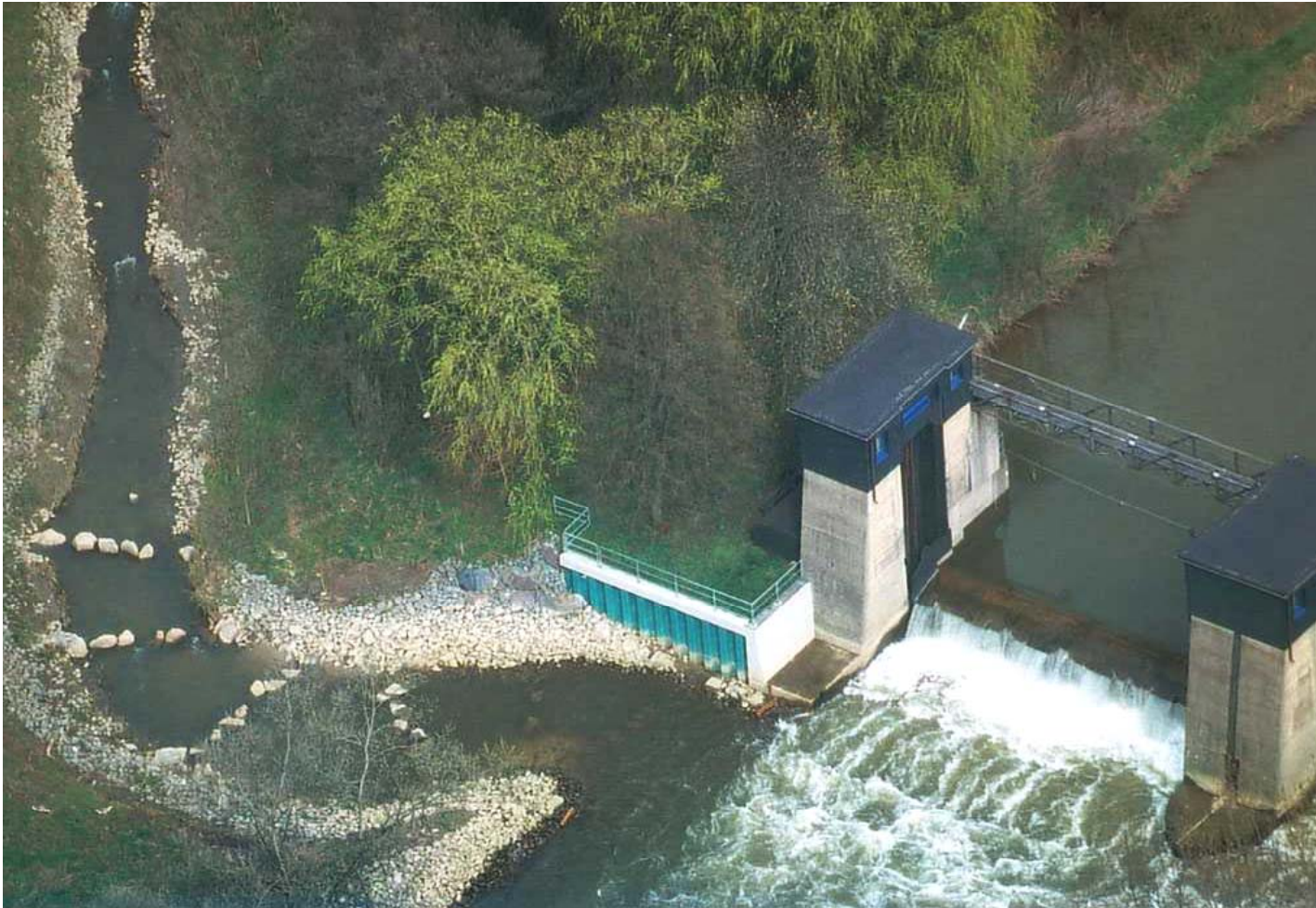


Mitigation Measures to improve the Water Quality of Rivers used for Hydropower Generation

U. Dumont -- Prague, October 18, 2005



Outline

- ▶ Results of studies: Dams & HP in rivers of states in West Germany
- ▶ River connectivity and development of fish populations
- ▶ Mitigation measures at dams and HP
- ▶ Strategy for rivers with dams & HP
- ▶ To Do / Next steps

