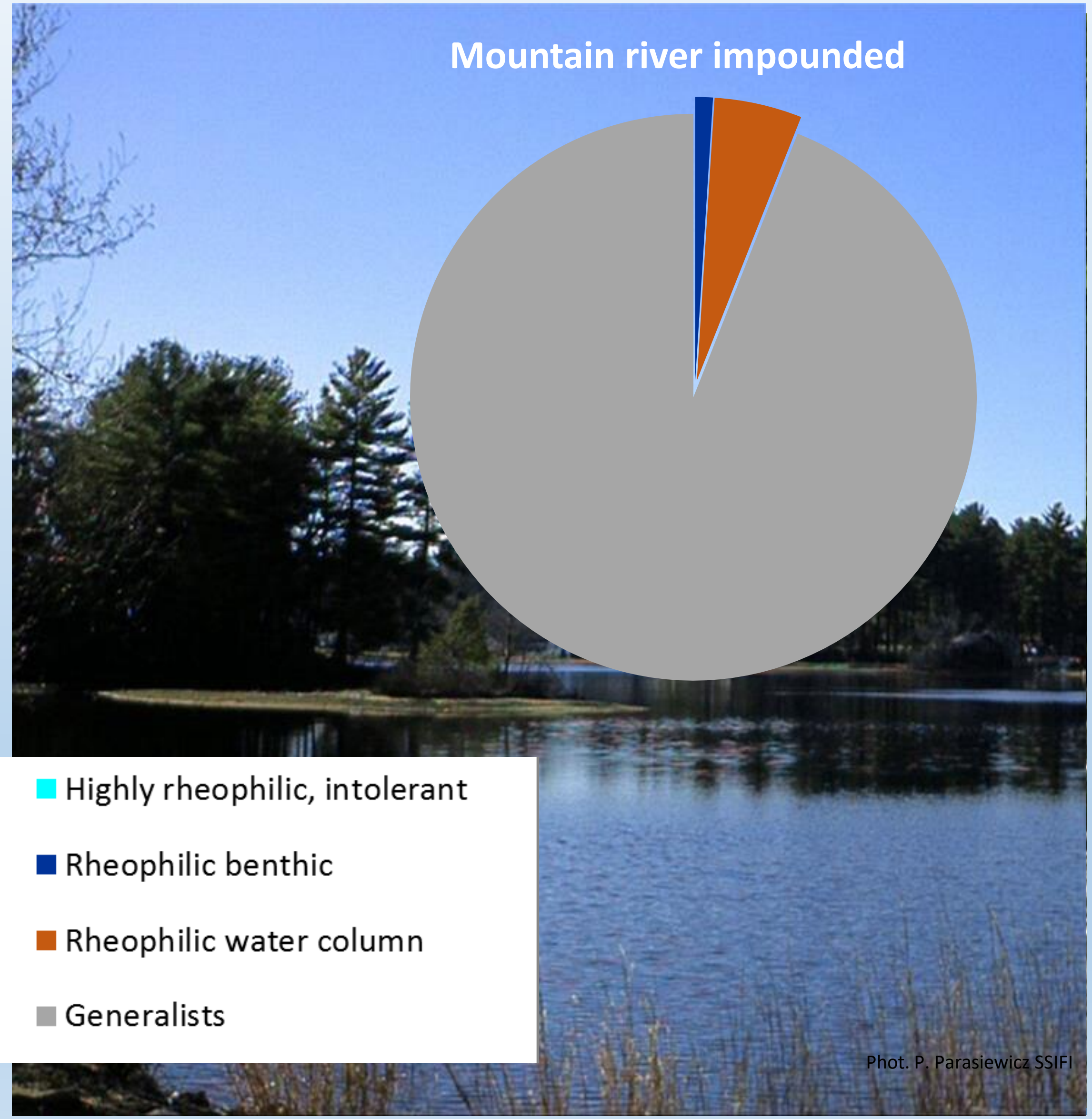
Upstream

- rheophilic fish guilds in undisturbed river

- change of lotic into lentic habitats

- altered fish community
- generalists - tolerant fish in impounded river



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Dam impact
on downstream habitat

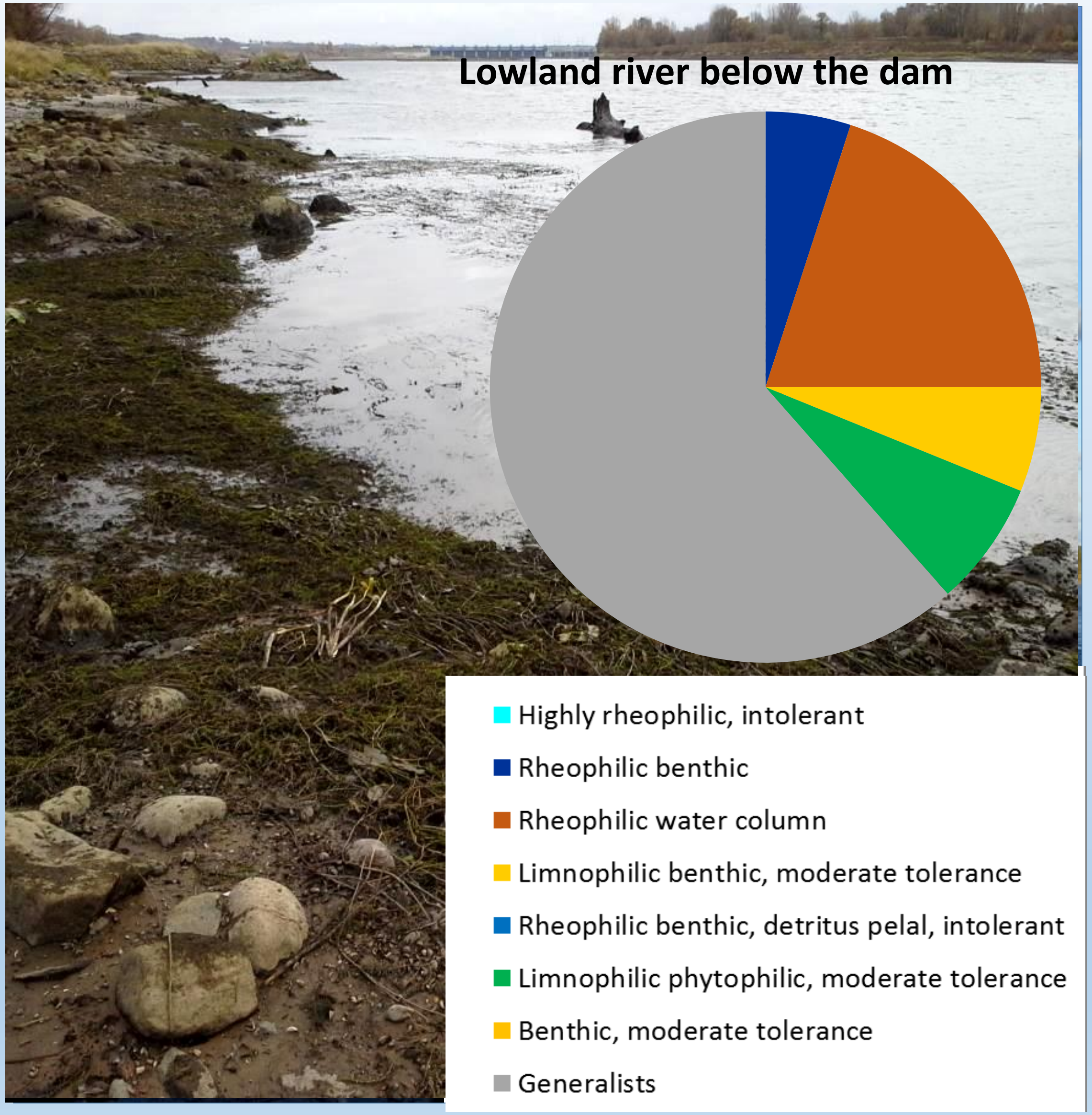
- flow regime
  - fluctuations:
    - depth
    - velocity
    - temperature
- blocked sediment
  - riverbed erosion
  - sediment armoring
- Dewatering (mortality)

