Ecohydraulic Engineering

Fachberatung für Fischerei Oberfranken

Conflict between canoeing and fish habitat – A habitat-based assessment approach

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Wiesent river

Southeast of Germany, 78 km long, in tourist region „Franconian Switzerland“

- *Balanced flow regime (Karst)*
  MAF / MALF / LF = 7.21 / 4.59 / 2.90 m³/s
- *Stable water temperature (high groundwater %)*

Important population of European grayling *(Thymallus thymallus), currently declining:*

- *Highly endangered species, very sensitive early life stages*
- *Climate change -> lower flows (reduced habitat availability, temperature increase)*
- *Fine sediment inflow (agriculture)*
- ***Intensive canoeing***

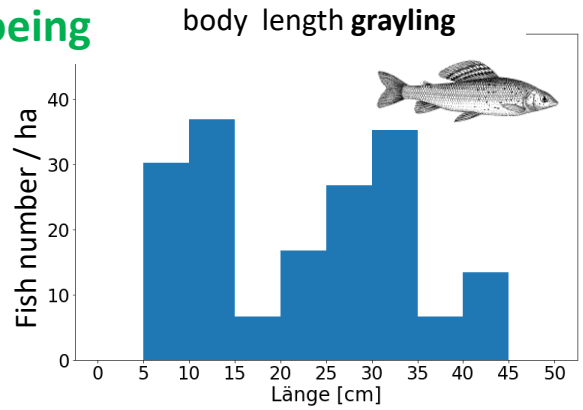
1. Investigation area

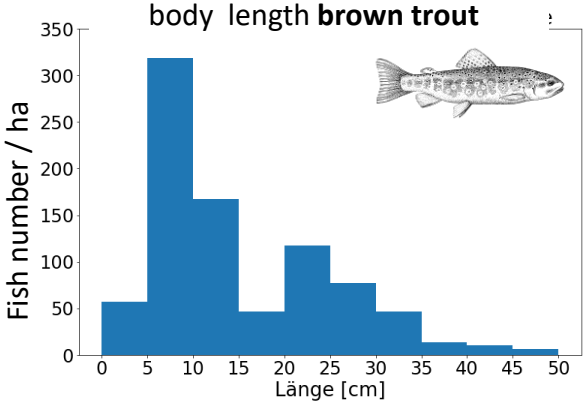
Performed studies

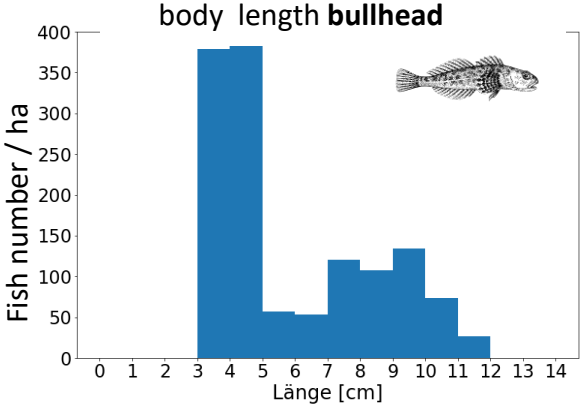
- **E-Fishing, hydraulic and habitat modelling / canoe agent simulations**
- **Passability in shallow reaches, canoe agent simulations**
- **Observation of canoers**
- **Fish behaviour observation with underwater camera**