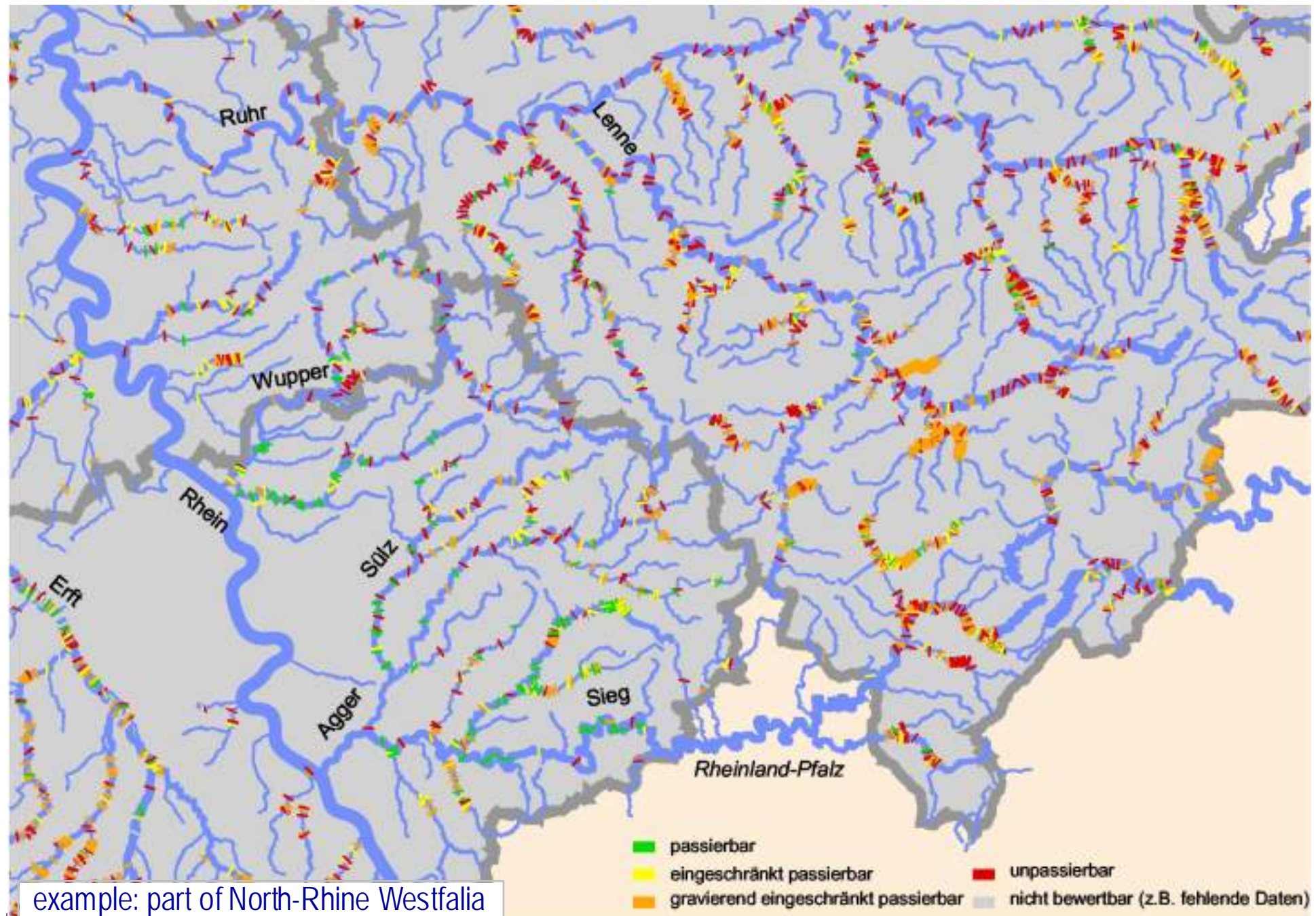


Investigation of obstructions to fish migration in North-Rhine Westfalia

Total length of rivers and brooks:	60,000 km
Total number of obstructions, $h > 0.2$ m	11,000
Dams & weirs, $h > 1$ m	1,700
Hydro Power Stations	ca. 500
Fishways	ca. 300

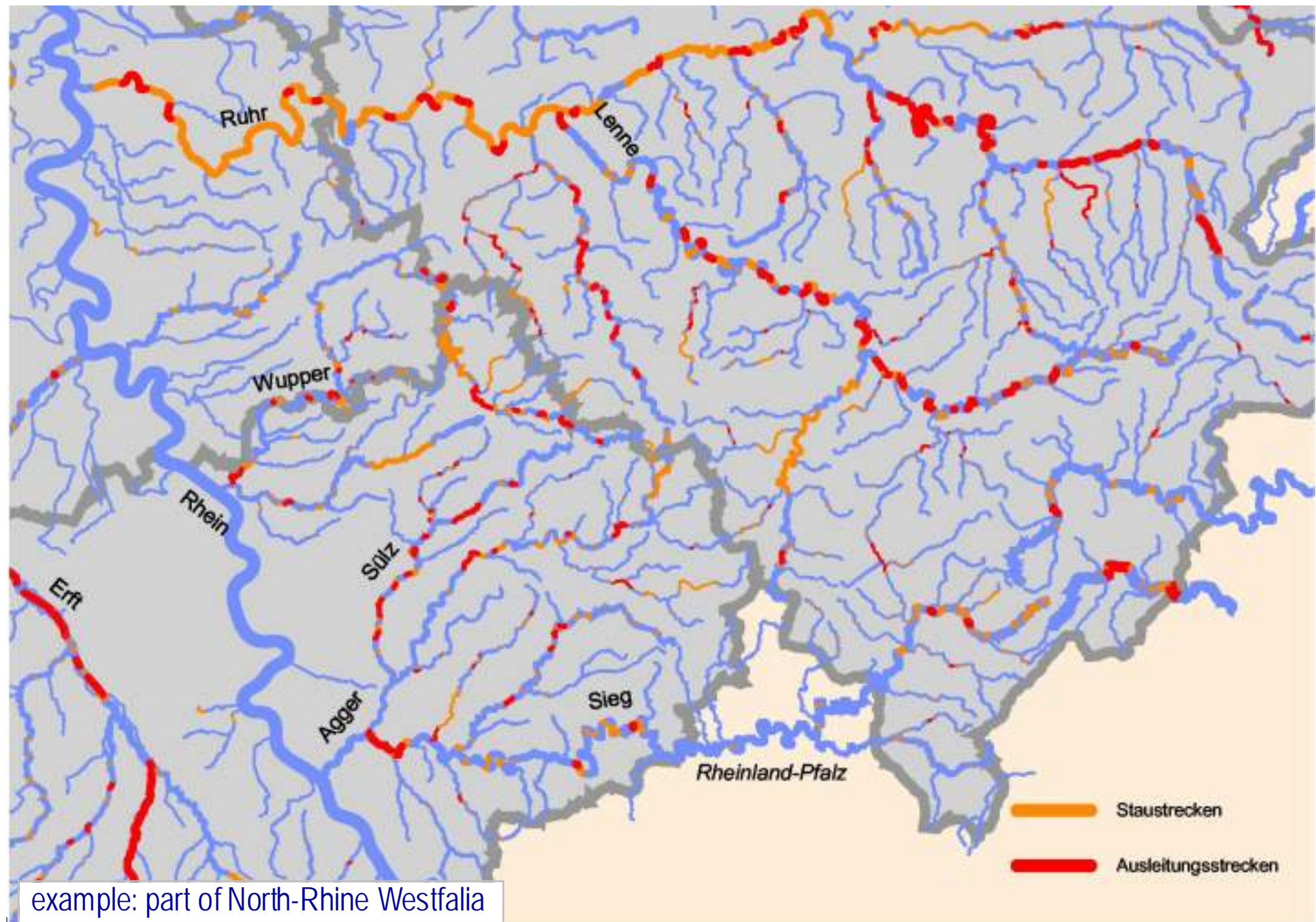


River Connectivity



example: part of North-Rhine Westfalia

Reservoirs and Divertions (5-50% loss of habitat)



example: part of North-Rhine Westfalia

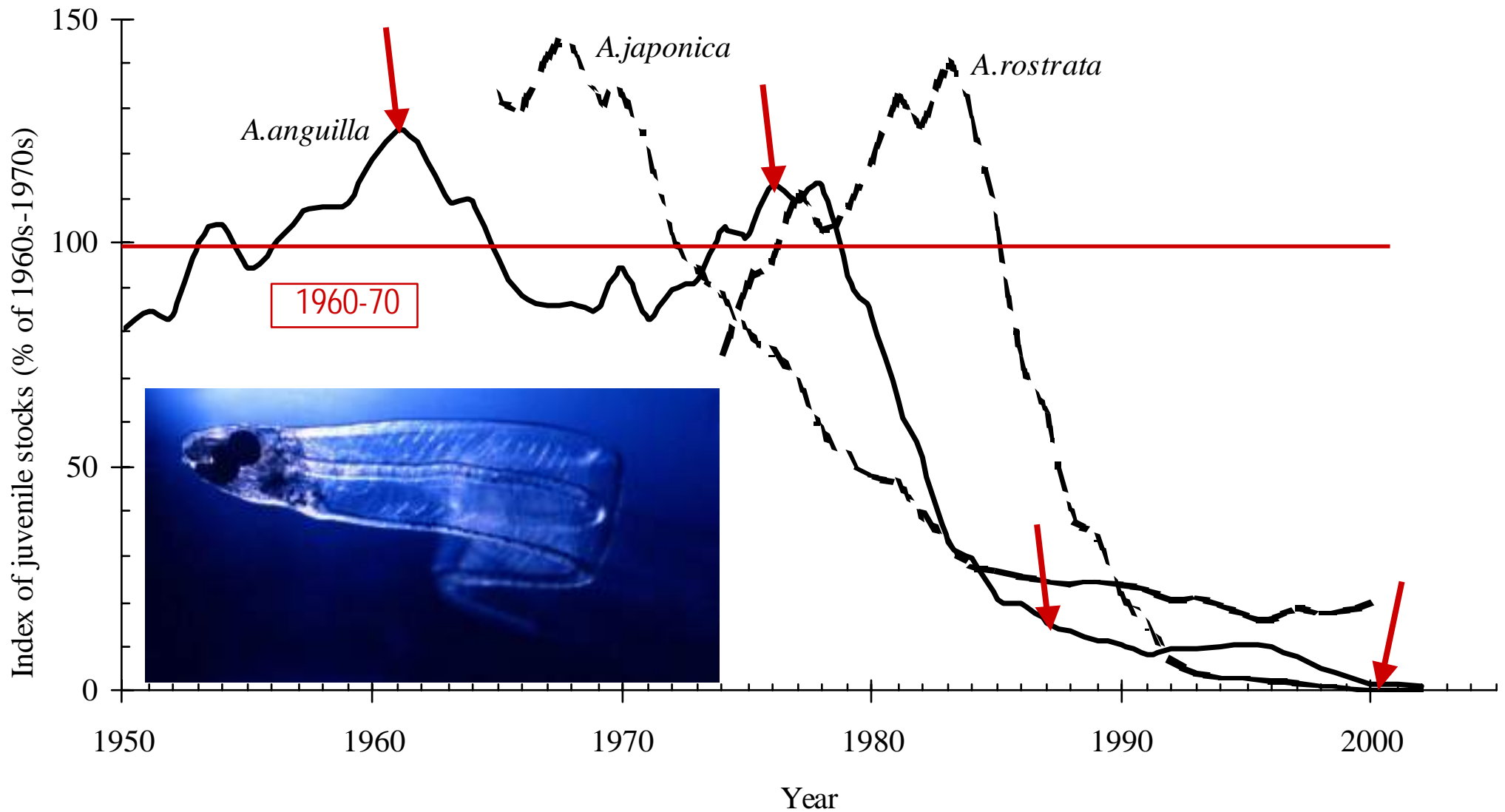
Downstream migration / fish protection: damaged eels at a grid



