Prioritisation concept for dam removal in North Rhine-Westphalia, Germany

Andreas Müller,
chromgruen, Velbert, Germany

Agenda

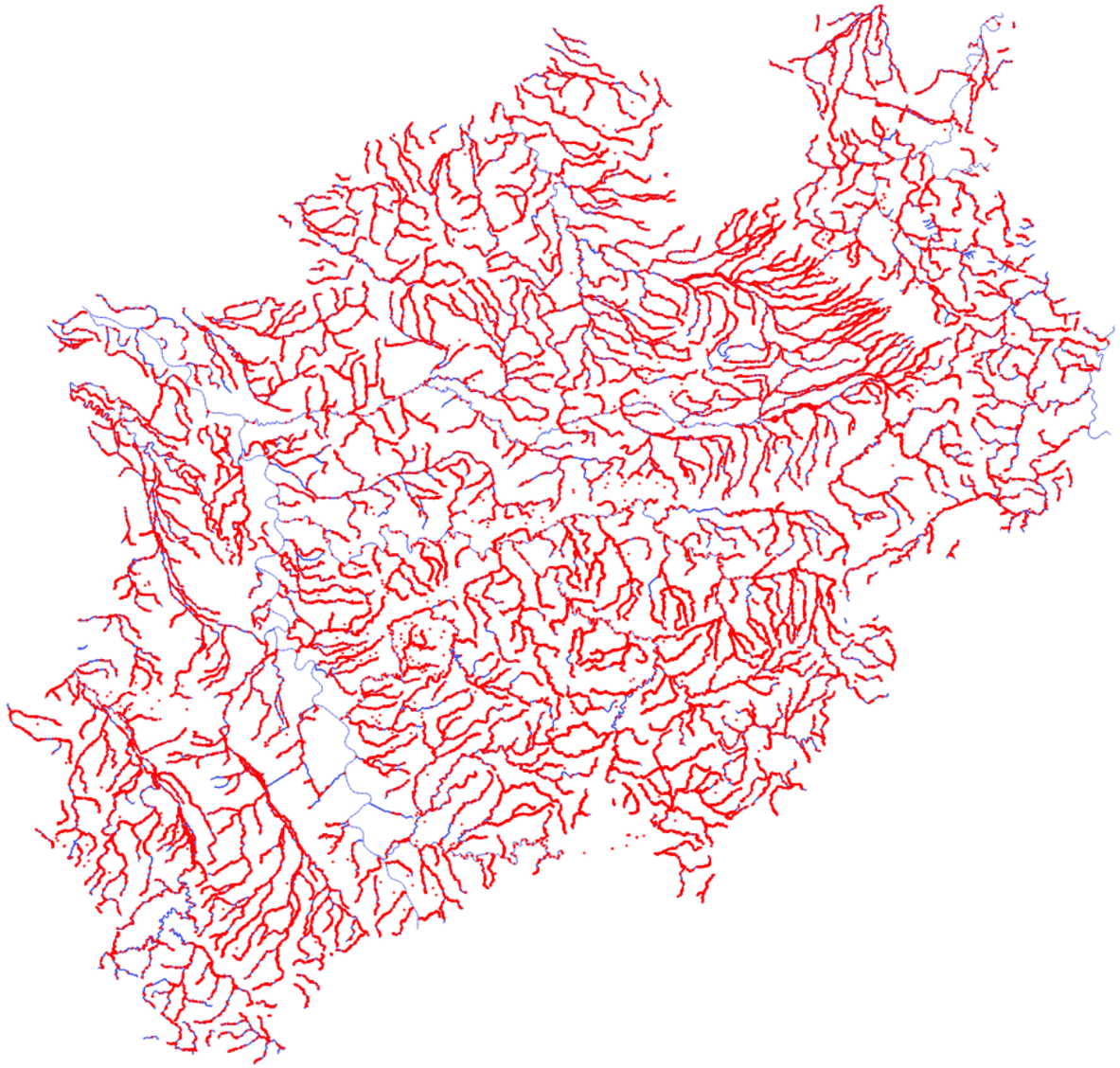
- Introduction
- Dams in North-Rhine Westphalia (NRW)
- Project „GIS-based determination of habitat gains achievable by dismantling transverse constructions“
- Results and their application

Introduction

- Studies of chemistry and computer science, Ph.D. in Physical Chemistry
- Since 1992: involved in method and software development for hydromorphological surveys in Germany („Gewässerstrukturkartierung“)
  - 1998: first truly mobile hydromorphological survey software „Beach“ (for Palm Handhelds)
  - 1999: Co-Editor of „Strukturgüte von Fließgewässern“ (Morphological quality of rivers). Springer.
  - 2010–12: Complete revision of method and software Beach 3 (for Android Tablets) + state-wide web-application
  - Today: Beach in use in 7 (of 16) German states for state-wide surveys
- > 50 projects with ties to WFD and/or river morphology (method and software development, data scientific analyses, river restoration, ...)