Phot. K. Susuka, P. Parasiewicz SSIFI

Downstream

- change of habitat quality and stability
- rapid bottom erosion

- altered fish community

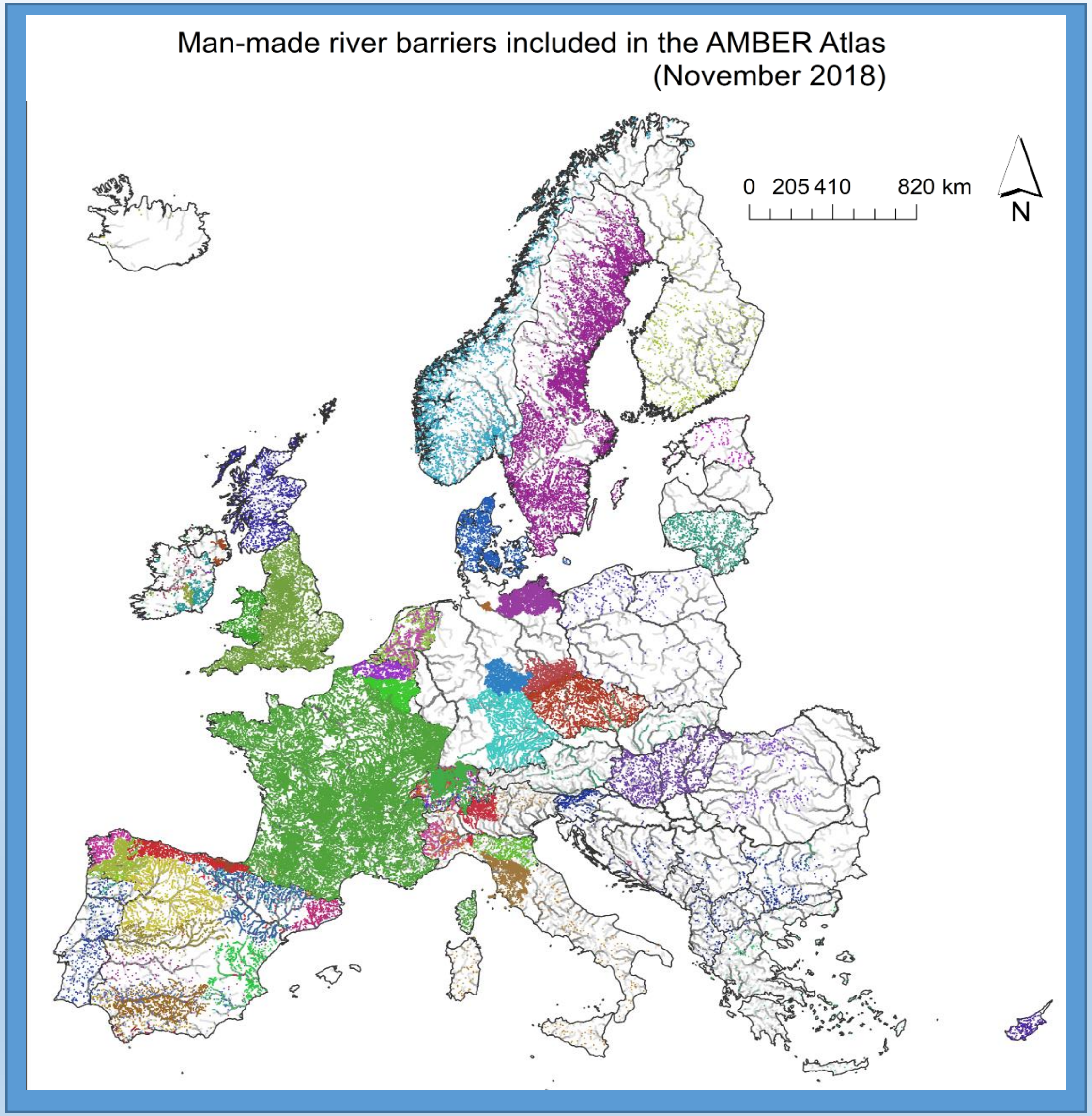


Phot. M. Adamczyk SSIFI

Barriers on European Rivers

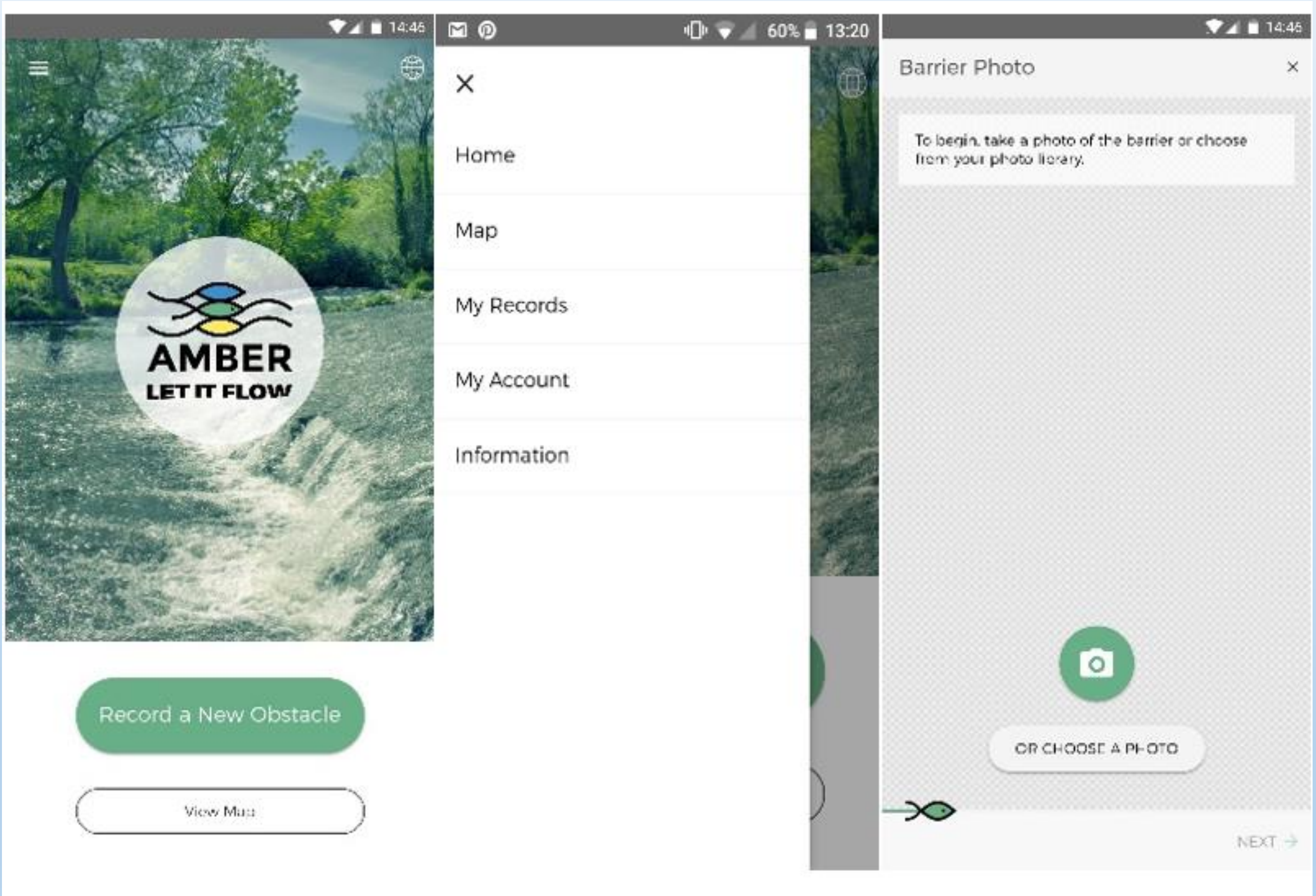
- **400.000** recorded in AMBER ATLAS (status Nov 2018)

> A barrier every river kilometer

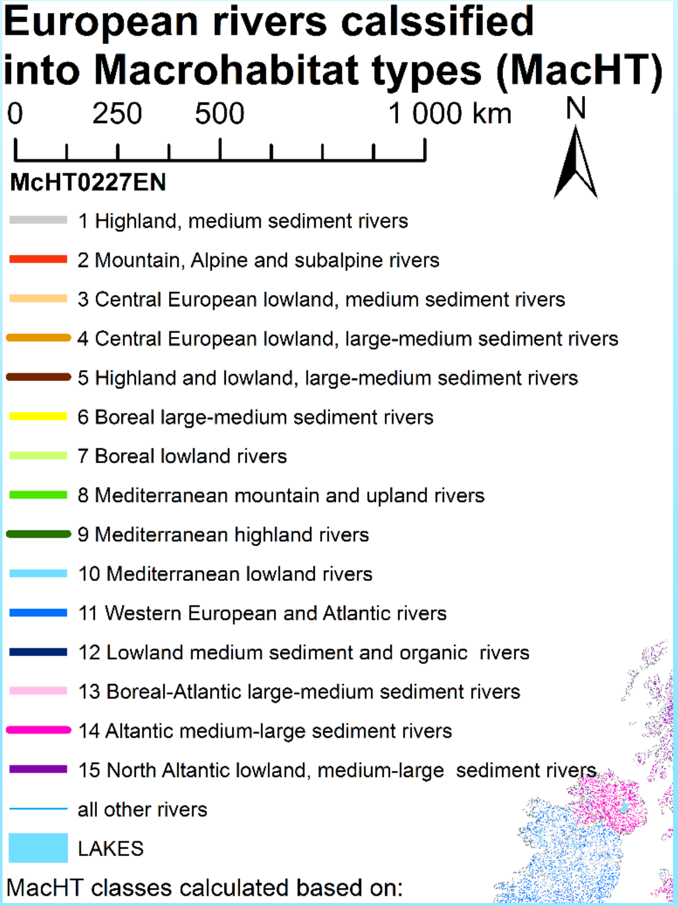


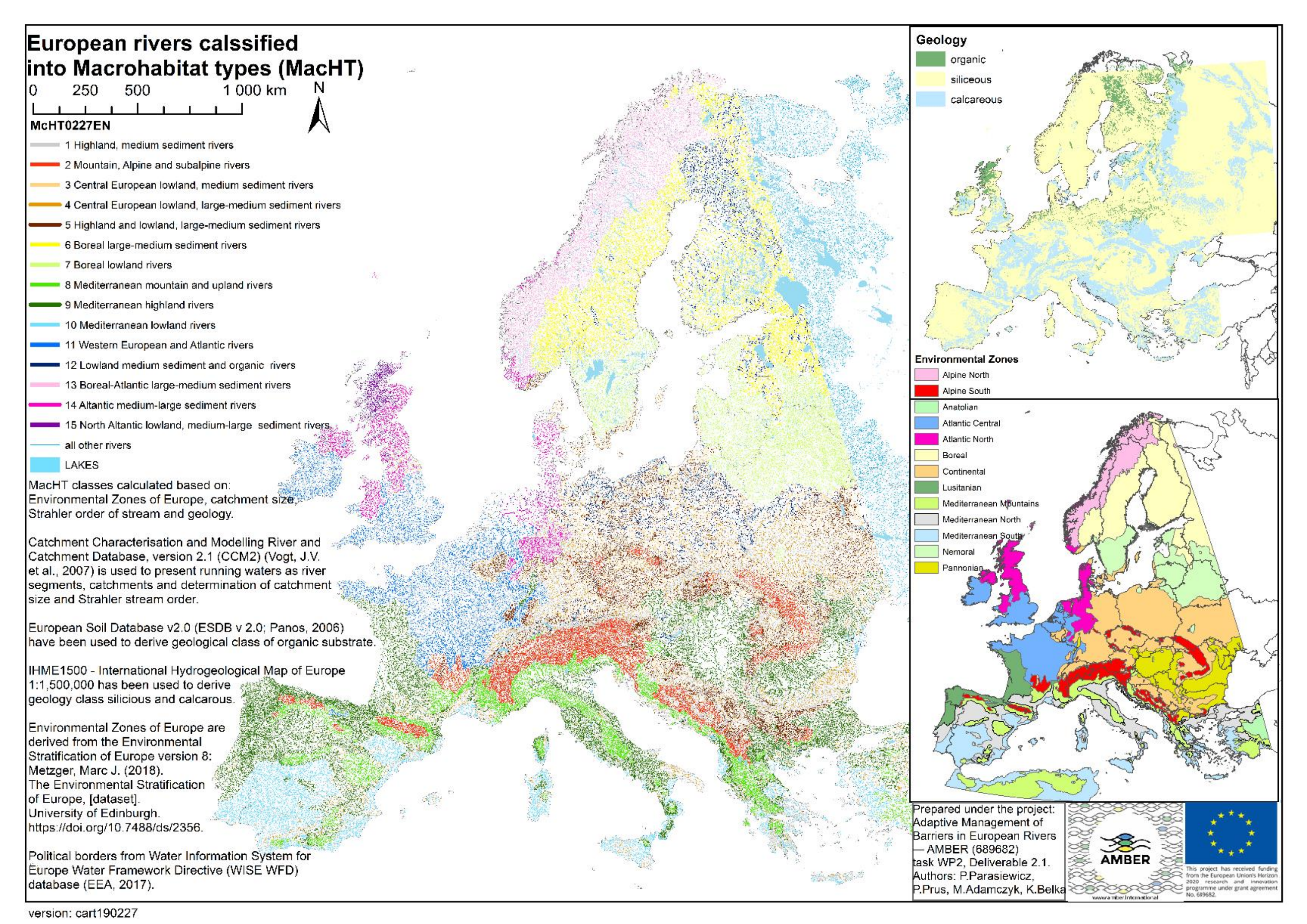
SOURCE: AMBER project

AMBER Barrier Tracker



European River Classification based on Intercalibration Database





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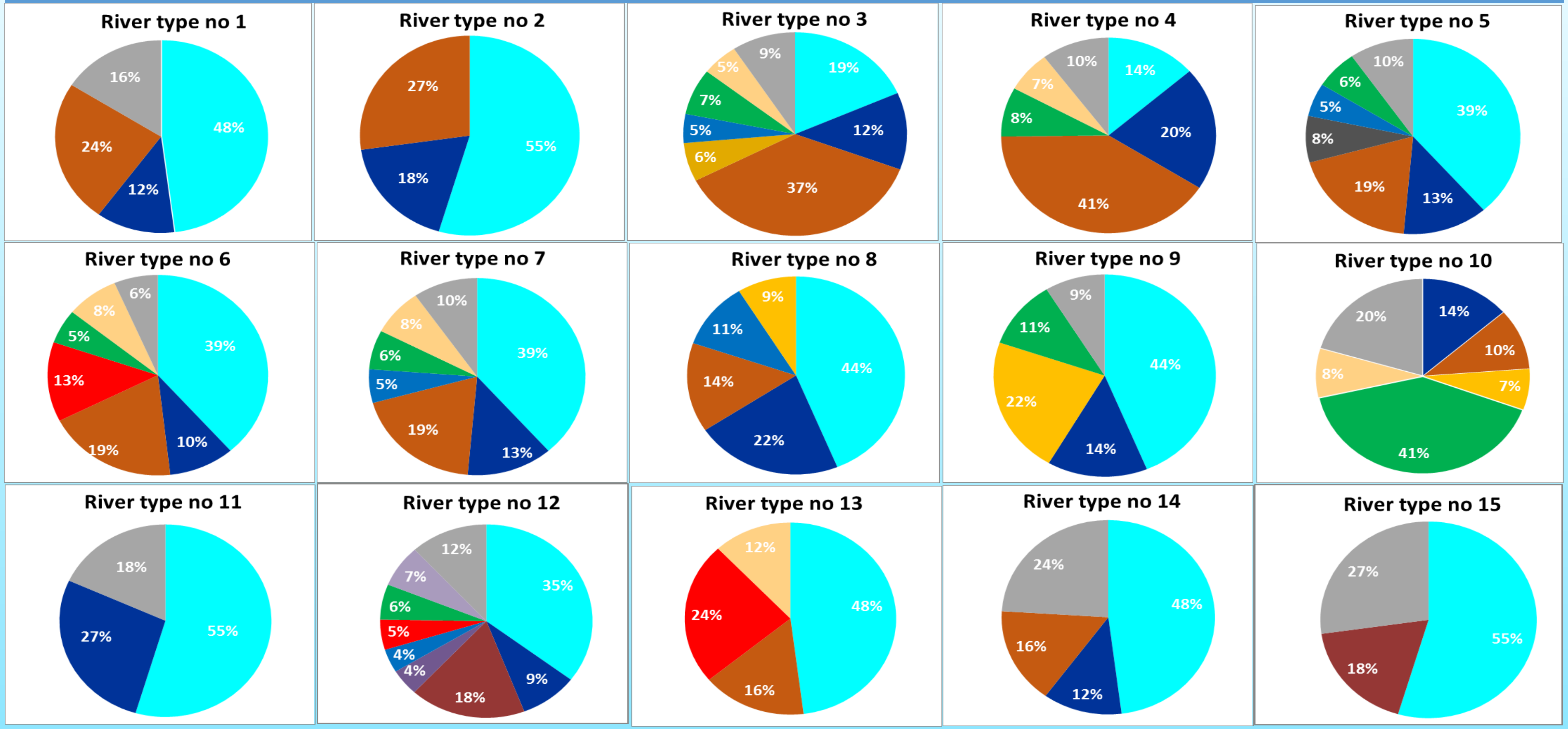
Fish MacroHabitat River Types



- Highly rheophilic, intolerant species
- Rheophilic benthic species, preferring sandy-gravel bottom substrate
- Rheophilic water column species, preferring sandy-gravel bottom substrate
- Limnophilic benthic species of moderate tolerance
- Limnophilic water column species of moderate tolerance
- Intolerant, rheophilic benthic species, preferring detritus or pelal bottom substrate
- Intolerant, water column species
- Limnophilic lithophilic species of moderate tolerance
- Limnophilic phytophilic species of moderate tolerance
- Benthic species of moderate tolerance
- Generalists - tolerant species