Source:
Karl Ebel



Worldwide decline of glass eels



Source: AFS 2003 (Quebec)

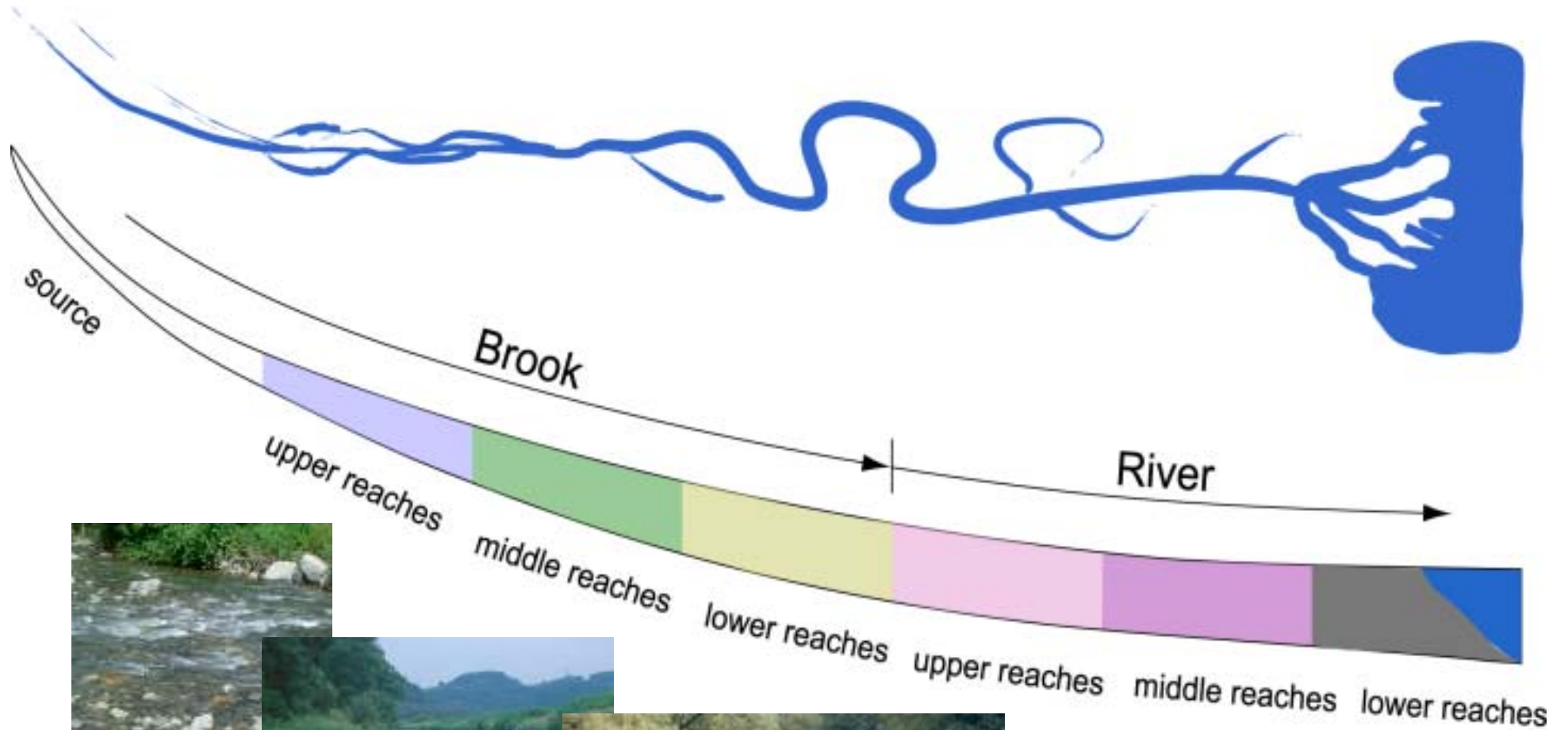
▶ River zoning

- ▶ By HUET (1949)
- ▶ Characterisation of habitats and populations

▶ Migration patterns

- ▶ Potamodromous species
- ▶ Diadromous species

River zoning (Huet)