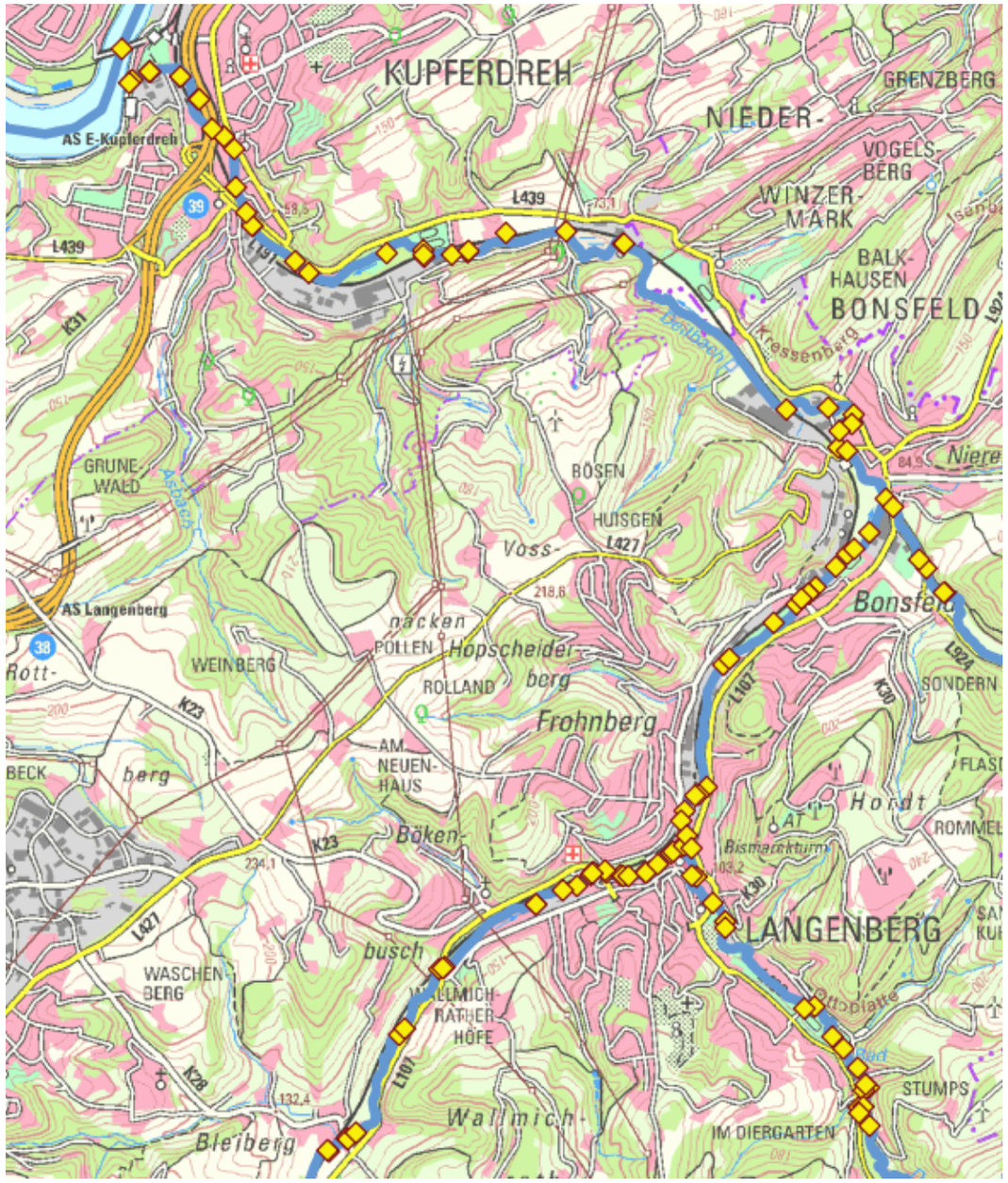
Dams in NRW

- 60,000 kilometers of water courses
- 14,000 kilometers designated as water bodies according to EU WFD (catchment area > 10km^2)
- 1998-2002 and 2011-2013: Comprehensive surveys of river morphology including several types of constructions (e.g., dams, weirs, ramps, slides, hydro power plants, culverts)
- State-wide geodatabase with web-interface accessible by all relevant authorities (designed and implemented by chromgruen) containing about 60,000 man-made transversal constructions



Dams in NRW

- Objective of WFD for rivers: „*… and river continuity*“
- NRW Environmental State Agency (LANUV) in 2015: Prioritisation scheme for dam removal is needed to support local authorities.
- Project „GIS-based determination of habitat gains achievable by dismantling transverse constructions“ is born.



GIS-based determination of habitat gains achievable by dismantling transverse constructions

Overview

- **Objective**: Prioritise removal or conversion of transverse constructions to create contiguous, barrier-free stretches of watercourse
- **Pilot project** by LANUV NRW
- **Implementation, validation and optimisation**
  - Consortium: chromgruen, Umweltbüro Essen and DIE GEWÄSSER-EXPERTEN! (GIS and ICT experts, biologists, engineers and geographers)
  - Expert working group from state, regional and local authorities

Work packages

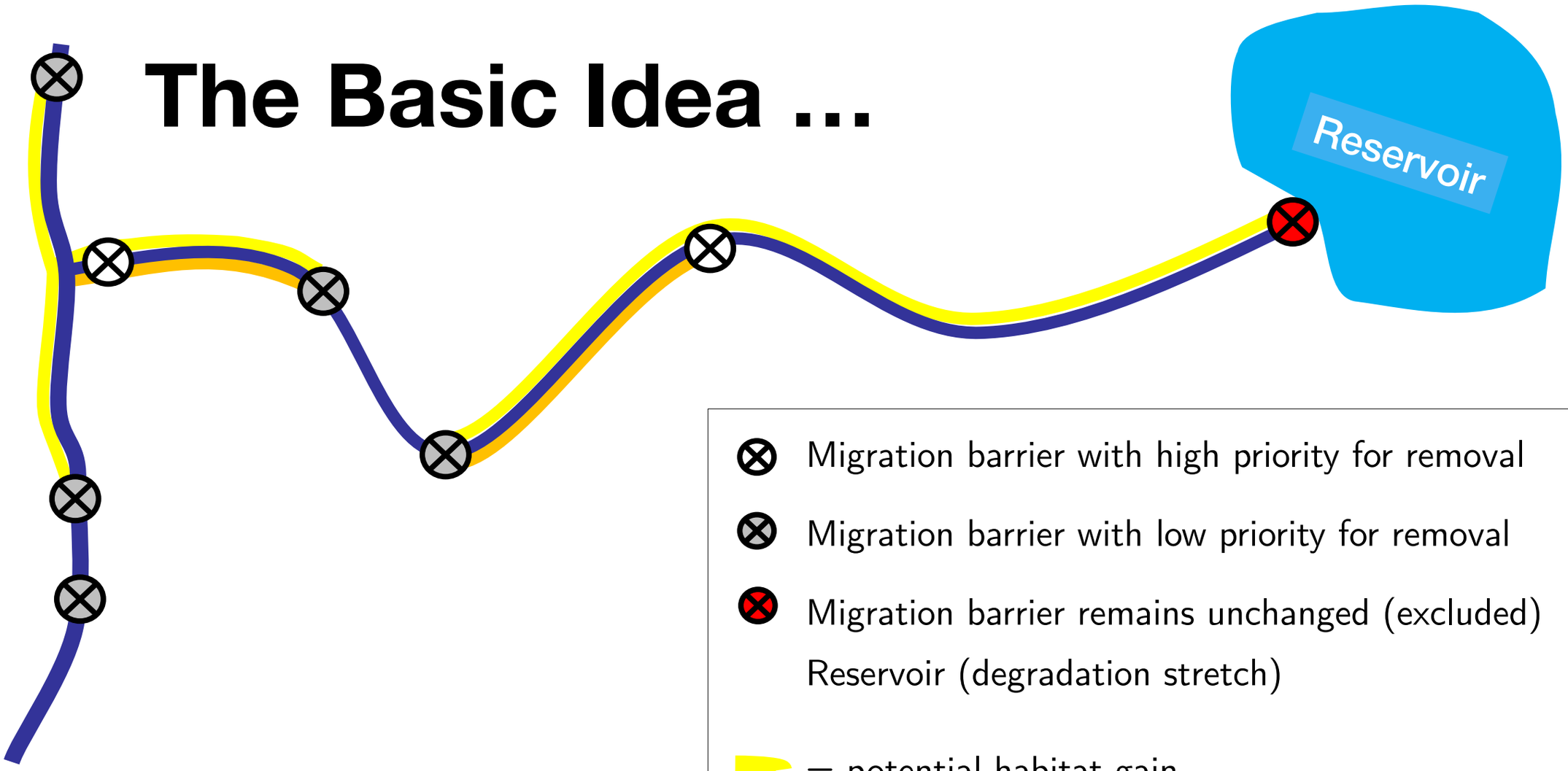
- **Literature search** on prioritisation methods
- **Optimisation of method developed by LANUV:**
  Coordination of relevant definitions and boundary conditions
- **Data preparation**:
  Topological cleansing of the river network
  Verification and correction of attributes
- **Implementation**