D2.2 Conceptual model of barier impact on fish habitats GEP: reference

	BARIER DESCRIPTION	PHOTO	PICTOGRAM
1	**Dam** - a barrier that blocks or constrains the flow of water and raises the water level. Fish passage facility provided		
2	**Weir** - a barrier aimed at regulating flow conditions and water levels. Fish passage facility provided		
3	**Sluice** - a movable barrier aimed at controlling water levels and flow rates in rivers and streams. Not blocking migration when open		
4	**Culvert** - a structure aimed at carrying a stream or river under an obstruction. Connected to river bed and substrate, free flowing		
5	**Ford** - a structure in a river or stream which creates a shallow place for crossing the river or stream by wading or in a vehicle. Water depth guarantee fish passing most of the year		
6	**Ramp** - a ramp or a bed sill is a structure aimed at stabilizing the channel bed and reducing erosion and is recognizable by its stair-like shape. Space in-between stones guarantee fish passing		

Table 4. Weighted remaining habitat proportion (wRHp) with regard to barrier type and FCMacHT. **Red – severe habitat loss (<10), orange – major habitat loss (10-50%), yellow – significant habitat loss (50-75%), green – moderate habitat loss (75-90%), blue – low habitat loss (>90).**

no.	River FCMacHT type	Dam wRHp %	Weir wRHp %	Sluice wRHp %	Culvert wRHp %	Ford wRHp %	Ramp wRHp %
1	Alpine	11	28	37	73	85	90
2	Continental	43	49	55	83	89	94
3	Mediterranean Highland	59	61	66	91	93	98
4	Mountain Highland Atlantic Continental	38	47	53	83	89	95
5	Boreal Lowland	46	52	57	84	90	95
6	Lowland Atlantic	63	63	66	93	93	99
7	Boreal Highland Costal	12	29	37	72	84	90
8	Mediterranean Mountain	34	44	50	81	87	92
9	Boreal Large	30	41	48	79	87	92

D2.2 Conceptual model of barier impact on fish habitats GEP: no-fish pass

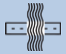
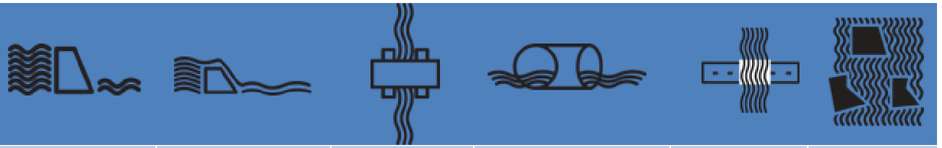
	BARIER DESCRIPTION	PHOTO	PICTOGRAM
1	**Dam** - a barrier that blocks or constrains the flow of water and raises the water level. Dam without fish pass migration		
2	**Weir** - a barrier aimed at regulating flow conditions and water levels. Weir without fish pass migration		
3	**Sluice** - a movable barrier aimed at controlling water levels and flow rates in rivers and streams. Sluice built on unpassable weir and without a fish pass		
4	**Culvert** - a structure aimed at carrying a stream or river under an obstruction. Culvert with crest blocking the upstream migration		
5	**Ford** - a structure in a river or stream which creates a shallow place for crossing the river or stream by wading or in a vehicle. Unpassable ford blocking the river most of the time		
6	**Ramp** - a ramp or a bed sill is a structure aimed at stabilizing the channel bed and reducing erosion and is recognizable by its stair-like shape. Unpassable barrier during low flood periods		

Table 5. Migration penalized weighted remaining habitat proportion (*wRHp*) with regard to barrier type and FCMacHT.

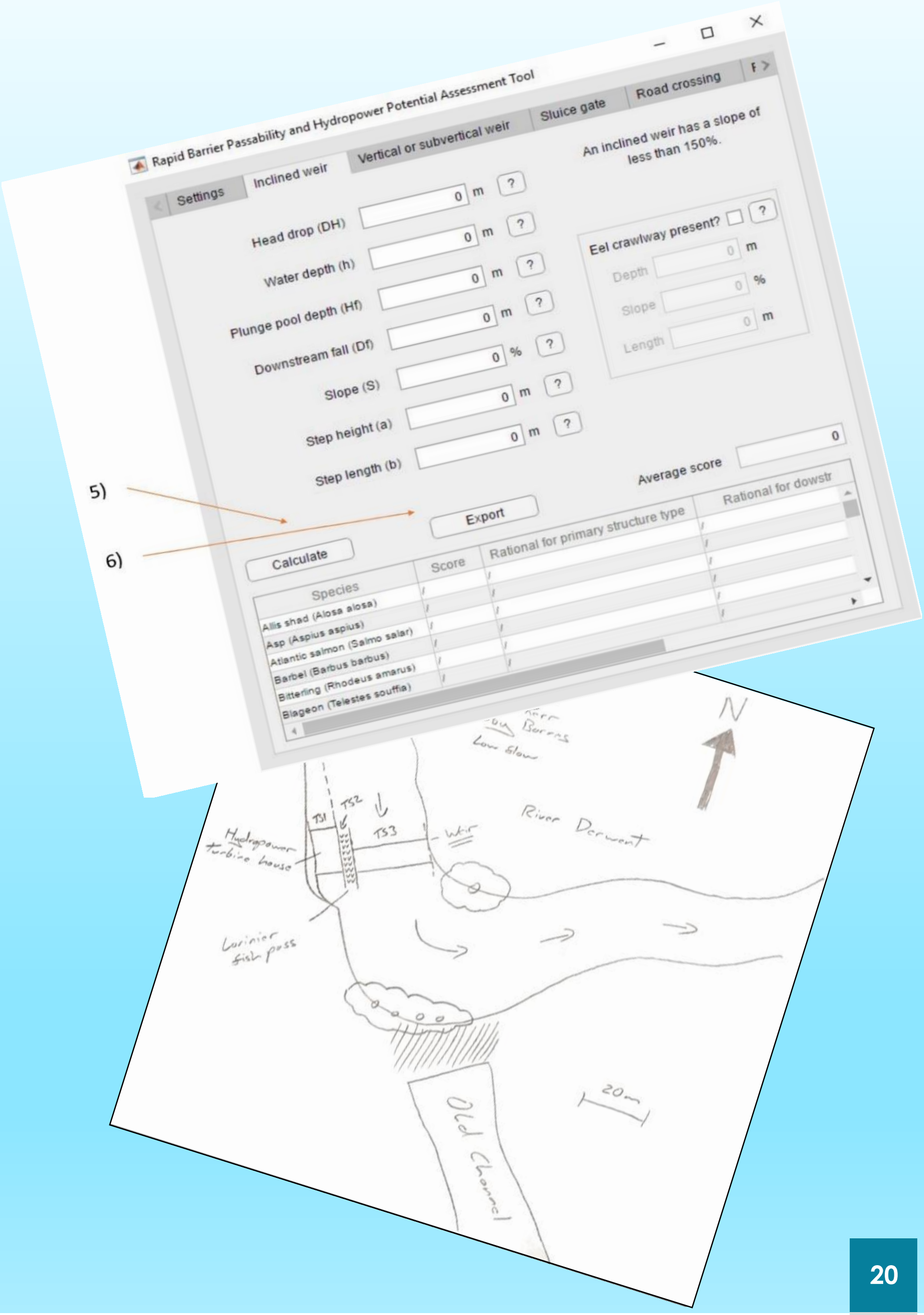
Red – severe habitat loss (<10), orange – major habitat loss (10-50%), yellow – significant habitat loss (50-75%), green – moderate habitat loss (75-90%), blue – low habitat loss (>90).



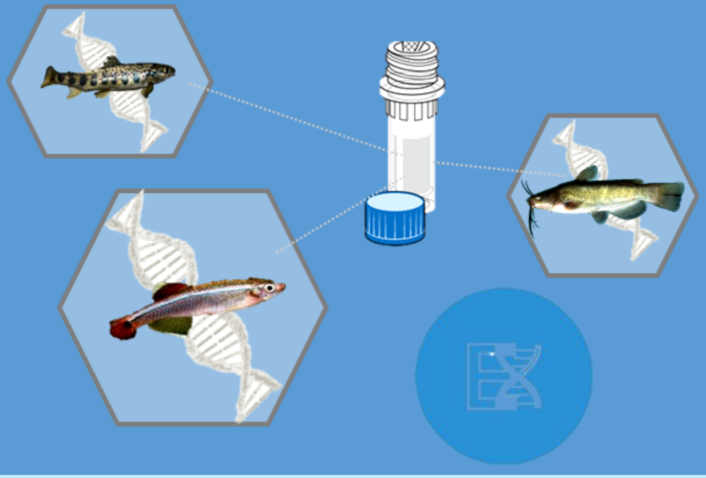
no.	River FCMacHT type	Dam *wRHp* %	Weir *wRHp* %	Sluice *wRHp* %	Culvert *wRHp* %	Ford *wRHp* %	Ramp *wRHp* %
1	Alpine	0	3	12	48	60	65
2	Continental	18	24	30	58	64	69
3	Mediterranean Highland	34	36	41	66	68	73
4	Mountain Highland Atlantic Continental	13	22	28	58	64	70
5	Boreal Lowland	21	27	32	59	65	70
6	Lowland Atlantic	38	38	41	68	68	74
7	Boreal Highland Costal	0	4	12	47	59	65
8	Mediterranean Mountain	9	19	25	56	62	67
9	Boreal Large	5	16	23	54	62	67

Rapid Barrier Passability Assessment Tool

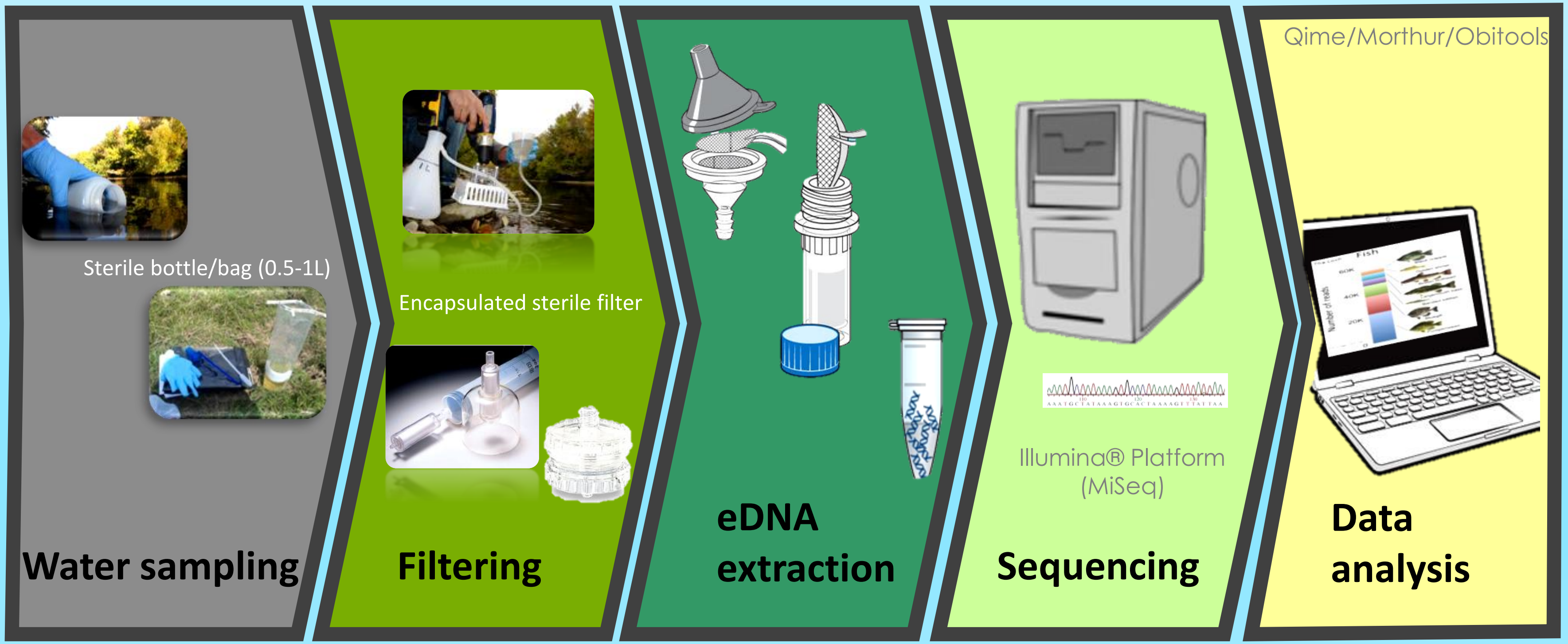
- Barrier types assessed include:
  - Sloping weir, vertical weir, culvert, rock ramp, ford, sluice gates.
- 47 different species/lifestages assessed
- Typical input parameters include:
  - Slope, head-drop, water depth, plunge pool depth, step heights etc…
- The tool was coded in Matlab but functions as a stand-alone bit of software that will run on a standard Windows computer.
- Software and installation and user guide available of AMBER website.