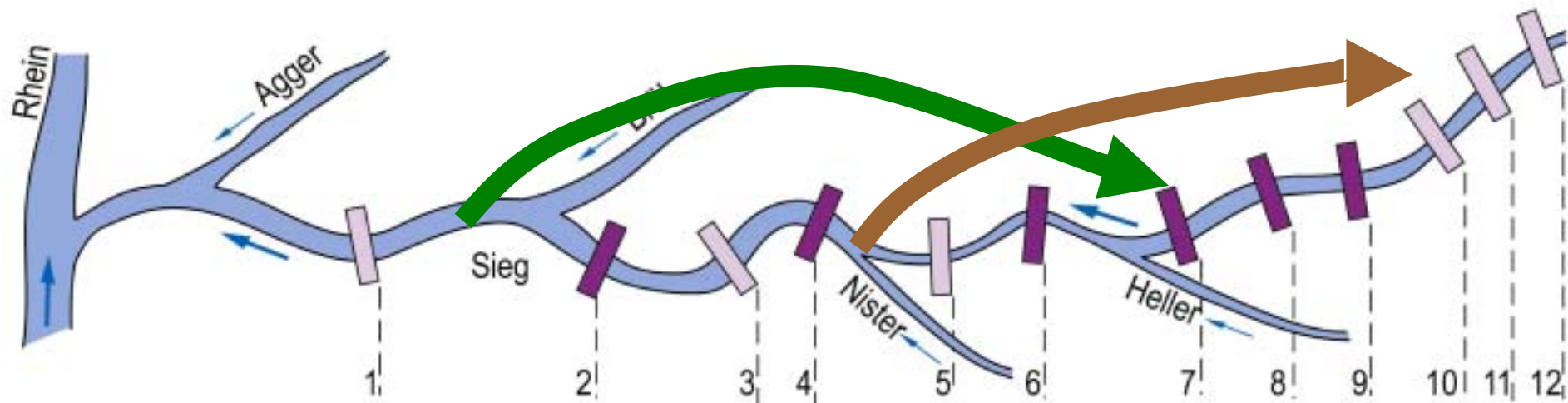


Migration of adult potamodromous fish

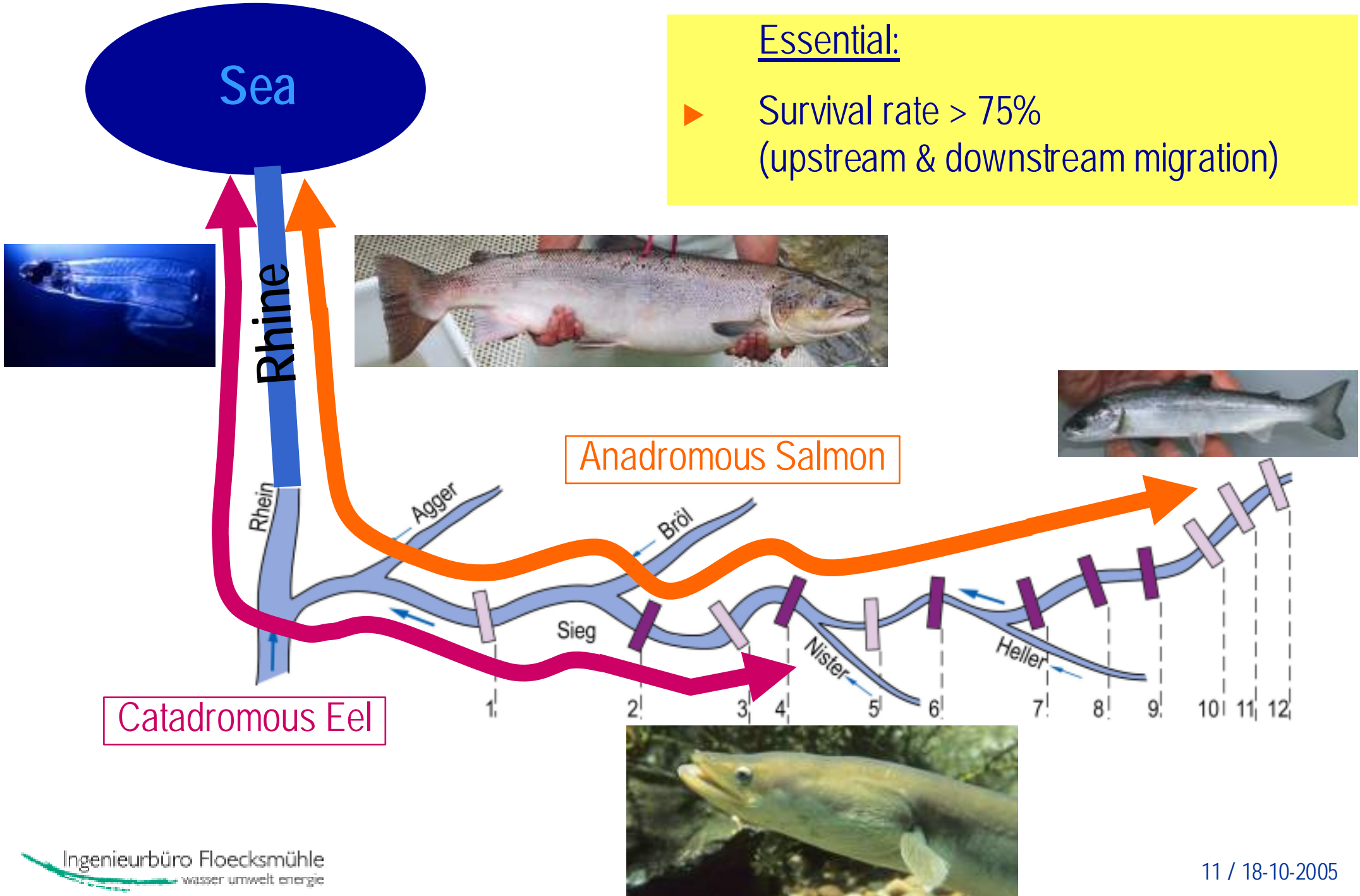


Essential:

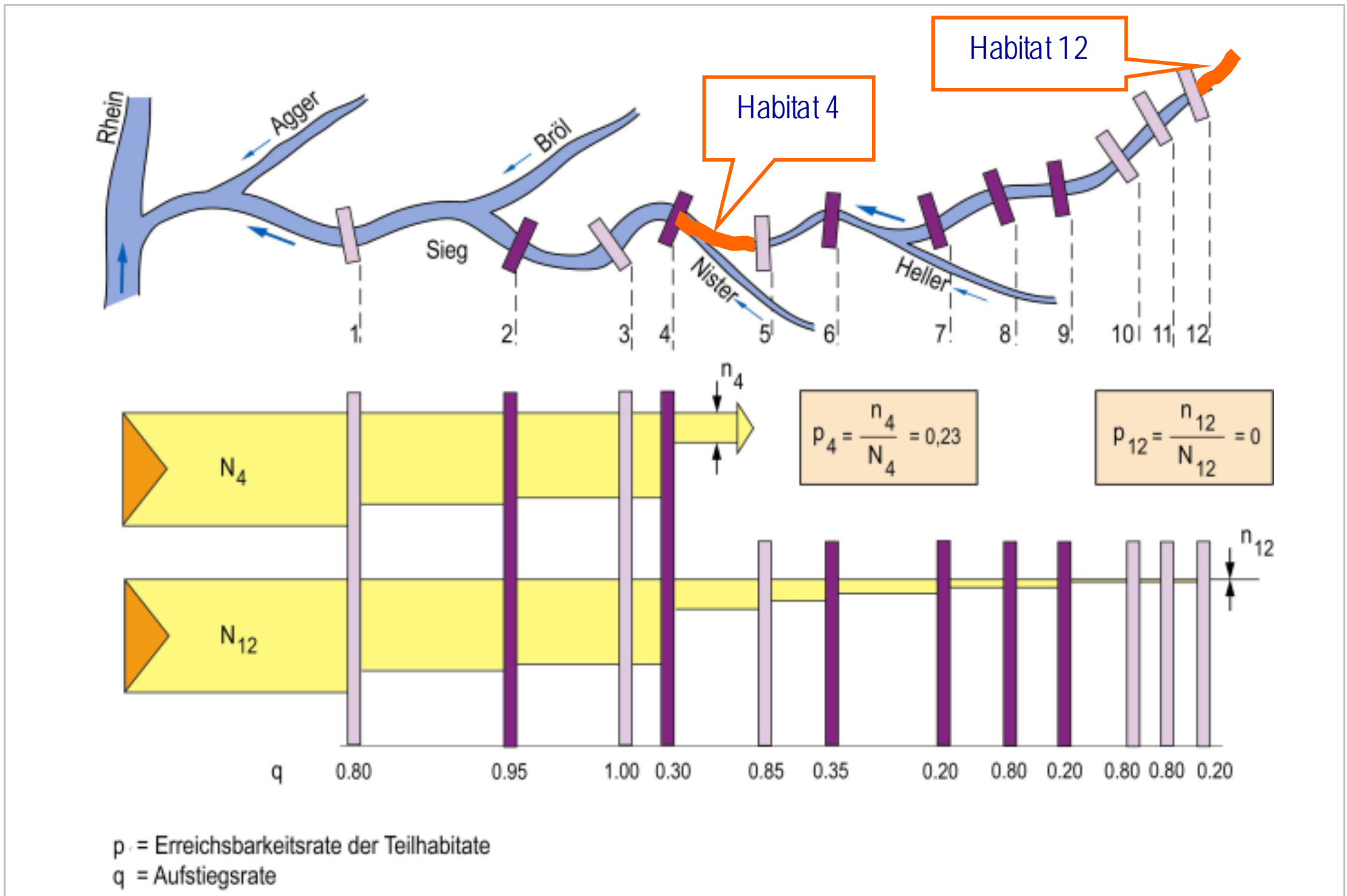
- ▶ Upstream migration at each dam
- ▶ Fish protection for endangered species