Method description

- **Classify** transverse constructions by barrier effects
- **Calculate distances** between barriers
- **Allocation and weighting** of attributes
- **Priority index calculation** for removal of barriers
- **Sensitivity tests** of attributes
- **State-wide calculation** and prioritisation
- **Preparation and visualisation** of results

Concepts & Definitions

The Basic Idea ...



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- Migration barrier remains unchanged (excluded)

Reservoir (degradation stretch)

= potential habitat gain

= potential additional habitat gain

Concepts & Definitions

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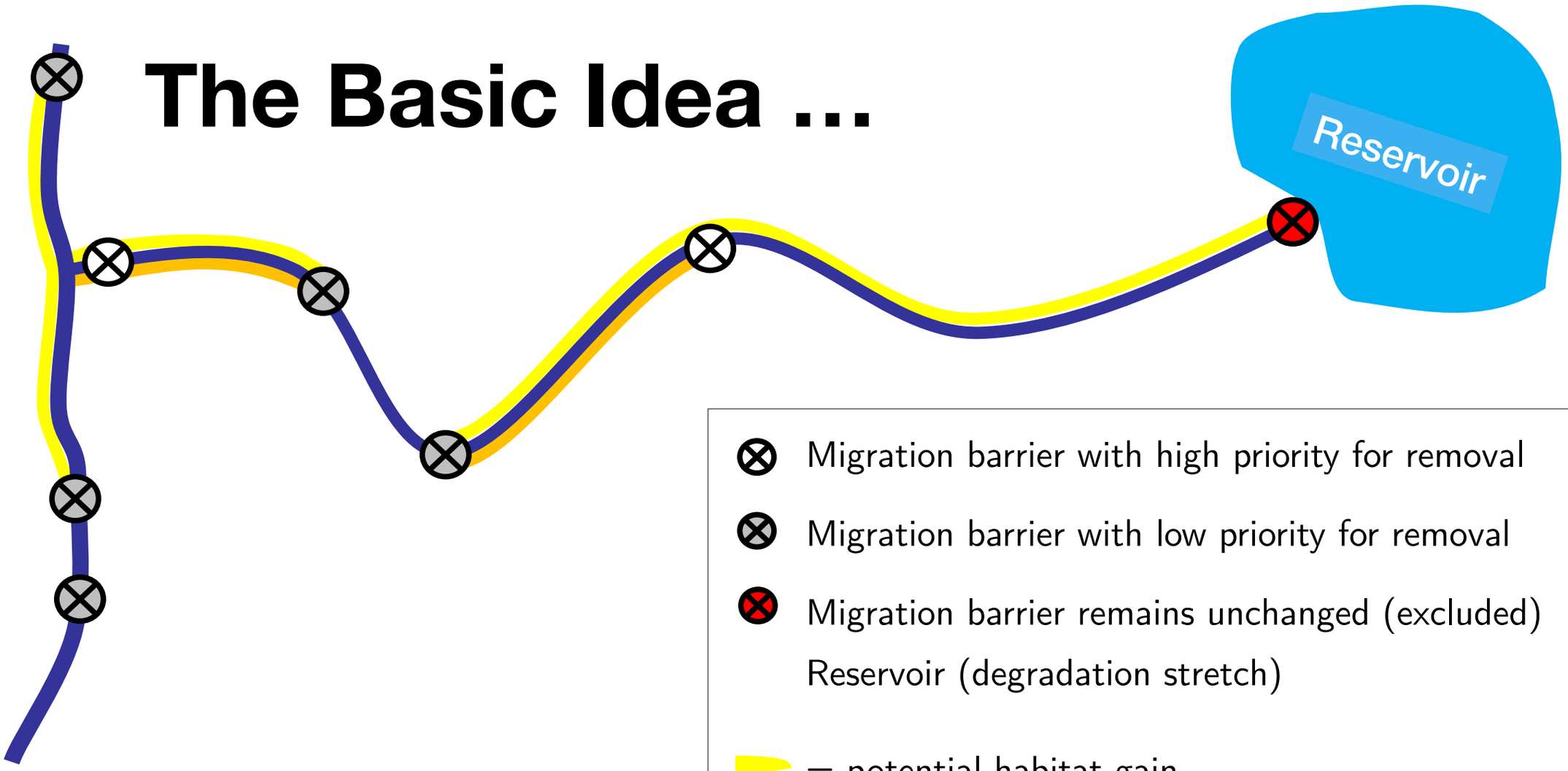

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Reservoir (degradation stretch)

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(shorter of the two stretches)

Concepts & Definitions

„Migration barriers“:

- **Pipings and culverts**
  length > 5 m (no sediment) or > 20 m
- **Falls and Weirs**, height > 0.1 m
- **Hydro power plants** in the main course
- **Inverted syphons, pumping stations**
- **Other constructions**, backwater length > 100 m

Concepts & Definitions

Attributes for prioritisation (classified)

- **Height** (weir, fall, etc.), **Length** (piping, culvert), **Backwater length**
- **Ecological status** macroinvertebrates, fish (worst case)
- Water bodies with **target species** eel, salmon, grayling or targeting potamodromous species
- **Median habitat quality** in developable stretches
- Positioned in **water dependent protected areas**
- Protects **European crayfish** (exclusion criterion)
- **Number of** potentially accessible small **tributaries**

Concepts & Definitions

Additional attributes (information only)

- Diversion/Drainage
- Located in **recolonization source**
- Removal already **planned**
- **Hydro power plant** in conjunction to barrier
- **Fishway** in conjunction to barrier
- Located in **urbanised area**
- **Water body status** (AWB, NWB, HMWB)

Calculation

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Priority Index = $\mathbf{Factor_A}$ x $\mathbf{Factor_B}$

$\mathbf{Factor_A}$: Sum of classified attributes

$\mathbf{Factor_B}$: Length of additional habitat gain / 100.

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Example

type	downstream	upstream	total	backwater
Weir	56,154 m	17,521 m	73,675 m	500 m

height	EQ fish	TS eel/salmon	TS pota.	backwater	habitat	tributaries
3	3	3	3	4	2	5

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3 river basins (Rhine, Ems, Weser), 26 Sub-basins

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Prioritisation within each sub-basin:

Sort by descending priority index

Prioritisation

Northrhine-Westphalia:

3 river basins (Rhine, Ems, Weser), 26 Sub-basins

Prioritisation within each sub-basin:

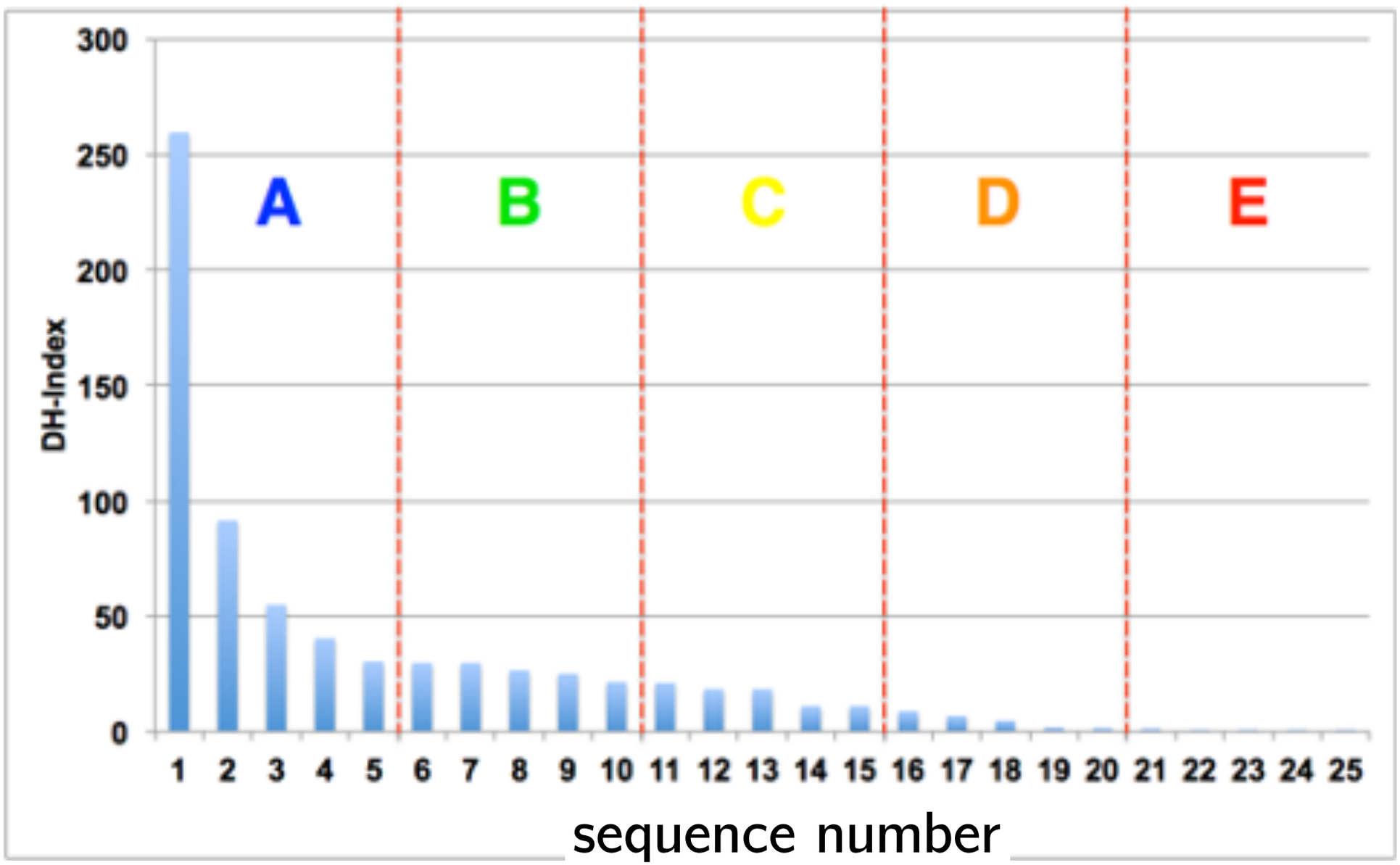
Sort by descending priority index

Purely numeric differences may be too small, thus:

classify into five priority groups (A ... E)