Task 2.5 Molecular toolkit: development of primers, protocols and pipelines **(D2.5 - 100%)**

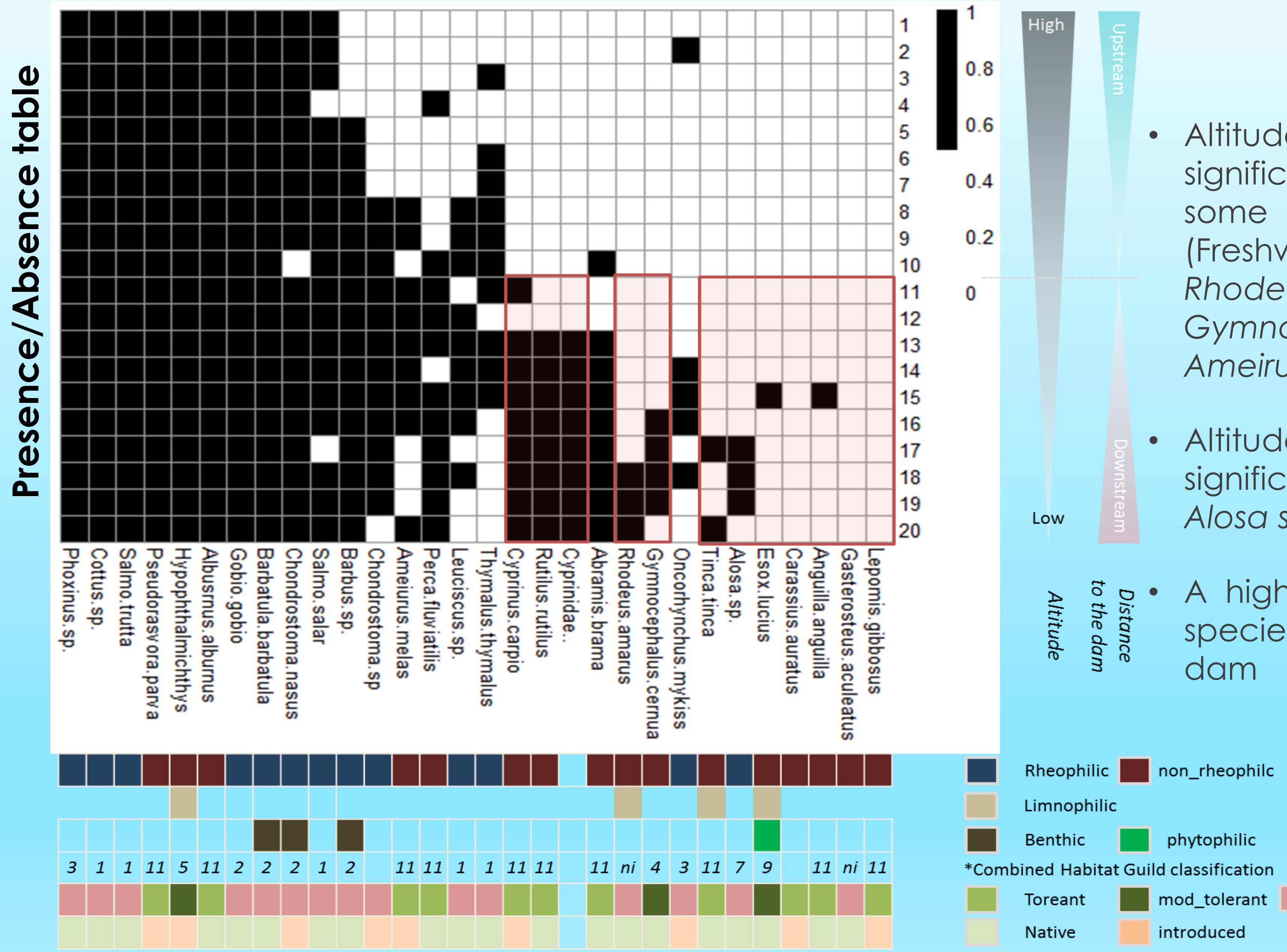


eDNA workflow



Swansea University
Prifysgol Abertawe
AMBER
Universidad de Oviedo

CASE STUDY: River Allier (France) eDNA Fish –Preliminary Results



- Altitude and distance to the dam are significant predictors of the presence of some species such as: *Abramis brama* (Freshwater bream), *Rutilus rutilus* (Roach), *Rhodeus amarus* (European bitterling), *Gymnocephalus cernua* (Ruffe) and *Ameirus melas* (Black bullhead).
- Altitude and cumulative height are significant predictors of the presence of *Alosa sp.* (Shads).
- A higher relative proportion of rheophilic species is detected upstream the Poutès dam

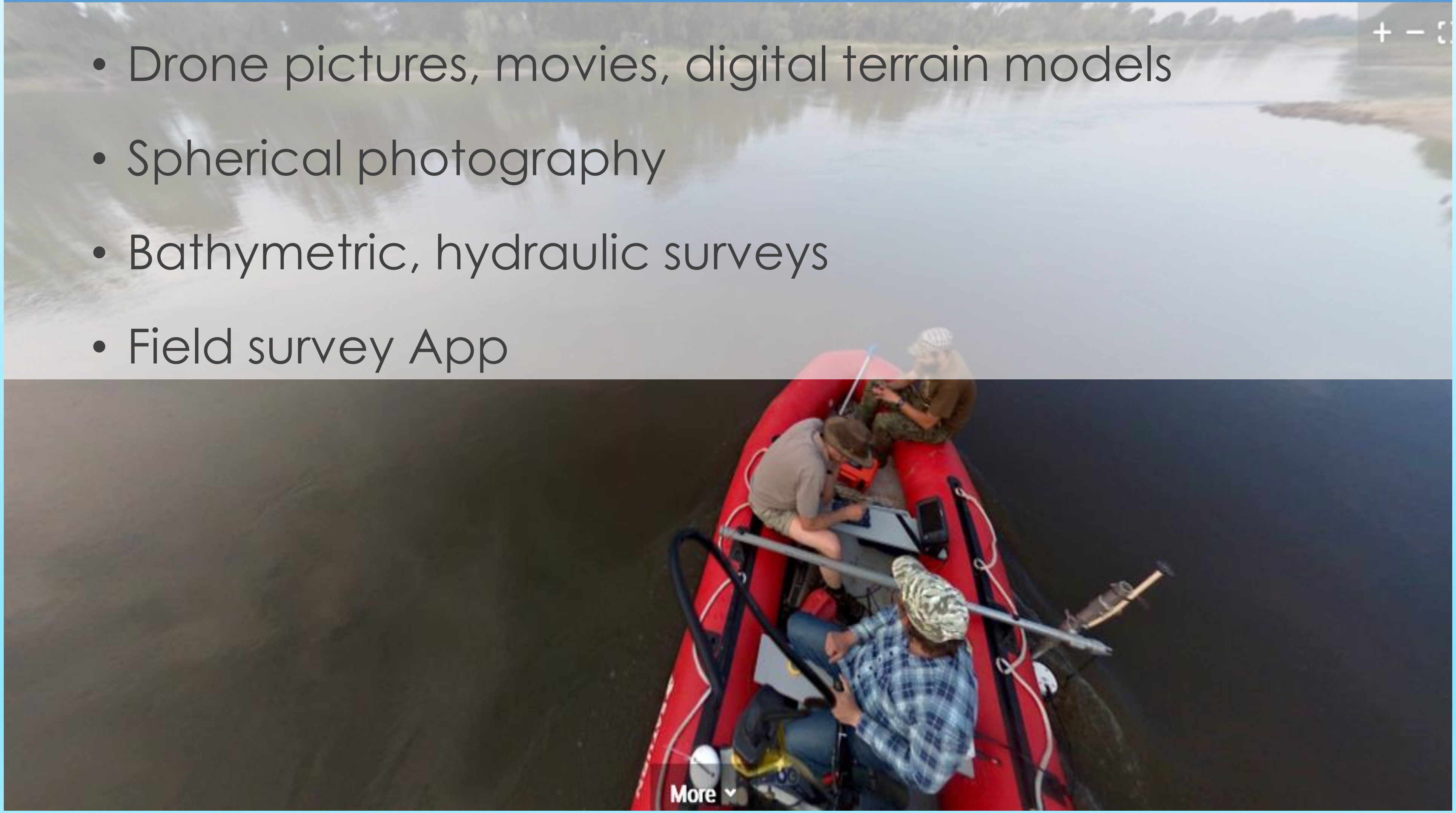
Investigating and mitigating impact of barriers

- Define habitat changes up- and downstream
- Develop mitigation scenarios
- Compare and select

Phot. ERCE, K. Susuka, P. Parasiewicz SSIFI

Rapid stream mapping

- Drone pictures, movies, digital terrain models
- Spherical photography
- Bathymetric, hydraulic surveys
- Field survey App



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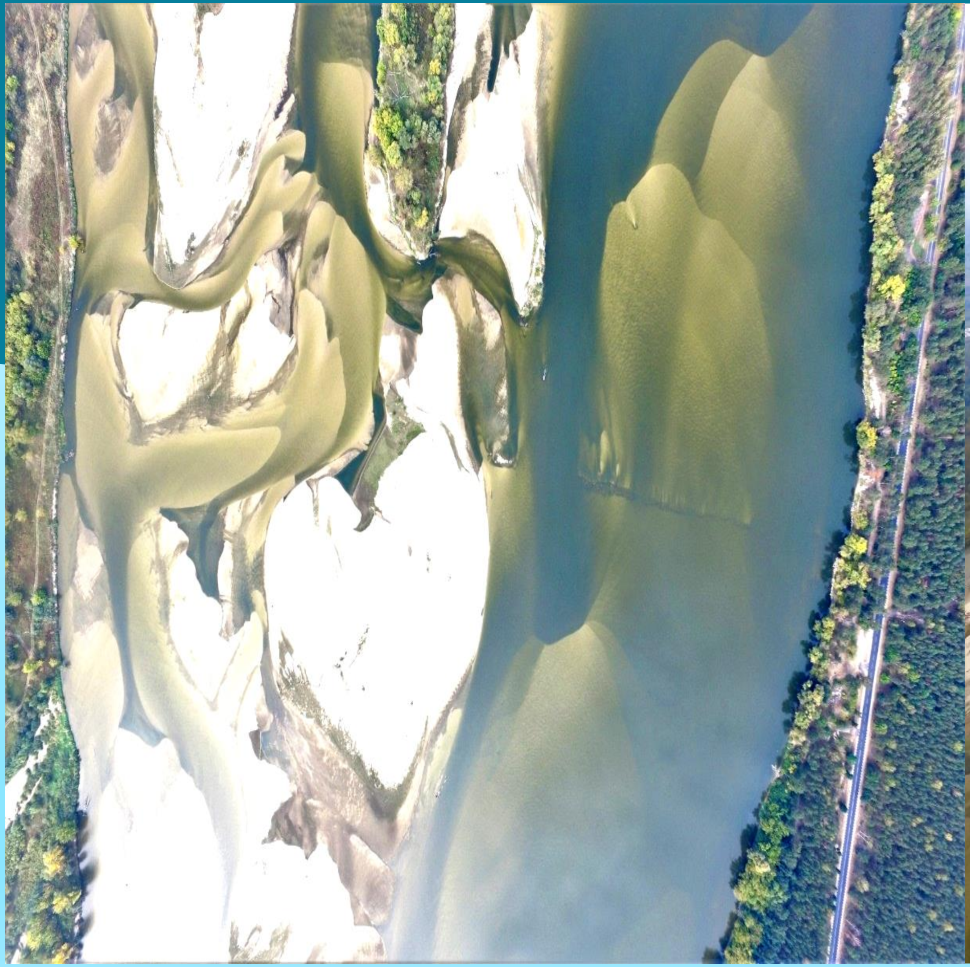
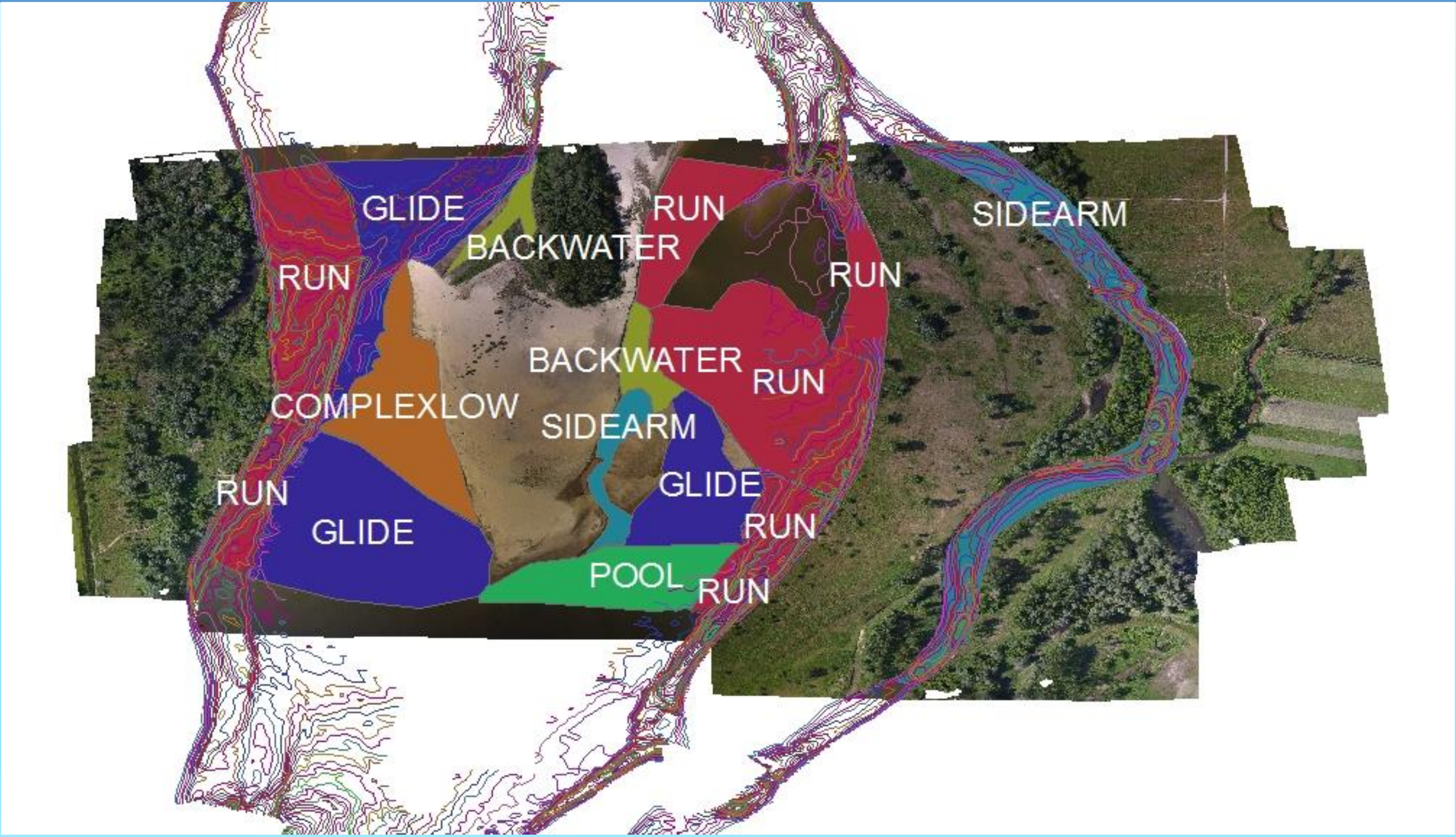
Mapping of large rivers