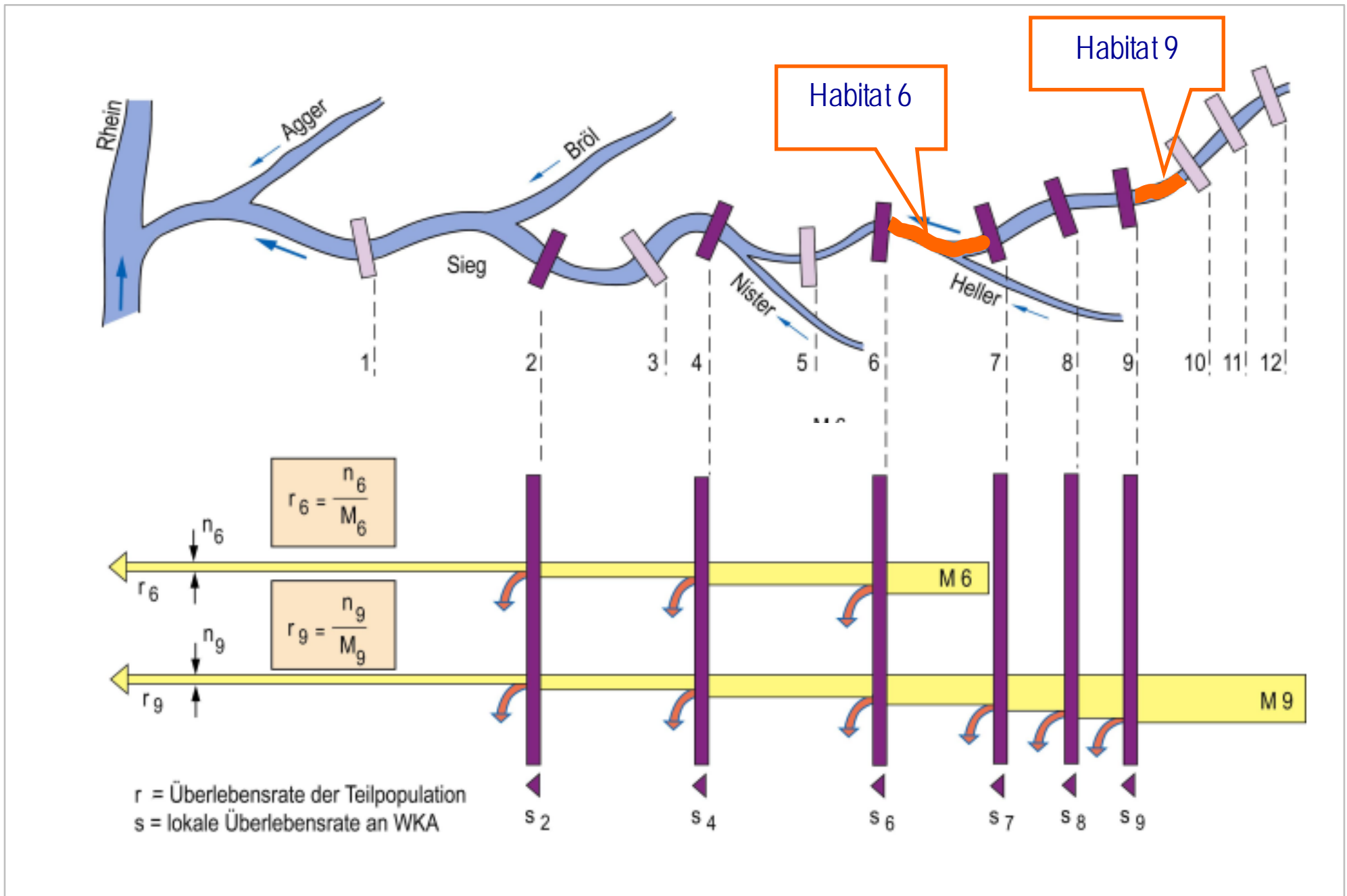
Migration of diadromous fish



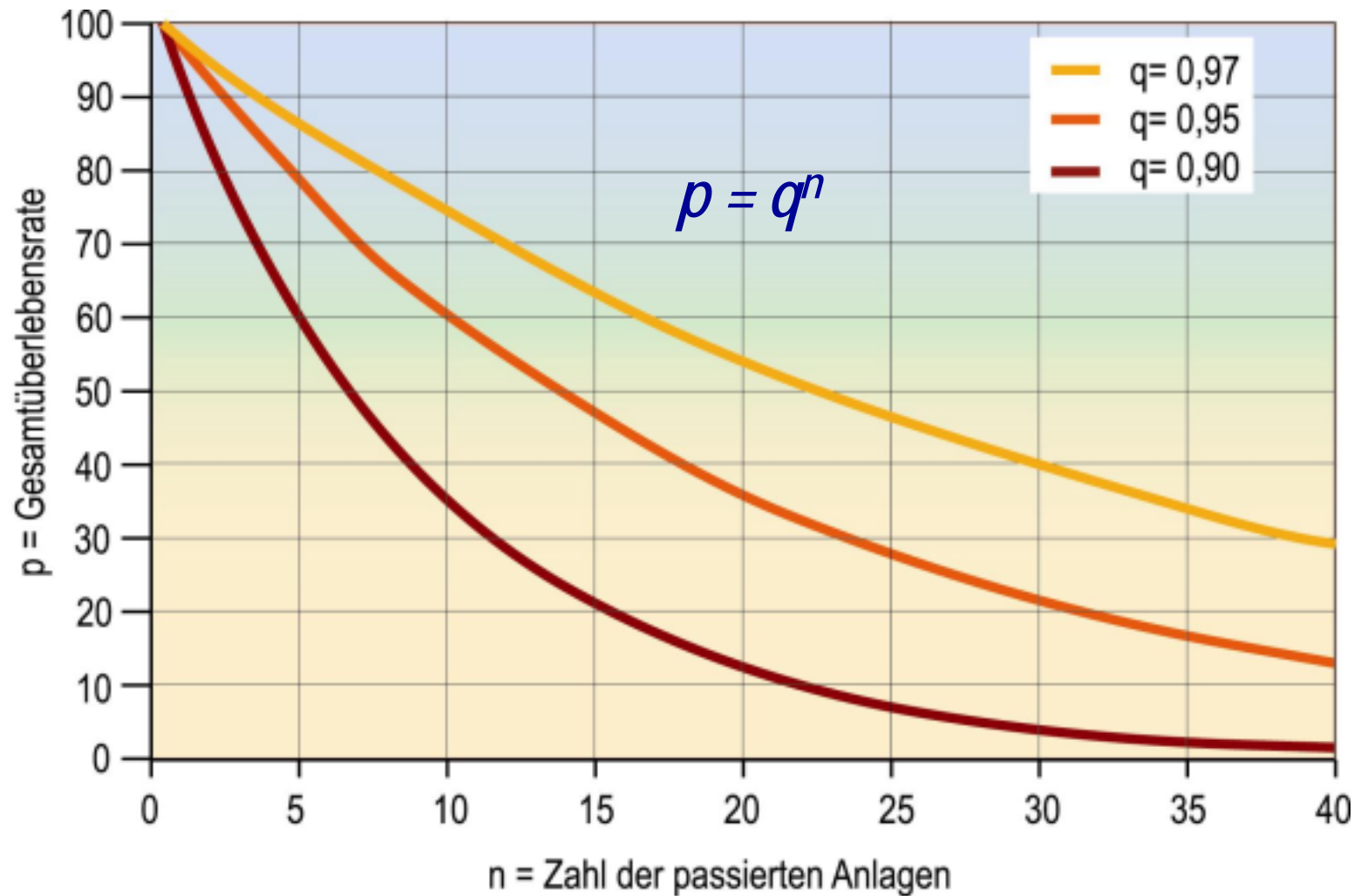
Upstream migration efficiency



Downstream migration efficiency / survival rate



Total survival rate at a chain of hydro power stations

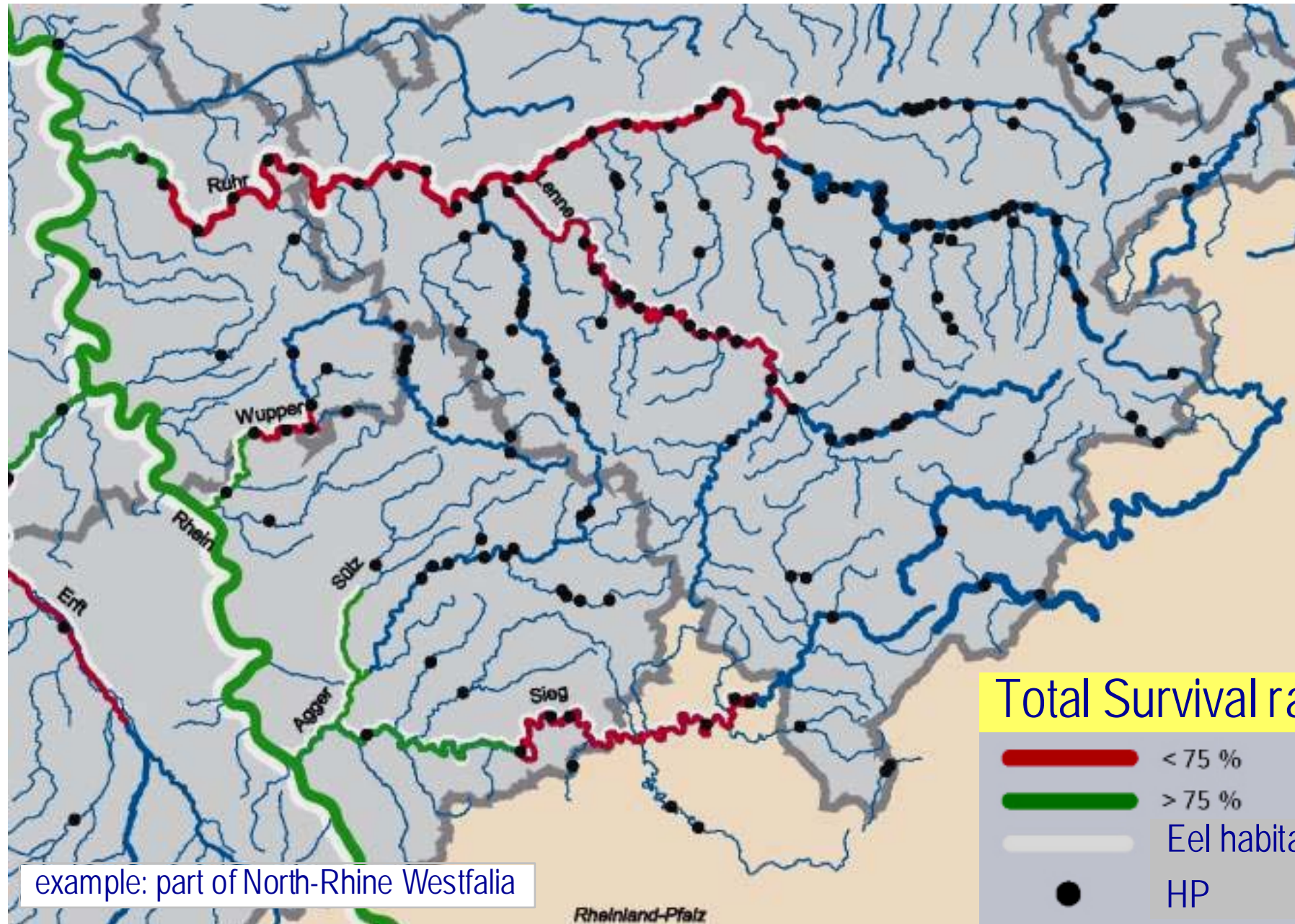


q = Survival rate at one hydro power station

p = Total survival rate after passage of n hydro power stations

n = Number of hydro power stations to be passed

Downstream migration of silver eel: present situation



▶ *Upstream migration*

- ▷ *Total number of dams within a river affects potamodromous and diadromous fish populations*

▶ *Downstream migration*

- ▷ *Total number of HPs within a river affects diadromous fish populations (potamodromous less)*

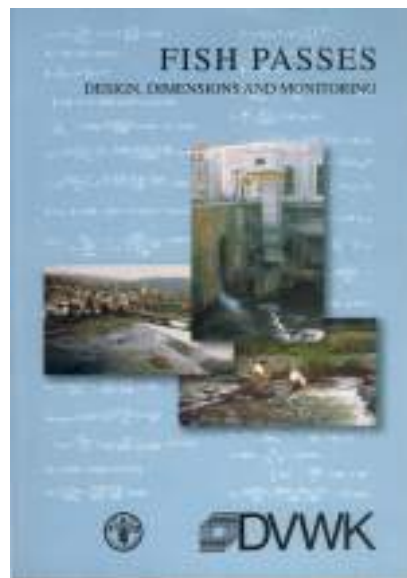
▶ Limitation of habitat loss

- ▶ New hydro power stations only at existing dams
- ▶ Habitat loss should be less than 25% of length of river zone
- ▶ If > 25 %: dam removal