Prioritisation

Fictitious example



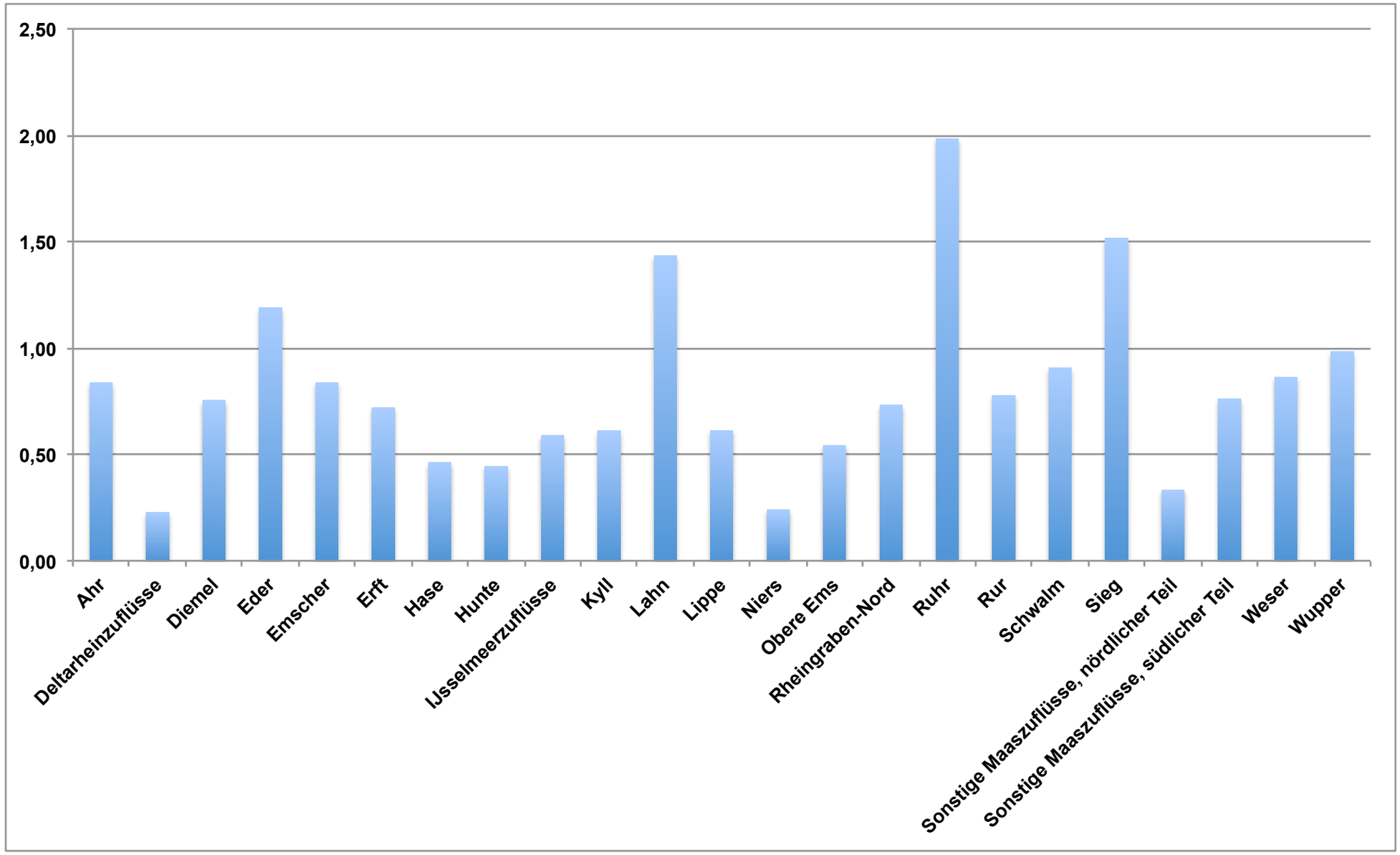
Results

Overview

total number of constructions	61,538
migration barriers	12,894
length of river network	14,127 km
sum of additional habitat gains	8,237 km
average habitat gain per migration barrier	588 m

Results

Barrier density (migration barriers/km) in sub-basins



Results

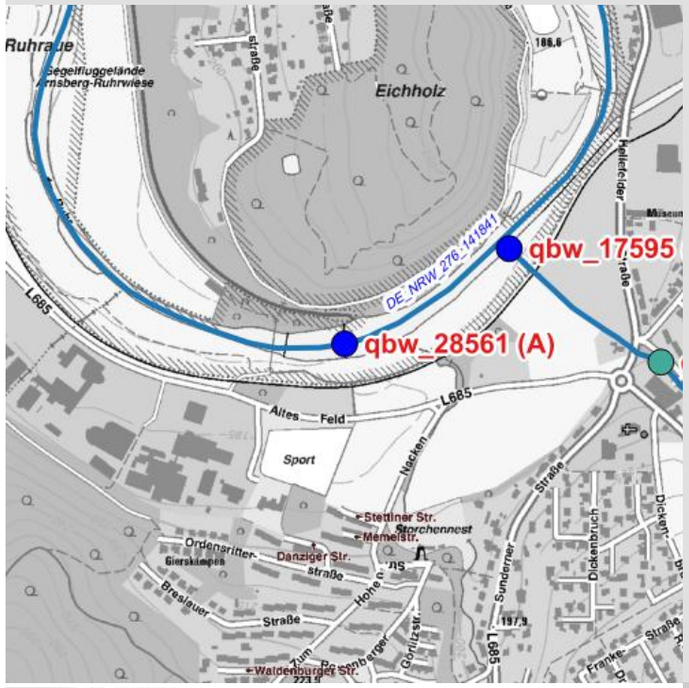
identification

location

photo

sub-basin

Gewässer	Ruhr	Stat. [m]	150989
PE	PE_RUH_1600 Ruhr		
OFWK3D-ID	DE_NRW_276_141841		
OFWK-Bez.	Ruhr		
Gemeinde	Arnsberg (BR Arnsberg)		
Bauwerk-ID	qbw_28561	Bauwerkstyp	Bewegliches Wehr
Anzahl DH in weniger als 50 m Entfernung	0	ID des nächsten DH in weniger als 50 m Entfernung	---



Ruhr

Prioritätsklasse

A

Rang 3 von 735

DH-Index	1133
Gewinn [m]	11429
Zugewinn [m]	5663

Bewertungskriterien		Punkte
Höhe	150 cm	3
Länge der Verrohrung	n.r.	0
Neigung	n.r.	0
Rückstau	k.A.	0
ÖZ MZB	3	3
ÖZ Fische	3	3
Habitatindex	mäßig	2
Zielart Aal/Lachs	Nein/Nein	0
Zielart potam./ Äschenschutzkul.	Ja/Ja	3
Schutzgebiet?	Ja	1
Edelkrebs?	Nein	0
angebundene Gewässer	hoch	5
Kerbtal?	Nein	0
Summe der Bewertungspunkte		20