Middle Vistula River, 2016

Wisła River UAV photos + bathymetry + HMU



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3D model of Sesia River (IT) obtained form drone work

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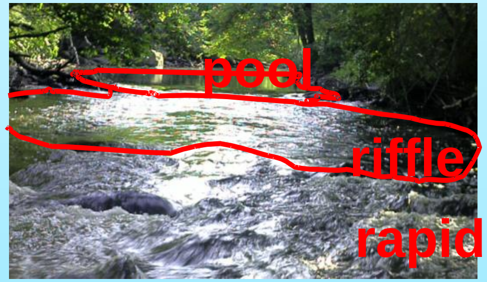
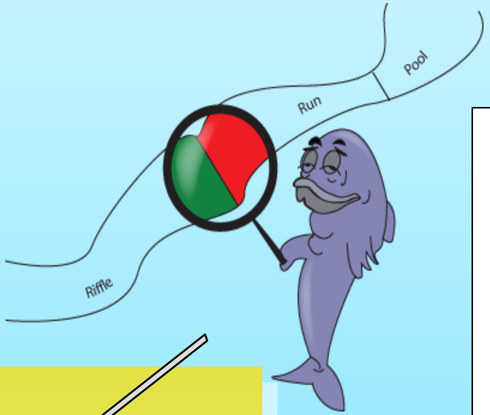
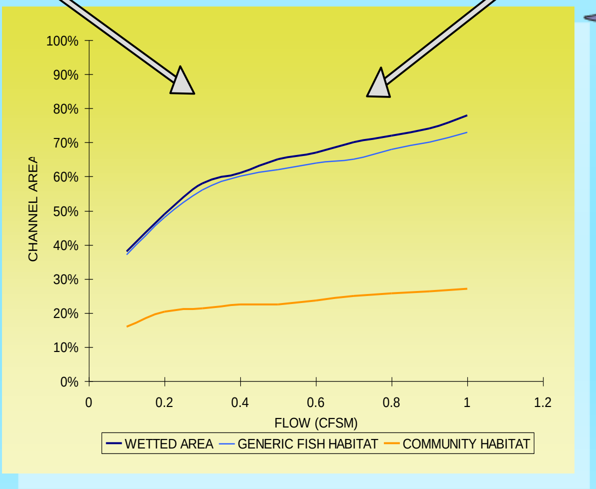
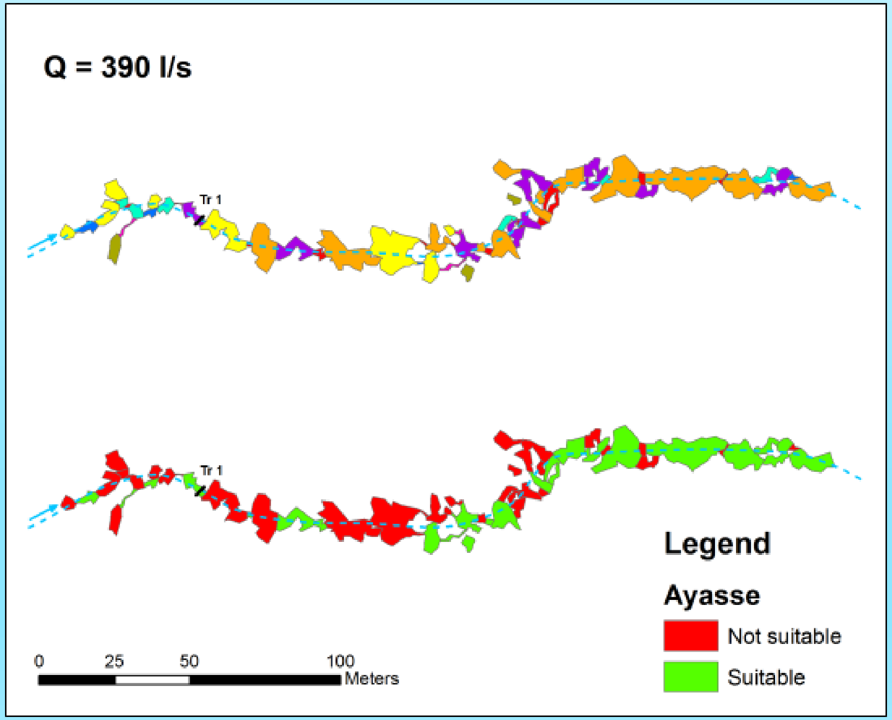
Habitat models of barrier effects on riverine habitats





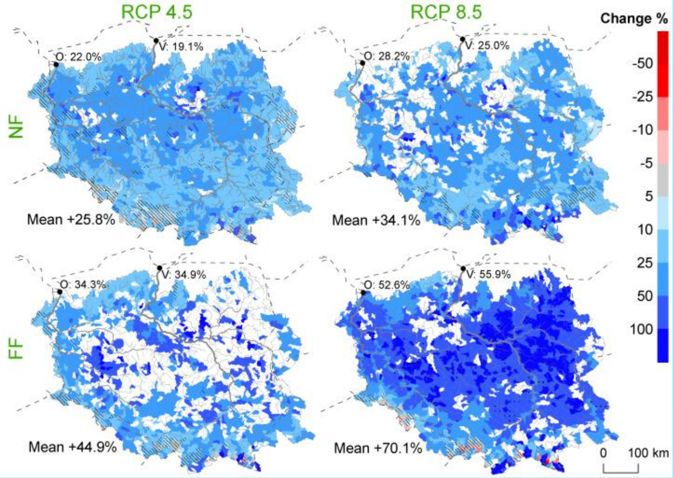




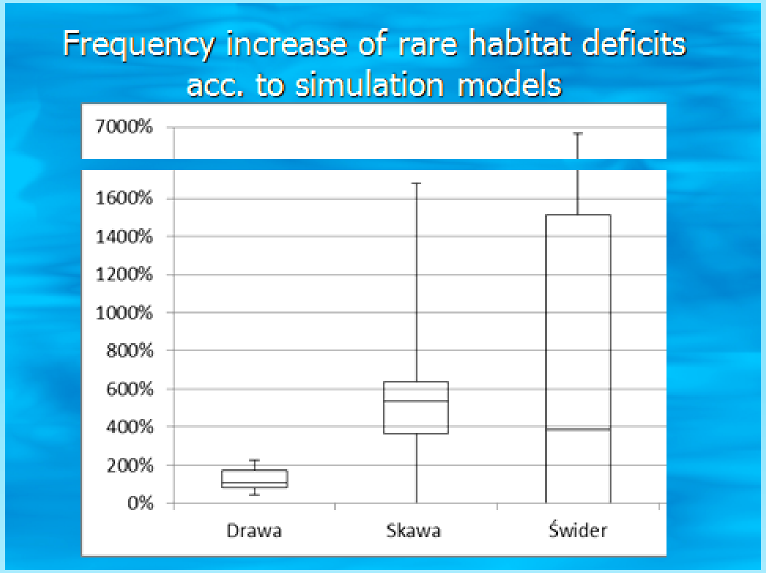
Modelling stream barrier effects under different scenarios of climate change

- Develop scenarios for impact of climate change on fragmentation in representative watersheds
- Habitat time series analysis
- Test model validity
- Apply Restoration Alternatives Analysis

Predicted changes in low flow patterns



Piniewski et al. (2017)



Modelling stream barrier effects under different scenarios of climate change

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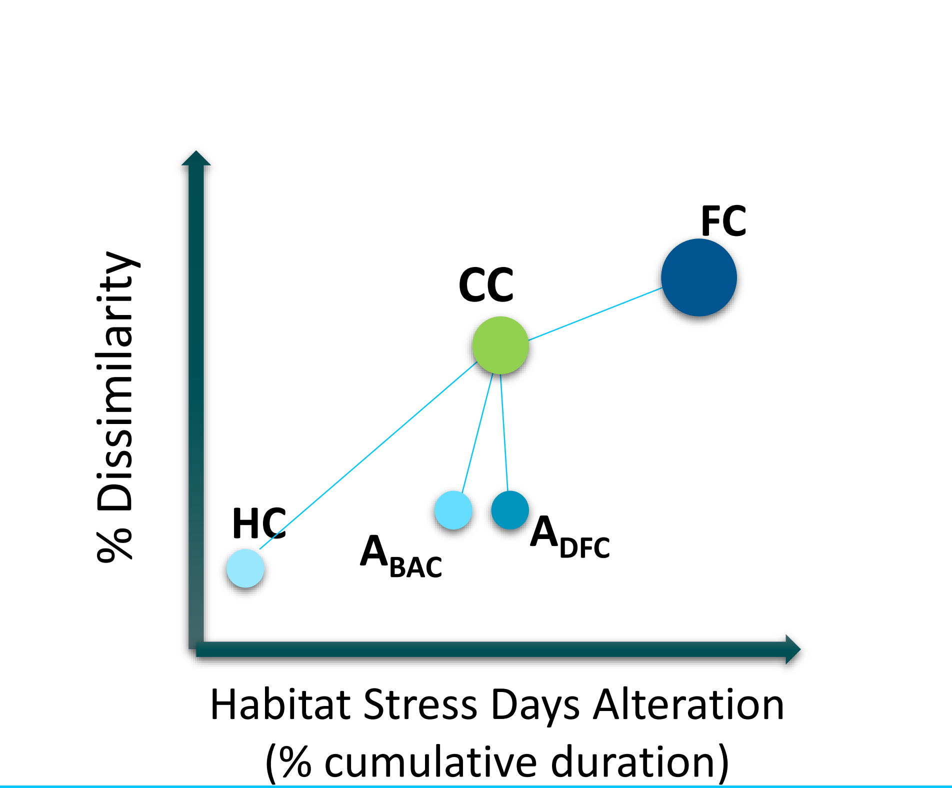
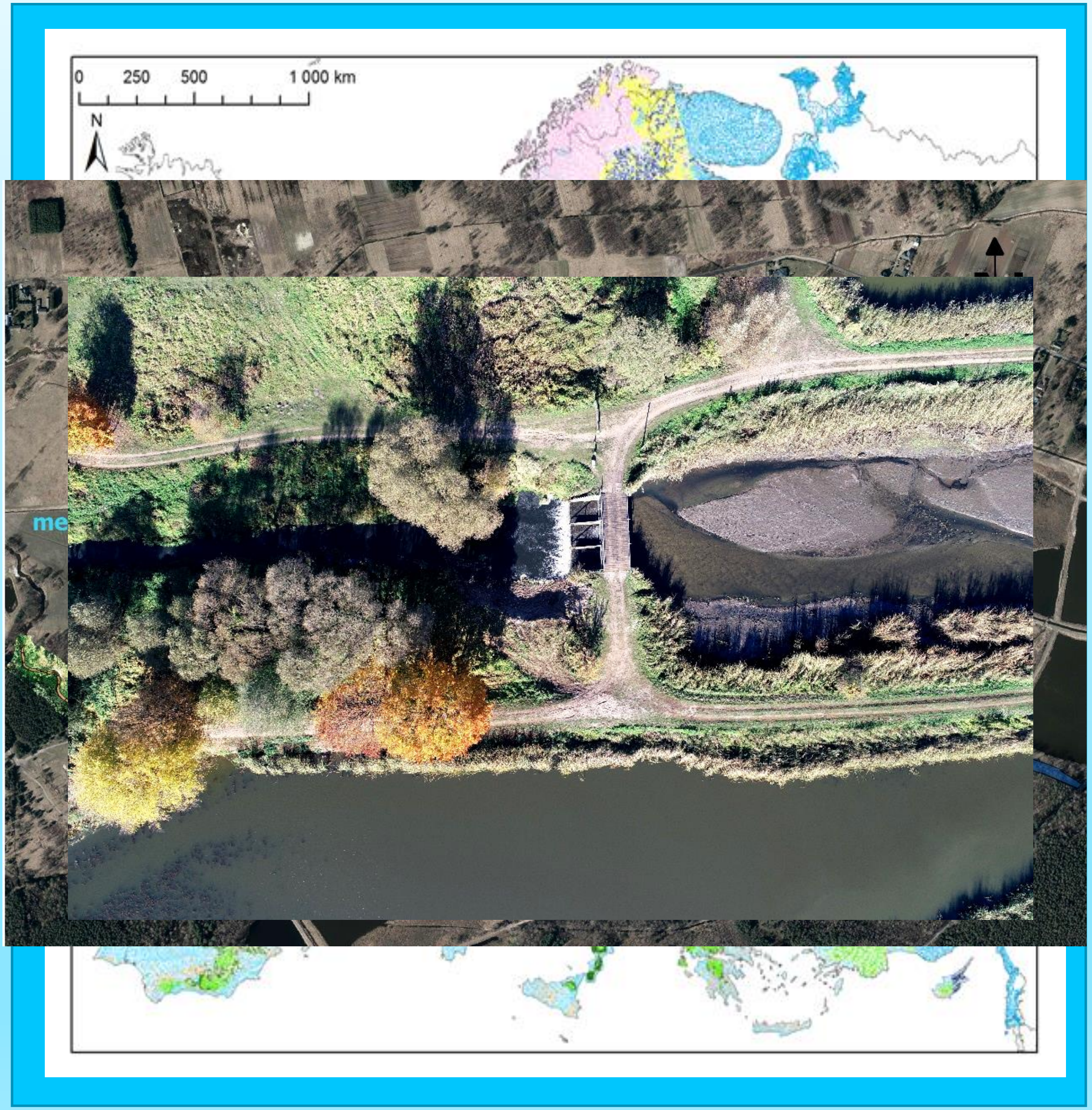