▶ Upstream migration of fish

- ▶ Installation of high quality fish passes at each dam (...or dam removal)
- ▶ Standards for design of fish passes should be set up within the EC



Example: Optimal position of fishpass, no dead end

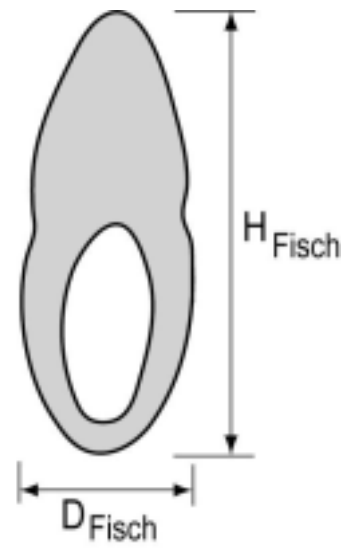


Source:: Lippeverband

Design of fish passes according to requirements of fish fauna



L_{Fisch}



▶ Downstream migration

- ▶ Measures: Mechanical barriers designed for target species, behavioral barriers not efficient
- ▶ Potamodromous fish: Minimum protection system
- ▶ Diadromous fish: Increased protection system

Behavior of eels at mechanical barriers (laboratory tests)



Grid with $d = 20$ mm and passing silver eel ($l = 70$ cm)

Tests & pictures:
Institut für Angewandte Ökologie



Fish protection, $d = 5$ mm

Wedge Wire Screen d=5mm at SHP (1,7 m³/s)



dR = 5 mm

Early warning system for migration of Silver Eel (MIGROMAT[®])

- ➔ *At HP stations where mechanical barriers technically are not feasible: fish friendly turbine management*
- ▶ Detection of migration peaks
- ▶ Successfull European project at river Meuse (2002/2003)



Wahnhausen/Fulda

MIGROMAT[®]: development by Institut für Angewandte Biologie and Floecksmühle

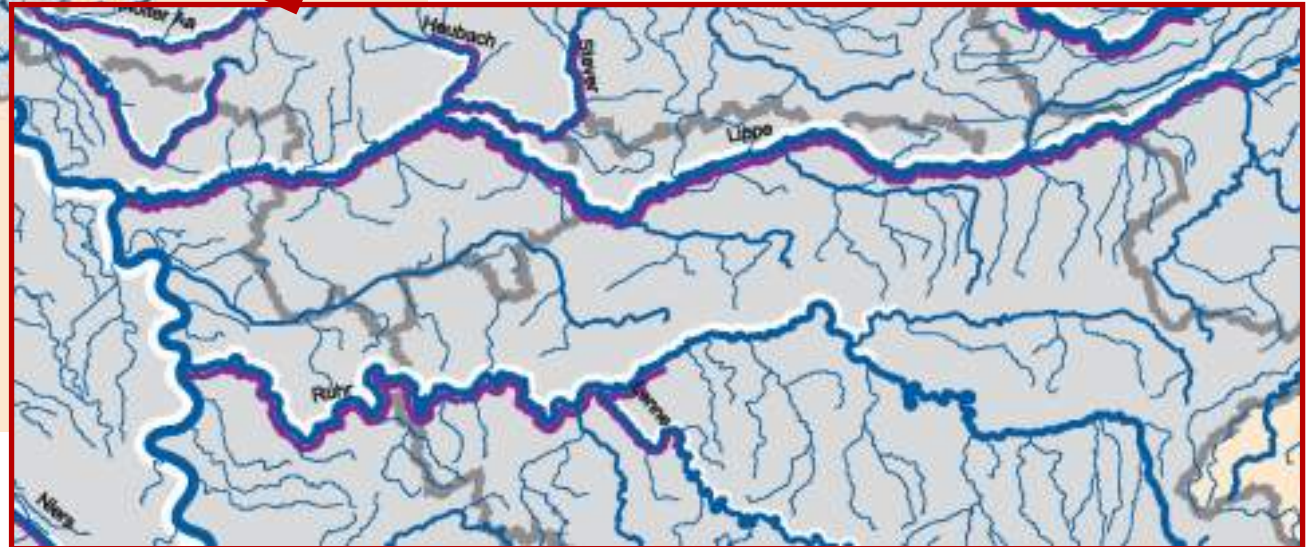
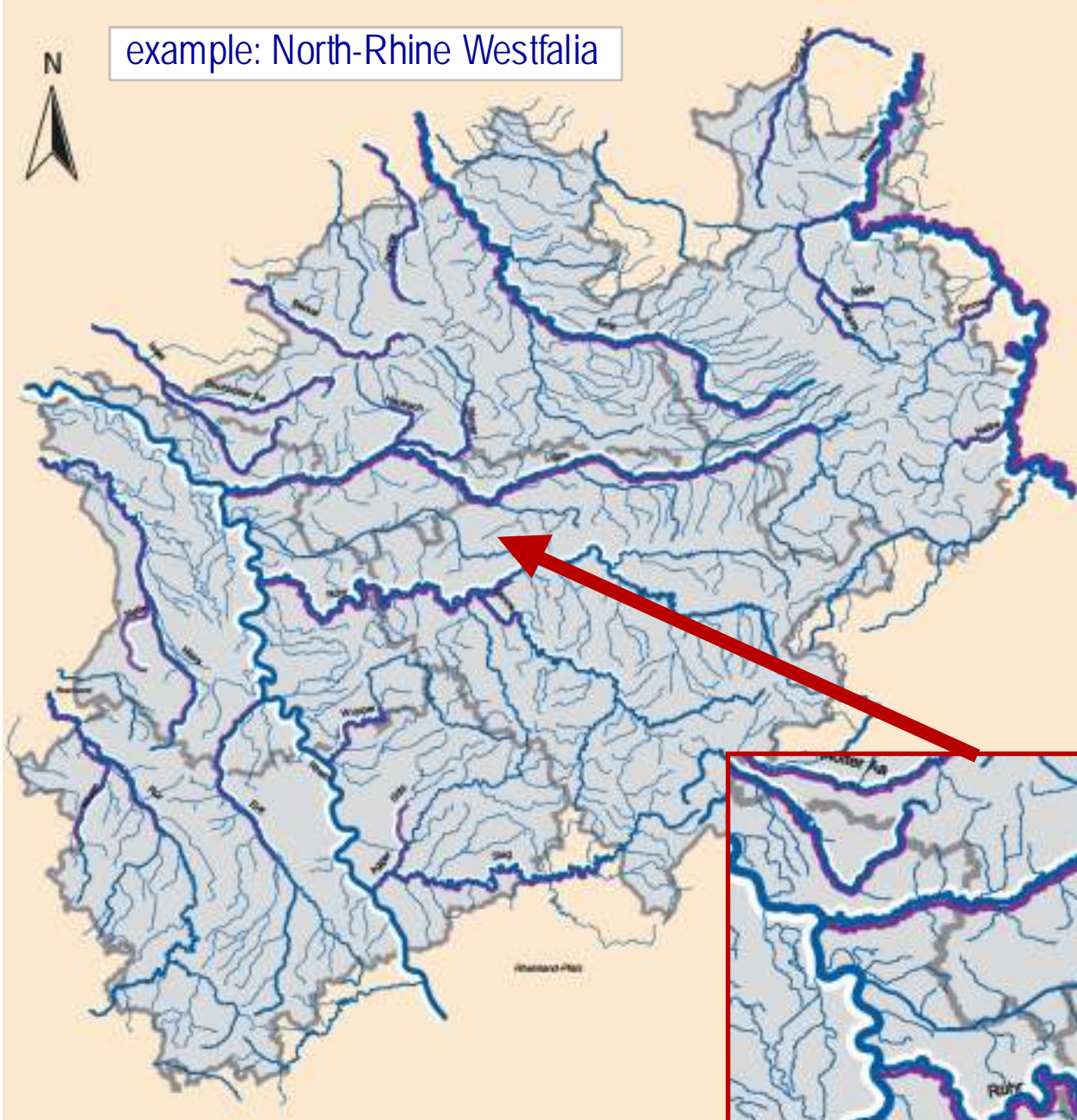
Strategy