Nachrichtlich:

Strahlursprung UFP?	Nein
Einzelmaßnahme?	Nein
hat Ausleitung?	ja
hat/ist WKA?	Nein
hat FAA?	Ja
in Ortslage?	Nein
Status OFWK	NWB

priority class, rank

priority index, habitat gain

classified attributes

informative attributes

Results

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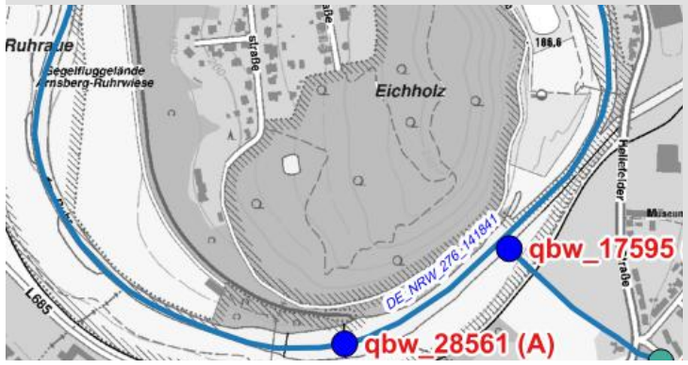
Zielart Aal/Lachs	Nein/Nein	0
Zielart potam./		3



Fact sheets for each migration barrier (12,984 pdf files)

photo

sub-basin

informative attributes

Strahlursprung UFP?	Nein
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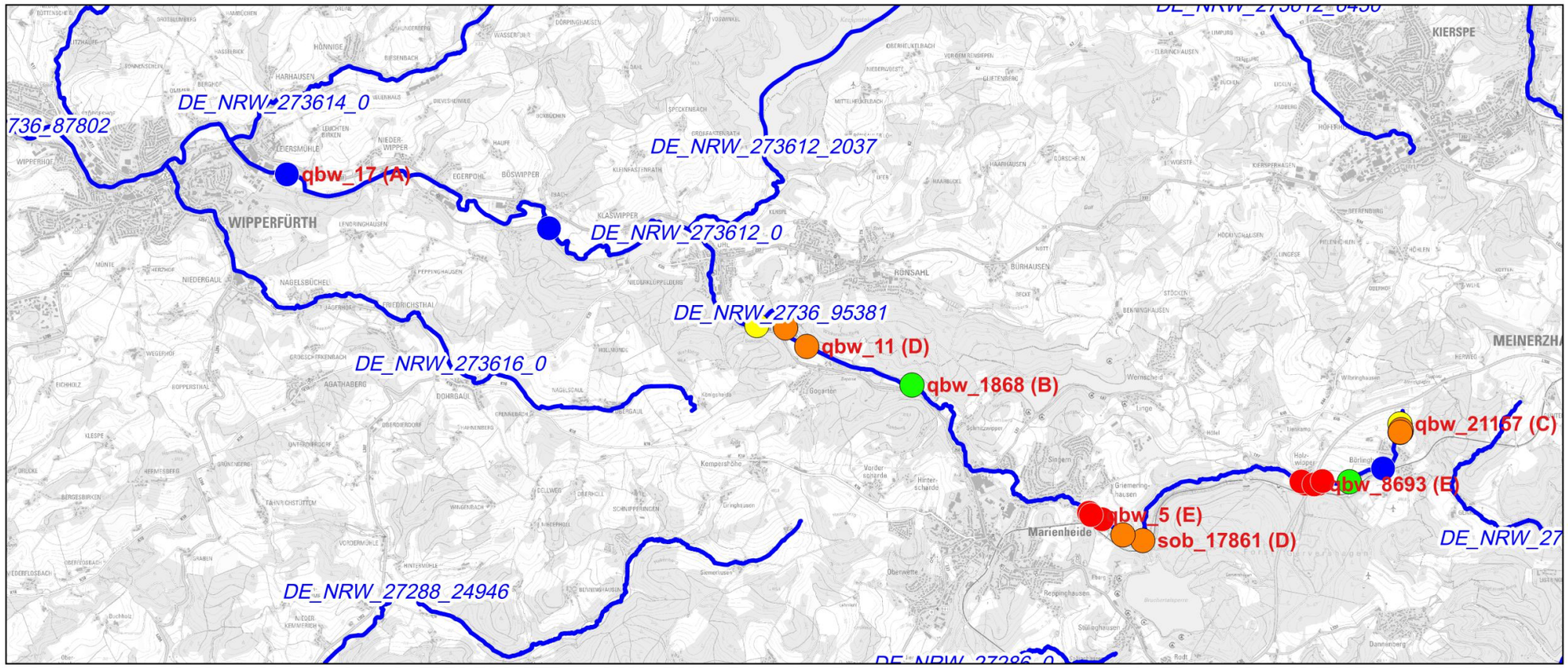
Ruhr

Results

Exemplary waterbody map with prioritised migration barriers



Lebensraumgewinn durch Rückbau von Querbauwerken

Legende

DH mit Prioritätsklassen

- A (0 bis 20% der DH)
- B (>20 bis 40% der DH)
- C (>40 bis 60% der DH)
- D (>60 bis 80% der DH)
- E (>80 bis 100% der DH)
- Oberflächenwasserkörper