HC - historical conditions
CC - current conditions
FC - future conditions
A_{DFC} - **Desired Future Conditions** alternative
A_{BAC} - **Best Available Conditions** alternative

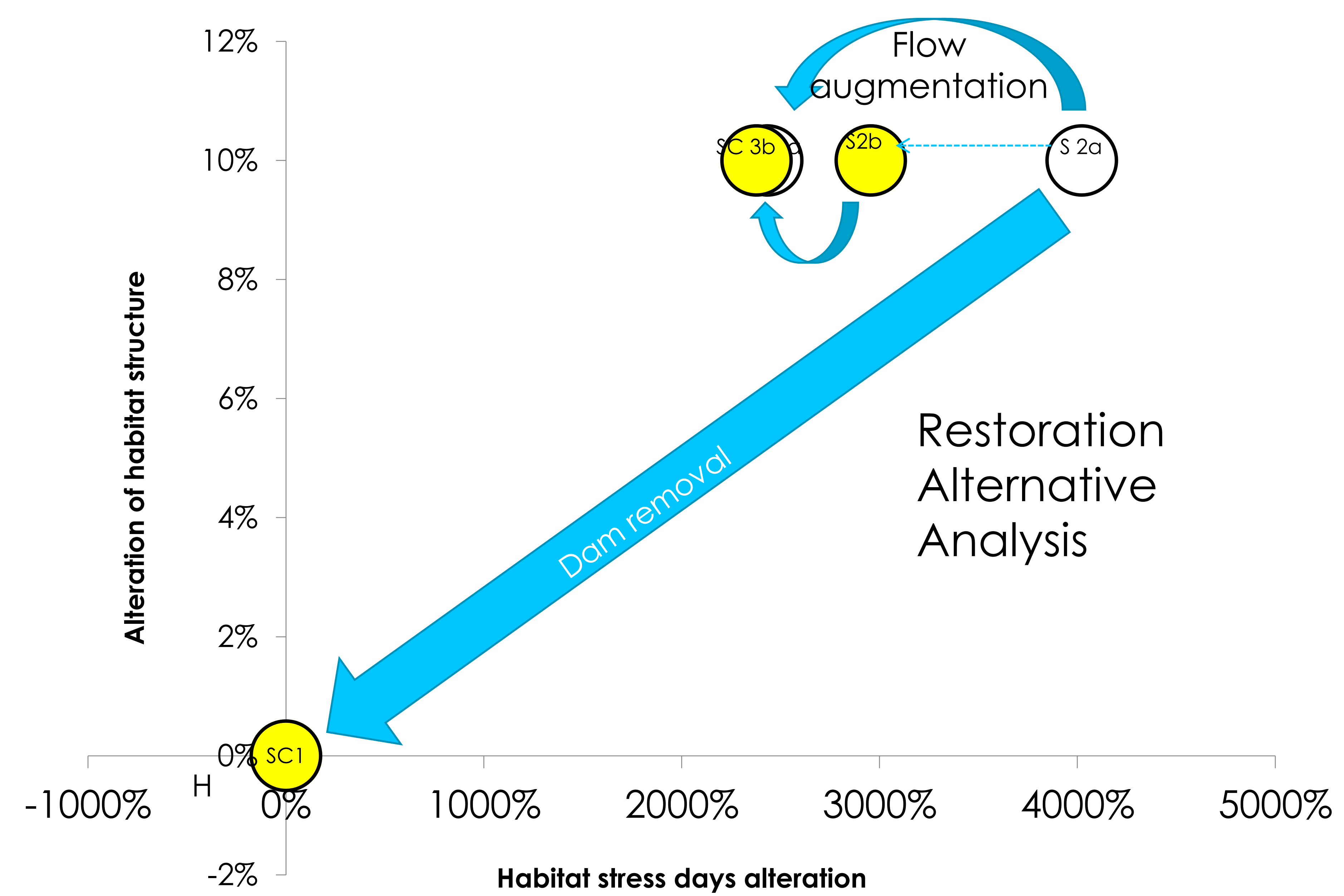
MesoHABSIM MODEL

Example of application: Mienia River (Central Poland)

- Watershed Area 256 km^2
- Stream Order 1-3 (Strahler)
- Siliceous surficial geology
- Low gradient, sandy bottom
- Average width 5 m
- Has many small barriers and a dam to supply water for fish farm
- No fish passage



UAV Phot. K. Suska SSIFI



Flow augmentation
SC 3b
S2b
S 2a
Restoration Alternative Analysis
Dam removal
SC1
12%
10%
8%
6%
4%
2%
0%
-2%
Alteration of habitat structure
-1000%
H
0%
1000%
2000%
3000%
4000%
5000%
Habitat stress days alteration

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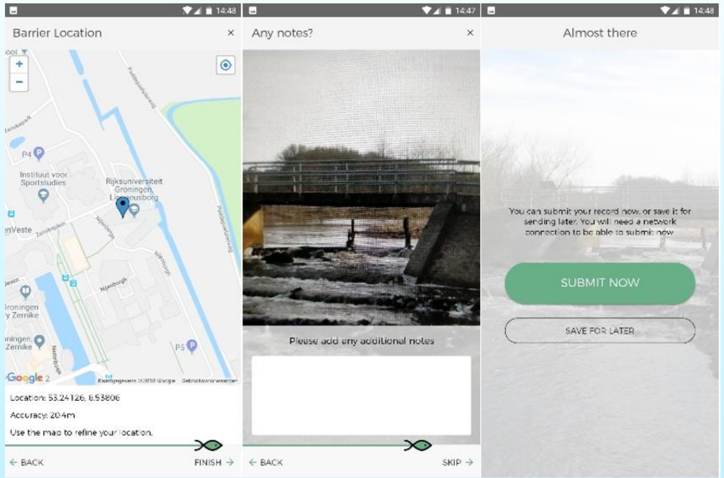
www.amber.international

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

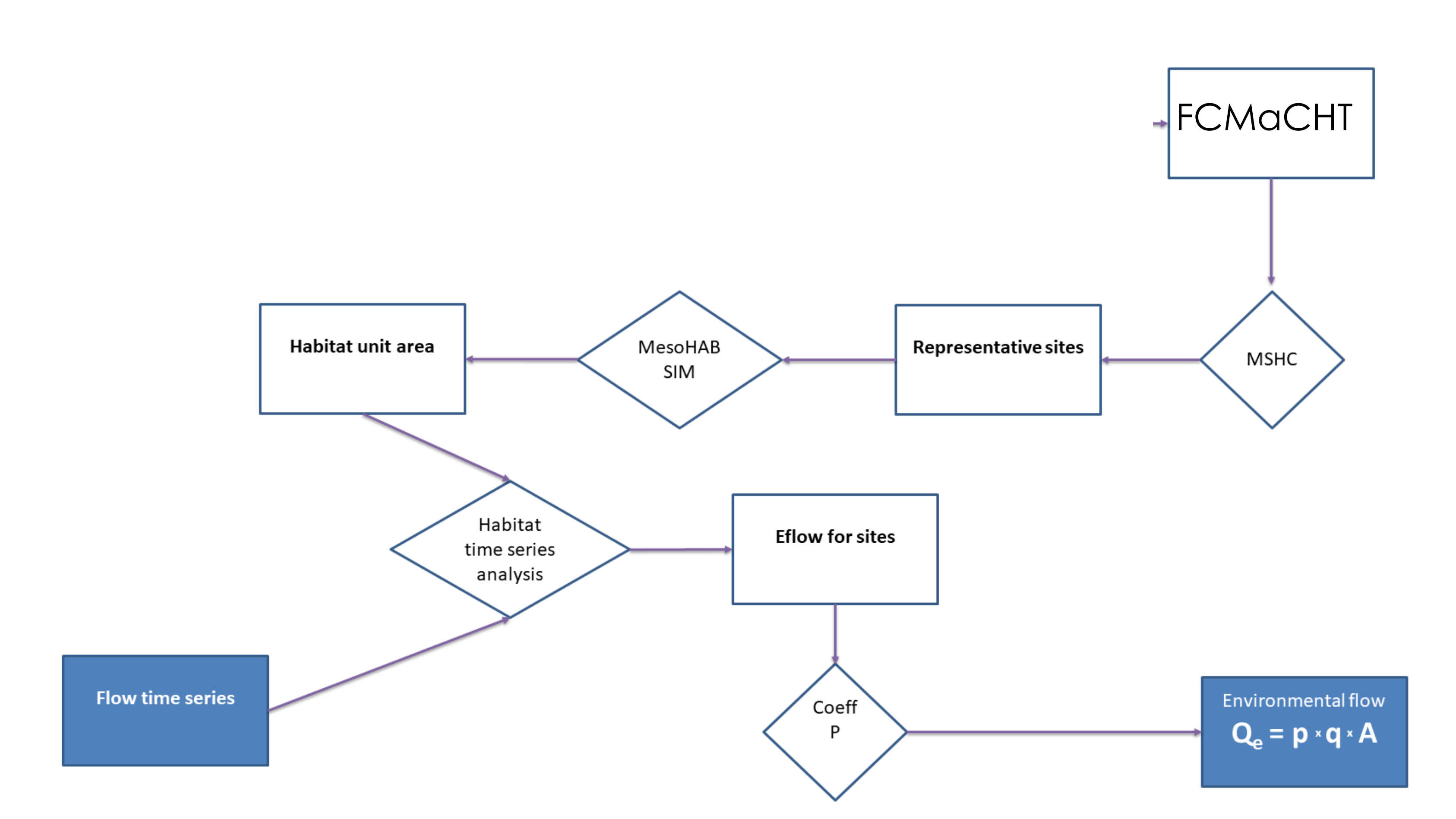
AMBER FIELD DATA COLLECTION MANUAL

This is the 1.0 version of the AMBER FIELD MANUAL. This document is a part of deliverable 5.10 – BOOK ON BEST GUIDANCE ON ADAPTIVE BARRIER MANAGEMENT IN EUROPE, of the AMBER project, which has received funding from the European Union's Horizon 2020 Programme for under Grant Agreement (GA) #689682.