- ▶ *Measures for development of diadromous fish populations will be successful in rivers with a small number of HPs only*
- ▶ *Selection of rivers with increased fish protection*
 - ▷ *GIS-based methods are developed by Floecksmühle Consultants (using quantity & quality of habitats)*

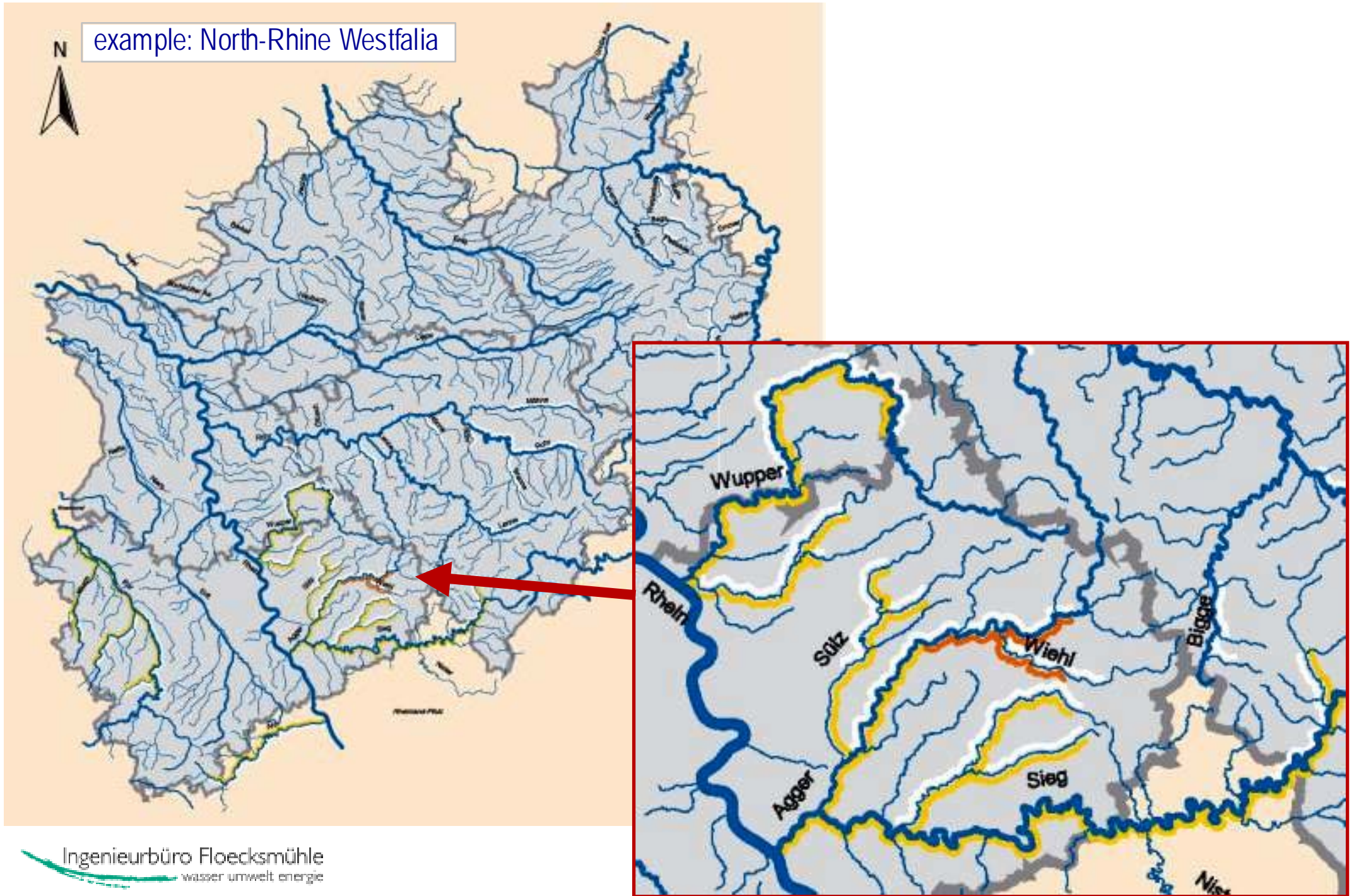


Priority rivers for installation of fish protection systems for silver eels

example: North-Rhine Westfalia



Priority rivers for installation of fish protection systems for Salmon smolts

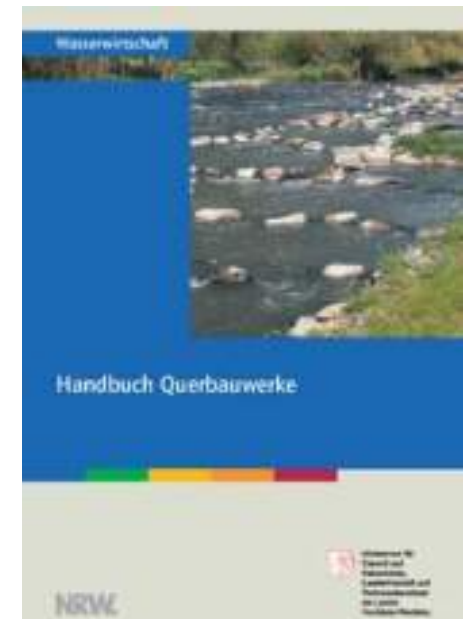


▶ Mitigation measures

- ▶ Limitation of habitat loss (25% of length of river zoning)
- ▶ Upstream migration facility at each dam (or dam removal), also for HMWB
- ▶ Priority rivers for development of diadromous fish populations
 - ▶ Mechanical barriers
 - ▶ Large HP: fish friendly turbine management

▶ To Do

- ▶ Set up of European standards for fish passes (upstream)
- ▶ Scientific work on fish protection & downstream migration → standards
- ▶ Strategy for priority rivers on a European scale (diadromous populations)
 - ▶ Including: natural rivers and HMWB



Thank you for your attention