OFWK-ID:
DE_NRW_2736_95381
Wipper

Maßstab: 1 : 50.000

Stand: 11.5.2017

Results

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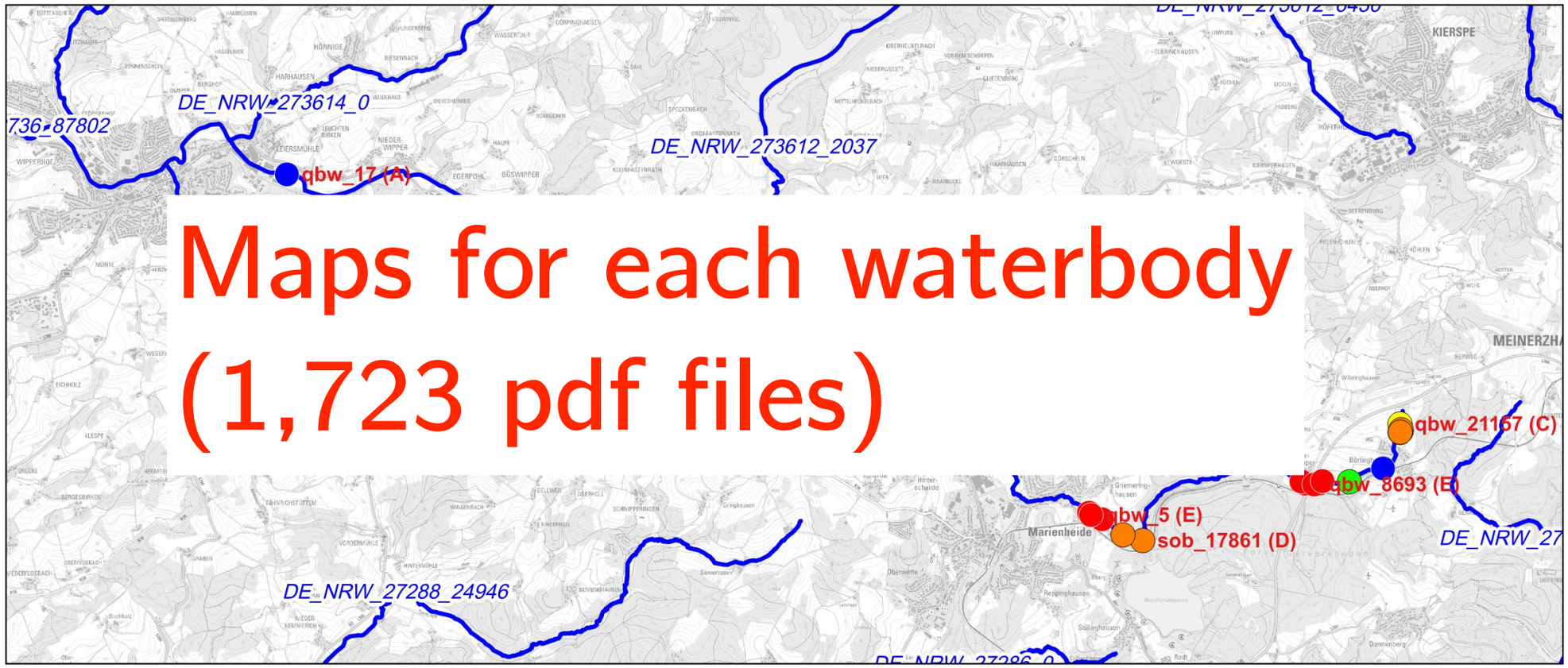

Maps for each waterbody (1,723 pdf files)

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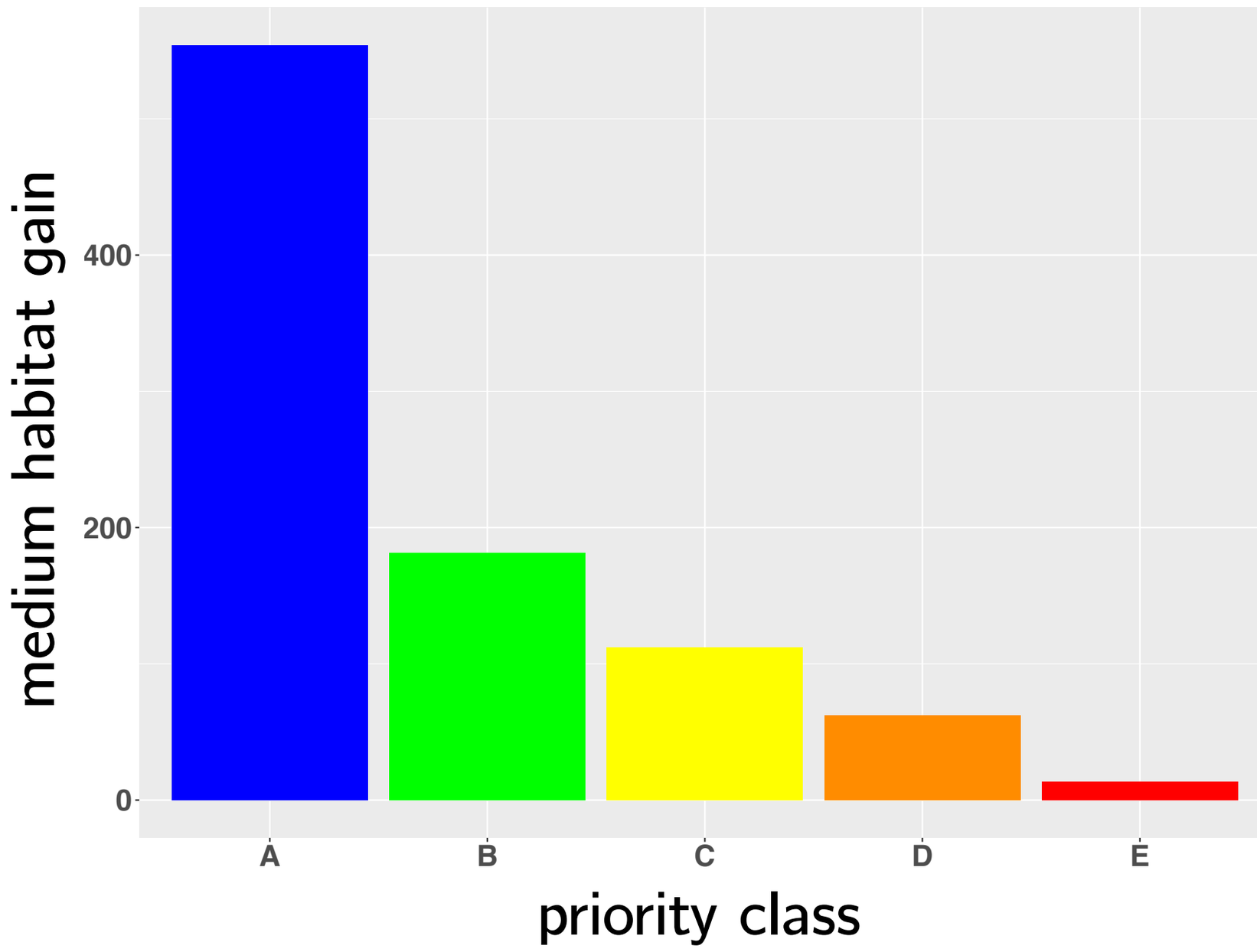
Distribution of medium habitat gain on priority classes