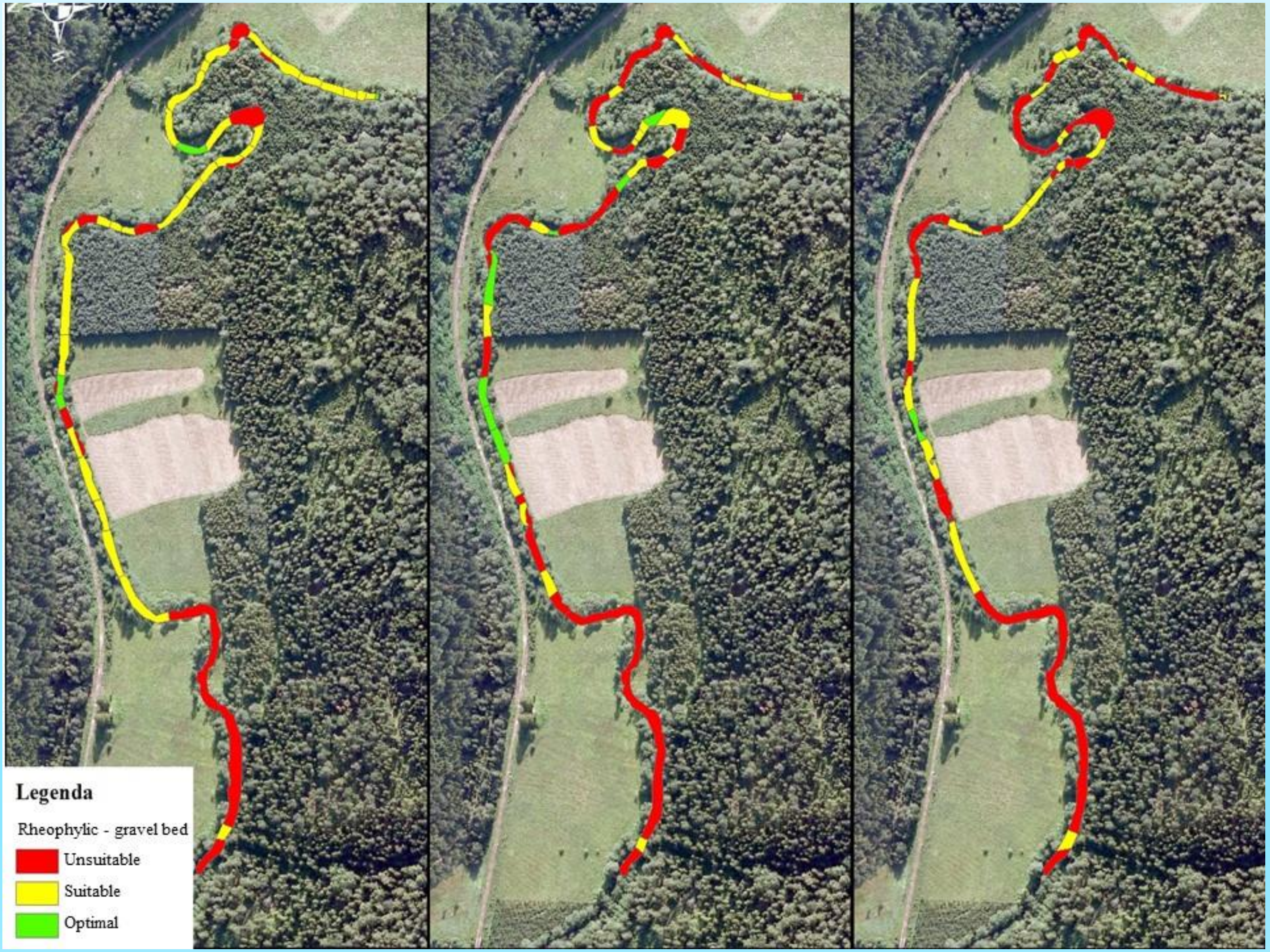
1



Process of establishing e-flows for FCMaCHT



MesoHABSIM model



Calculating e-flows in non-modelled locations

$$Q_{sef,k} = p_b \cdot q_{MBLF,k} \cdot A_k$$

p_b = tabulated value of index obtained from

pilot studies specific for bioperiod and

FCMacHT

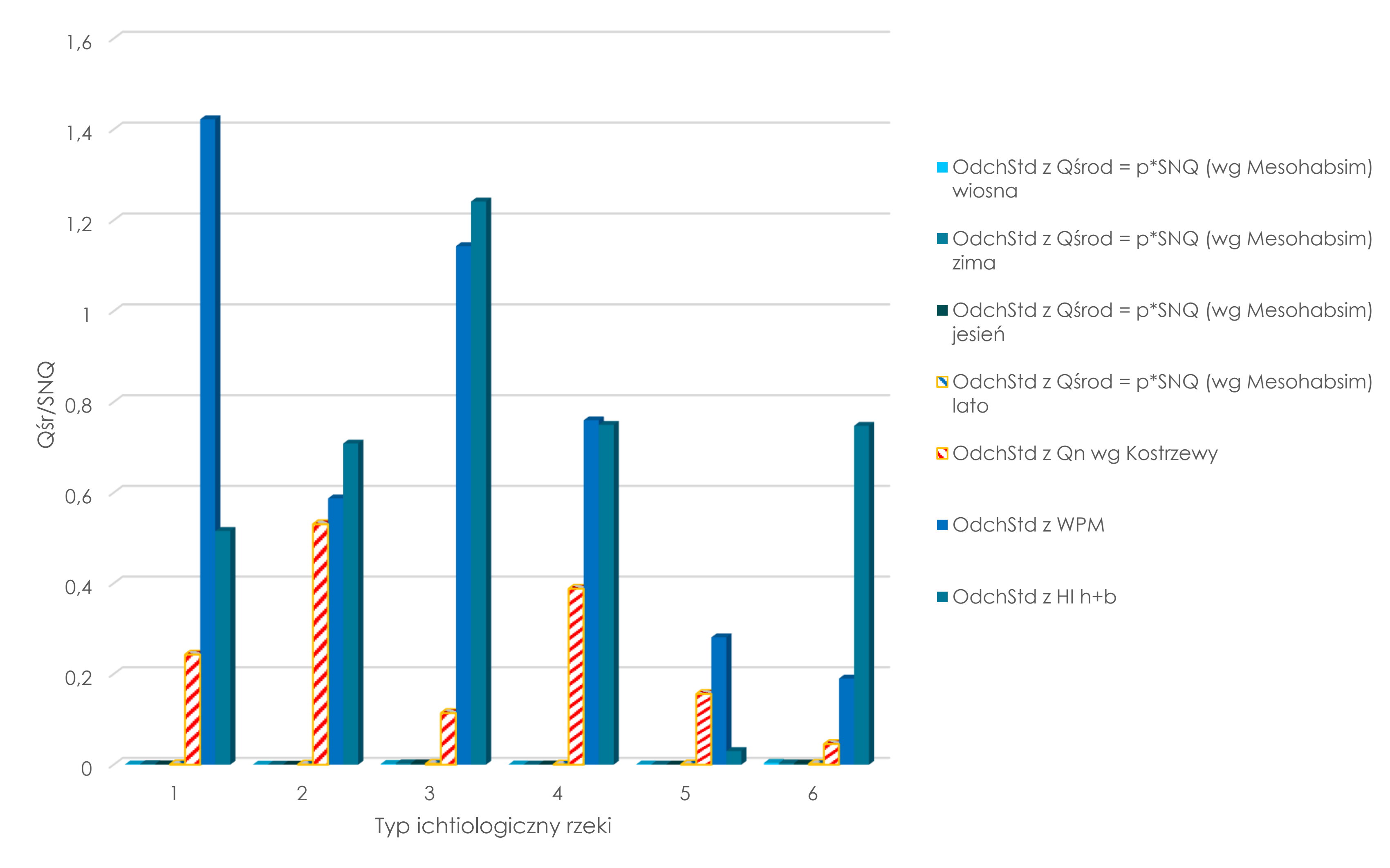
$q_{MBLF,k}$ = specific mean low flow for the bioperiod at the

cross-section k

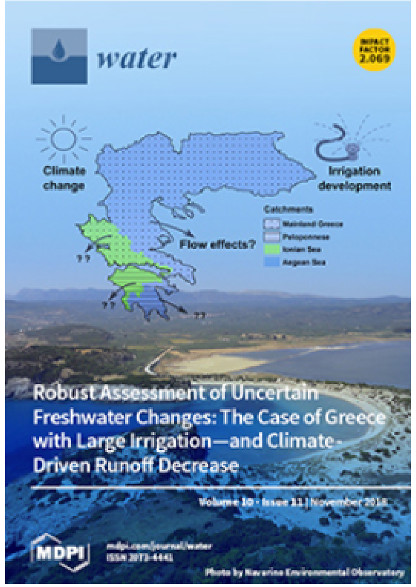
A_k = catchment area at the cross-section k

Standard deviation of e-flows calculated with four methods

- 6 FCMacHT
- MesoHABSIM
- Standard setting Kostrzewa
- Wetted Perimeter
- R2Cross



Volume 10, Issue 11



Water **2018**, *10*(11), 1501; https://doi.org/10.3390/w10111501

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Article

"E = mc²" of Environmental Flows: A Conceptual Framework for Establishing a Fish-Biological Foundation for a Regionally Applicable Environmental Low-Flow Formula

Piotr Parasiewicz [1,*,†], **Paweł Prus** [1], **Katarzyna Suska** [1] and **Paweł Marcinkowski** [2]

1 Department of River Fisheries, S. Sakowicz Inland Fisheries Institute, Oczapowskiego 10, 10-719 Olsztyn, Poland

2 Department of Hydraulic Engineering, Faculty of Civil and Environmental Engineering, Warsaw University of Life Sciences—SGGW, Nowoursynowska 166, 02-787 Warsaw, Poland

* Correspondence: p.parasiewicz@infish.com.pl

† Current address: Department of River Fisheries, S. Sakowicz Inland Fisheries Institute, Zabieniec Główna 48, 03-500 Piaseczno, Poland.