Population densities in reaches without and with canoeing

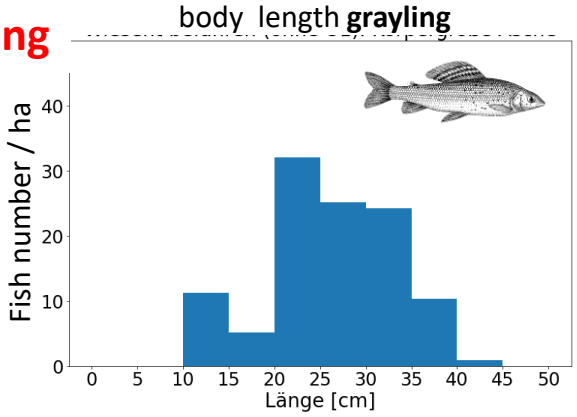
No canoeing

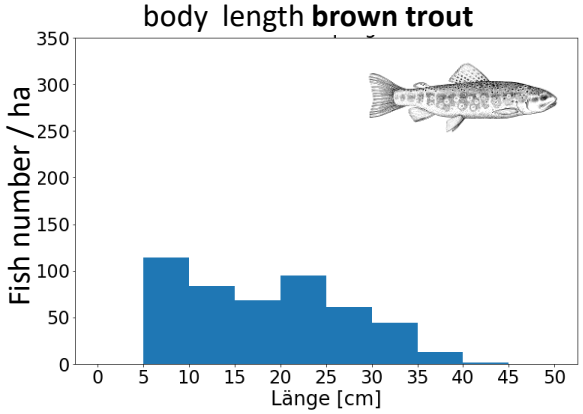


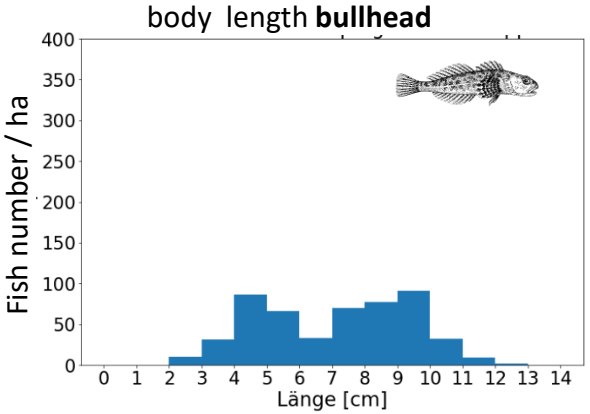




canoeing







Condition factor as disturbance indicator

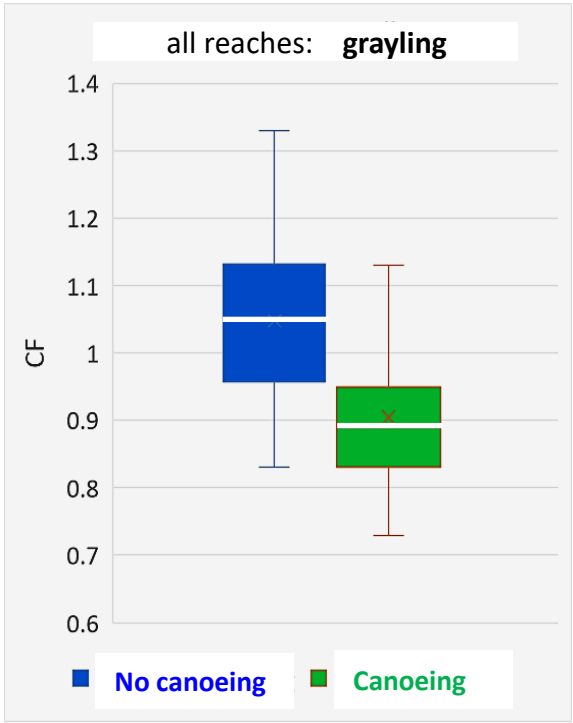
Condition factor CF delivers info on nutritional status of fish

$$CF = \frac{100 \times body\ weight\ (g)}{length\ (cm)^3}$$

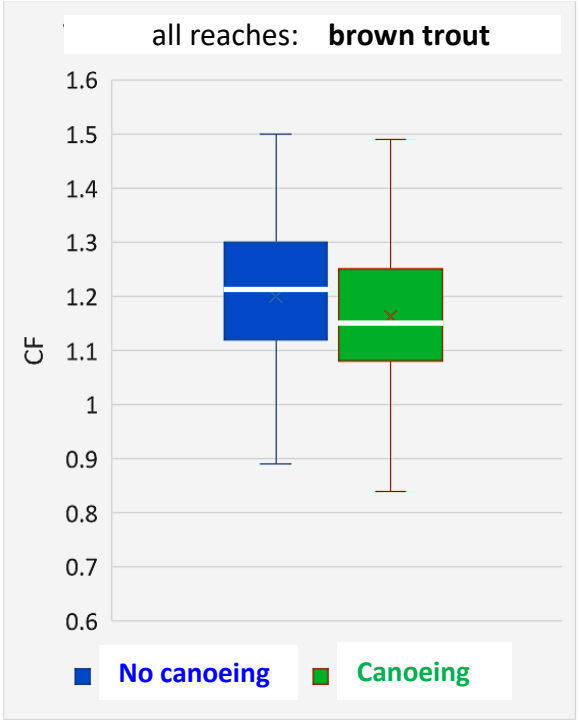
In reaches with canoeing CF for grayling and brown trout is statistically significantly lower than in reaches without canoeing