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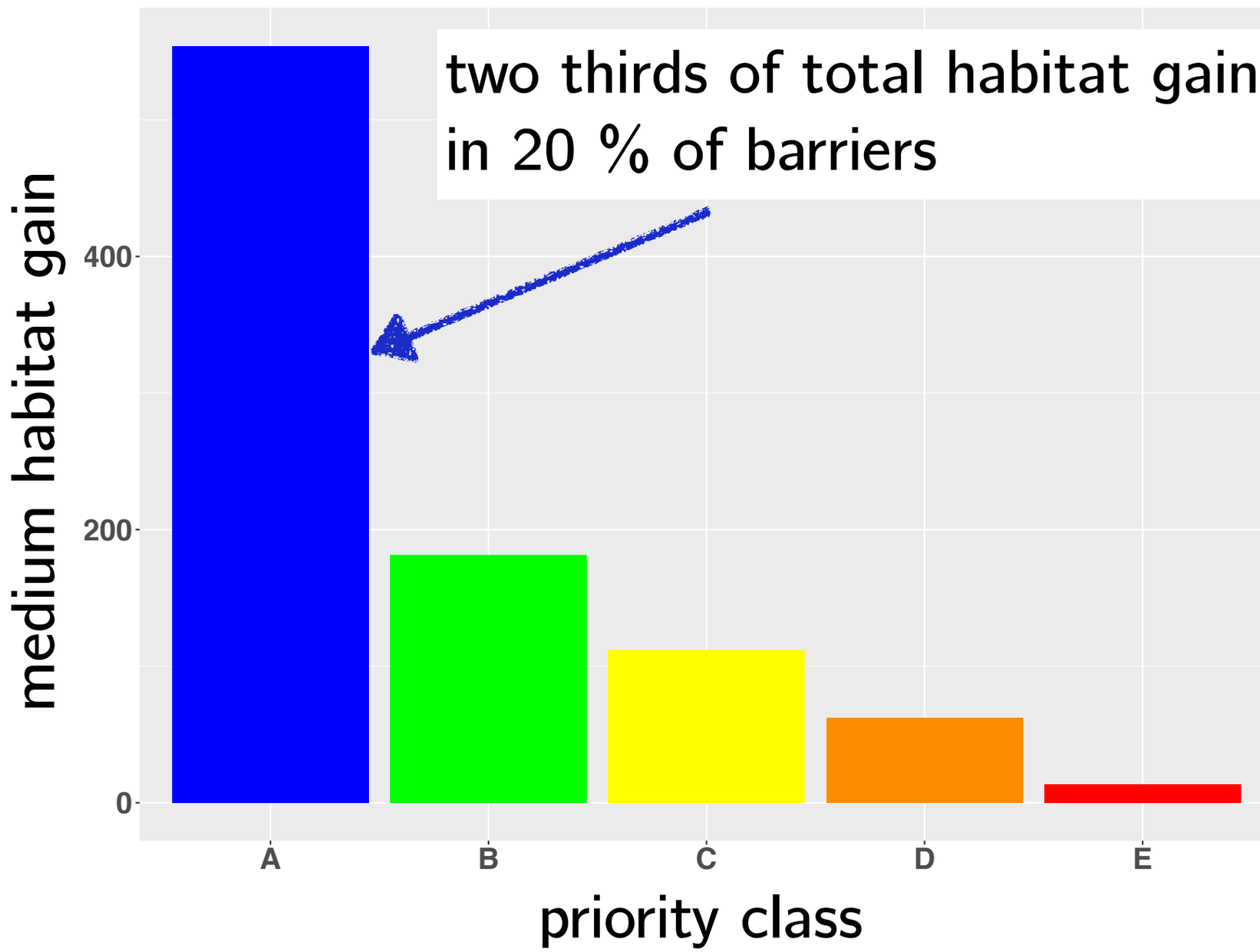

Sensitivity analysis

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1. Random variation of barrier position [-50 ... 50] m

Potential habitat gain, location in protected area, affiliation with surface water body (and thus ecological status assessment), habitat quality, or number of potentially connectable water bodies may be influenced by incorrect position

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Some classified attributes may be influenced by incorrect geometry (i.e., height, length, backwater length)

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Population: all migration barriers of two sub-basins

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68% of all cases: no change in priority class
24%: change by 1 class, 8%: change by 2 classes

barrier location should be correct by << 50 m

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6 % of all cases: change by 1 class
barrier type „fall“: 9%, barrier type „piping“: 5%, barrier types „weir“ and „culvert“: 4%

exact geometries less relevant than exact location

Applications

In-house tool to support authorities in planning and prioritisation of measures to establish continuity

Fact sheets and water body maps helpful in meetings

Results freely scalable:
water body, river, catchment area, administrative boundaries

Benefits and limitations

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Positive (side) effects:

systematic clean-up of statewide dataset

algorithm will be integrated in state water database

index calculation easily adaptable (if need occurs)

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Limitations of applicability:

data only available for notifiable waterbodies

no quantitative forecast of target achievement („good state“ etc.)

local expertise cannot be substituted (local restrictions, legal permits ... are not taken into account)

Acknowledgements

Fundamental works: LANUV NRW Dpt. 54, Dr. Thomas Euler

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Literature search and ecological expertise: umweltbüro essen
Data clean-up and validation: Die Gewässer-Experten!
Data management, algorithms and implementation, project management: chromgruen

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Thank you for your interest!

Landesamt für Natur,
Umwelt und Verbraucherschutz
Nordrhein-Westfalen

Lebensraumgewinn
durch Rückbau von Querbauwerken

Abschlussbericht
Velbert / Essen / Lohmar, Mai 2017

Projektteam chromgruen – ube – DIE GEWÄSSER-EXPERTEN!

chromgruen ube umweltbüro essen DIE GEWÄSSER-EXPERTEN!