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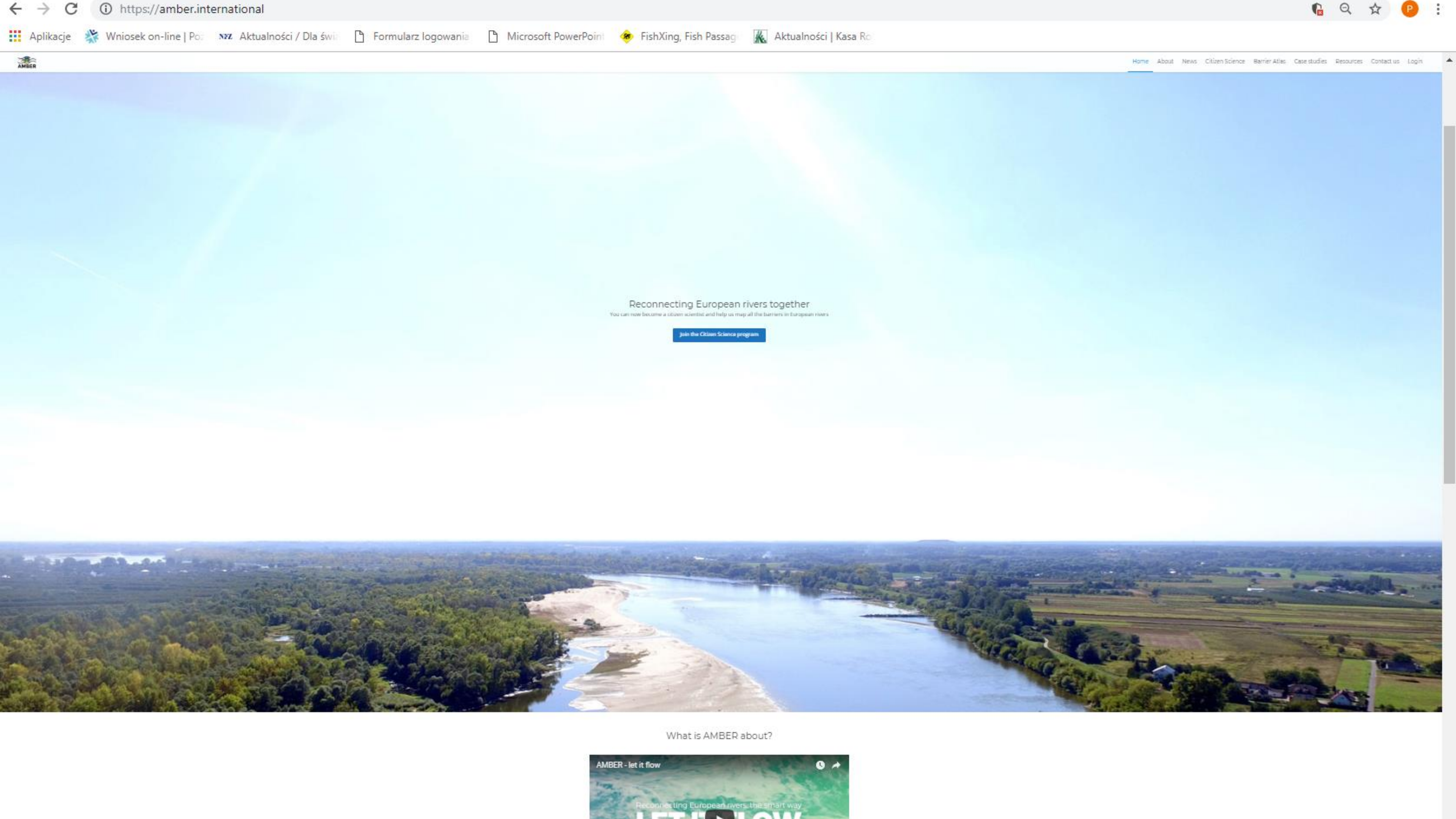
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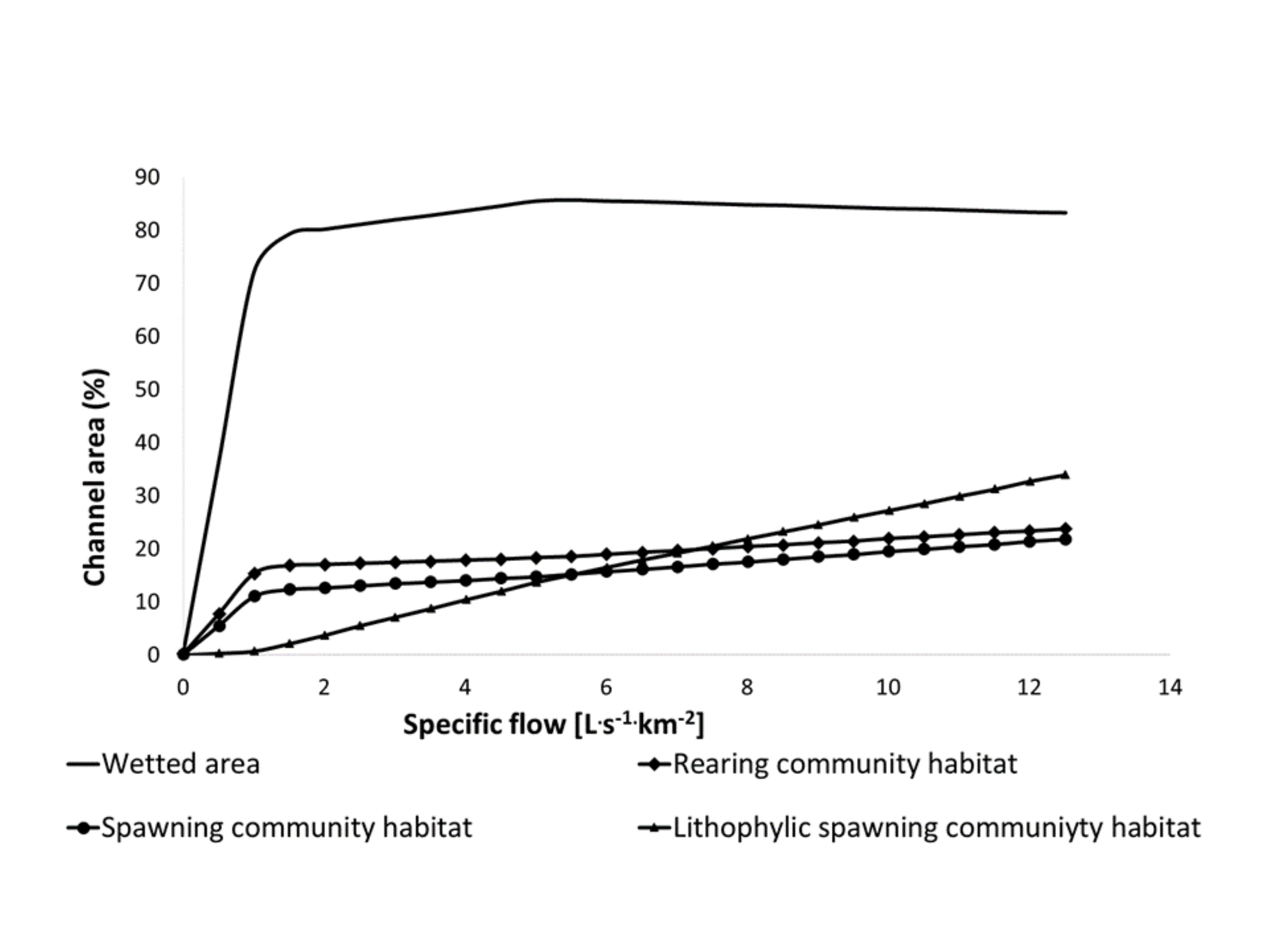
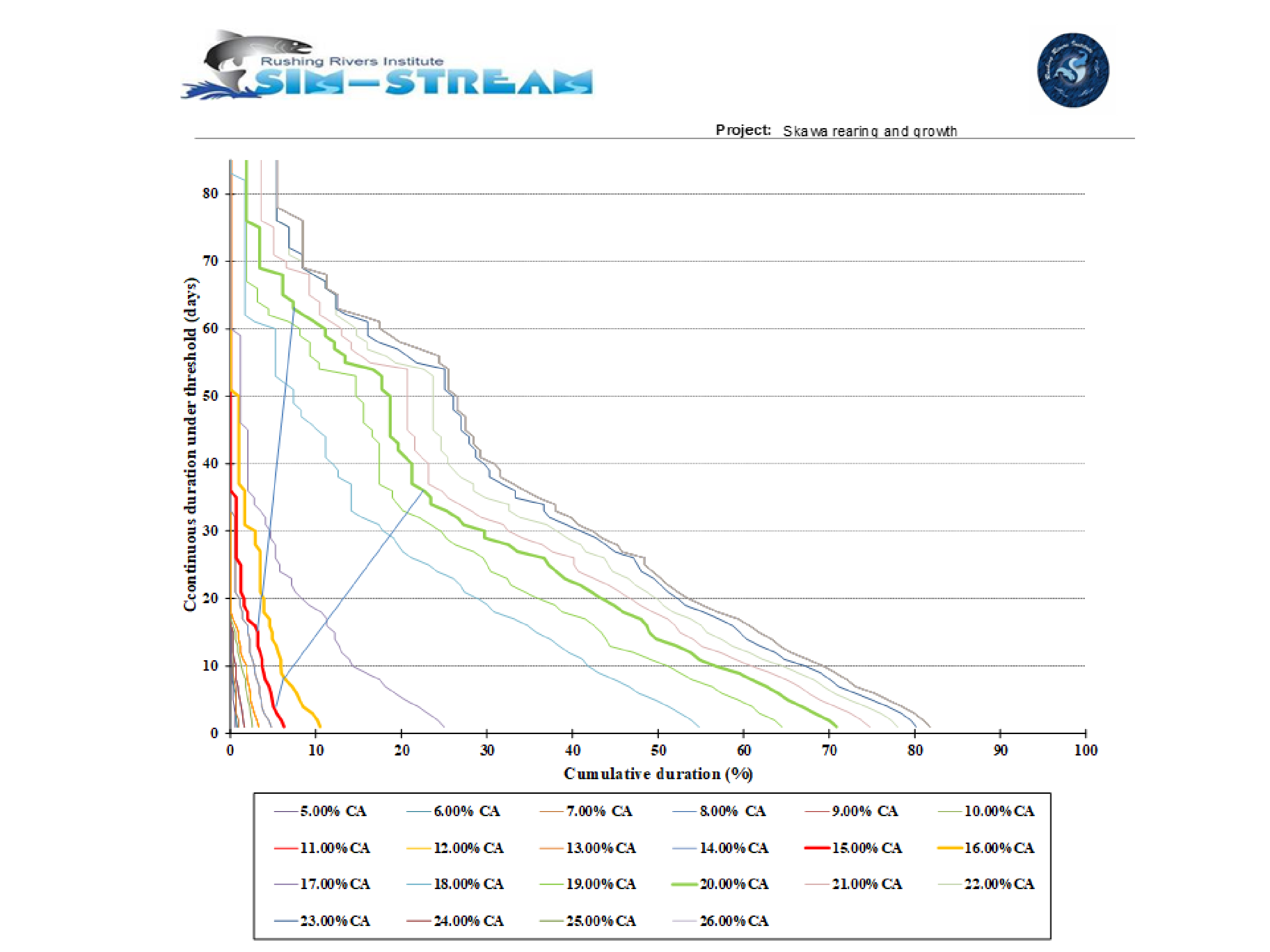
AMBER - let it flow
Reconnecting European rivers, the smart way

Rating curves



Habitat time series analysis

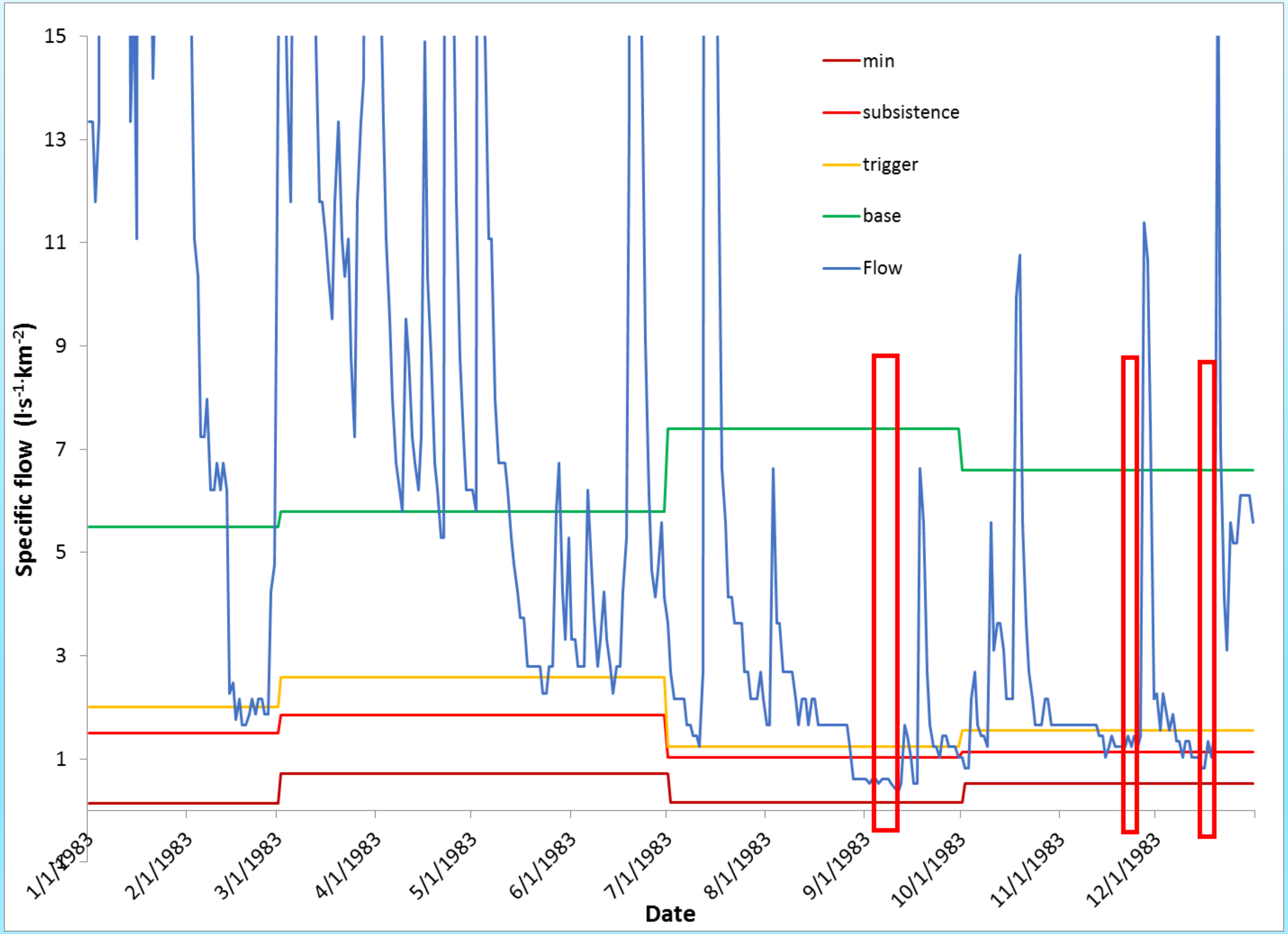


Results

Skawa – Type 2, flysch rivers

Bioperiod	spring spawning	searing	fall spawning	over-wintering
Months	III-VI	V-IX	X-XII	I-II
Common habitat (% Channel Area)	**15,5**	**20**	**18**	**-**
Persistent duration (days)	22	36	27	32
Catastrophic duration (days)	36	62	51	42
Corresponding ecological base flow ($ls^{-1}km^{-2}$)	5,8	7,4	6,6	5,5
Corresponding ecological flow (m^3s^{-1})	0,56	0,715	0,64	0,531
Critical habitat (% Channel Area)	**13**	**16**	**2**	**-**
Persistent duration (days)	7	9	8	8
Catastrophic duration (days)	15	20	14	32
Corresponding trigger flow ($ls^{-1}km^{-2}$)	2,59	1,24	1,55	2
Corresponding trigger flow (m^3 s^{-1})	0,25	0,12	0,15	0,193
Rare habitat (% Channel Area)	**12,5**	**15**	**1**	**-**
Persistent duration (days)	6	4	6	8
Catastrophic duration (days)	11	16	7	12
Corresponding subsistence flow ($ls^{-1}km^{-2}$)	1,86	1,03	1,14	1,5
Corresponding subsistence flow (m^3s^{-1})	0,18	0,099	0,11	0,145
Absolute minimum ($ls^{-1}km^{-2}$)	**0,725**	**0,166**	**0,518**	**0,414**

Example of adaptive system



Hydrological standartisation for spatial transferability

p= specific flows/mean low flow of bioperiod

	Bioperiod	Spring spawning	Rearing and growth	fall spawning/ overwintering	overwintering
	River\Months	III-VI	VII-IX (X)*	X (XI)*-XII	I-II
index p_b	Skawa (2)	1.15	0.74	0.21	0.80
	Kamienna (1)	0.87	1.07	1.15	0.82
	Mitręga*	1.57	0.57	0.82	0.83
	Mienia*	0.74	0.86	0.79	0.79
	Sąpólna* (3)	1.28	1.17	0.73	0.62
	Świder* (4)	1.02	0.92	0.75	0.74
	Drawa (4s)	1.11	0.95	1.02	0.89