Assumed reason:

Differing foraging strategies



Highly significant



significant

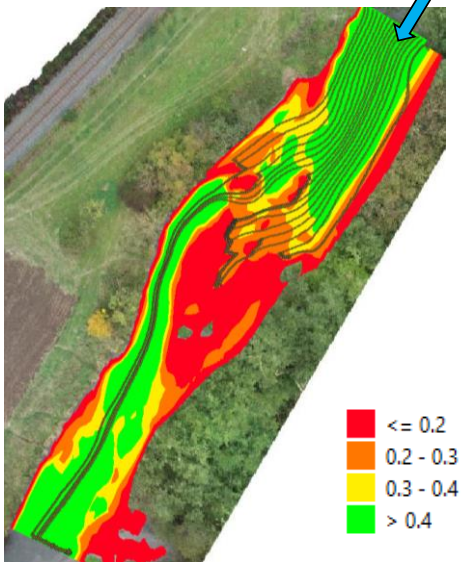
Canoe agents in shallow water reaches (path lines)

- 20 cm minimum depth (draught of boats)
- 80% of boats should pass without grounding

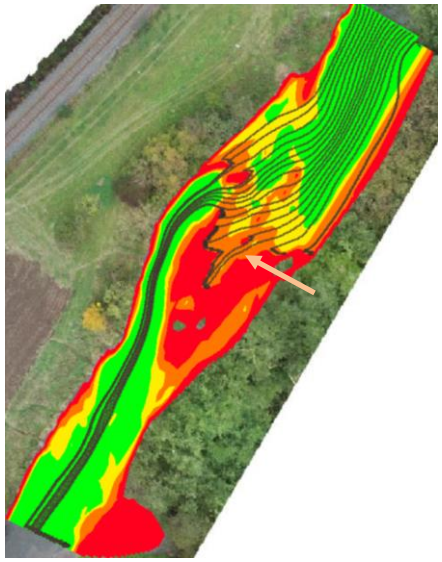
Water depth [m]

<= 0.2	Grounding
0.2 - 0.3	Paddle impact
0.3 - 0.4	Transition zone
> 0.4	No impact

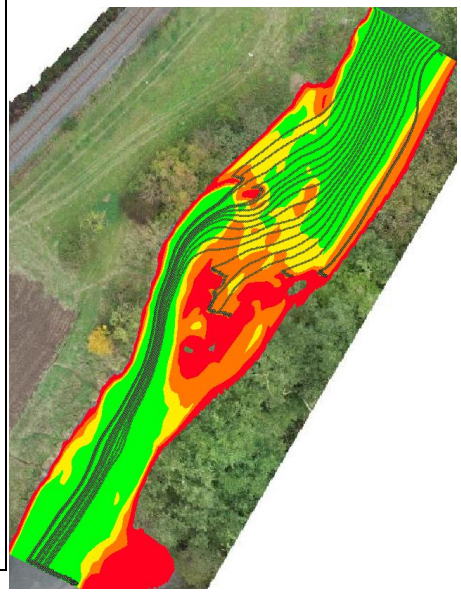
Q2=2,98 m³/s (LF)



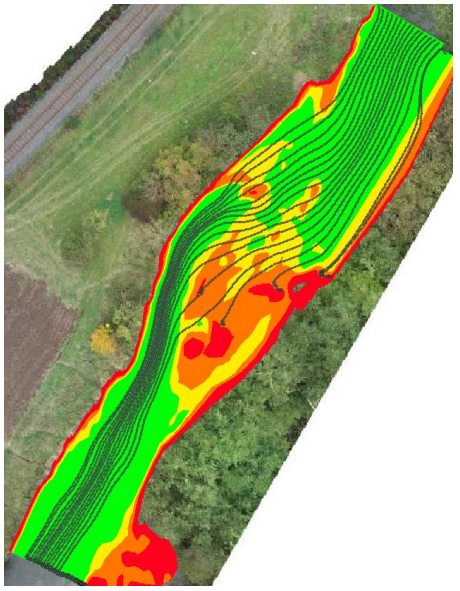
Q3=3,85 m³/s



Q4=4,73 m³/s (MALF)

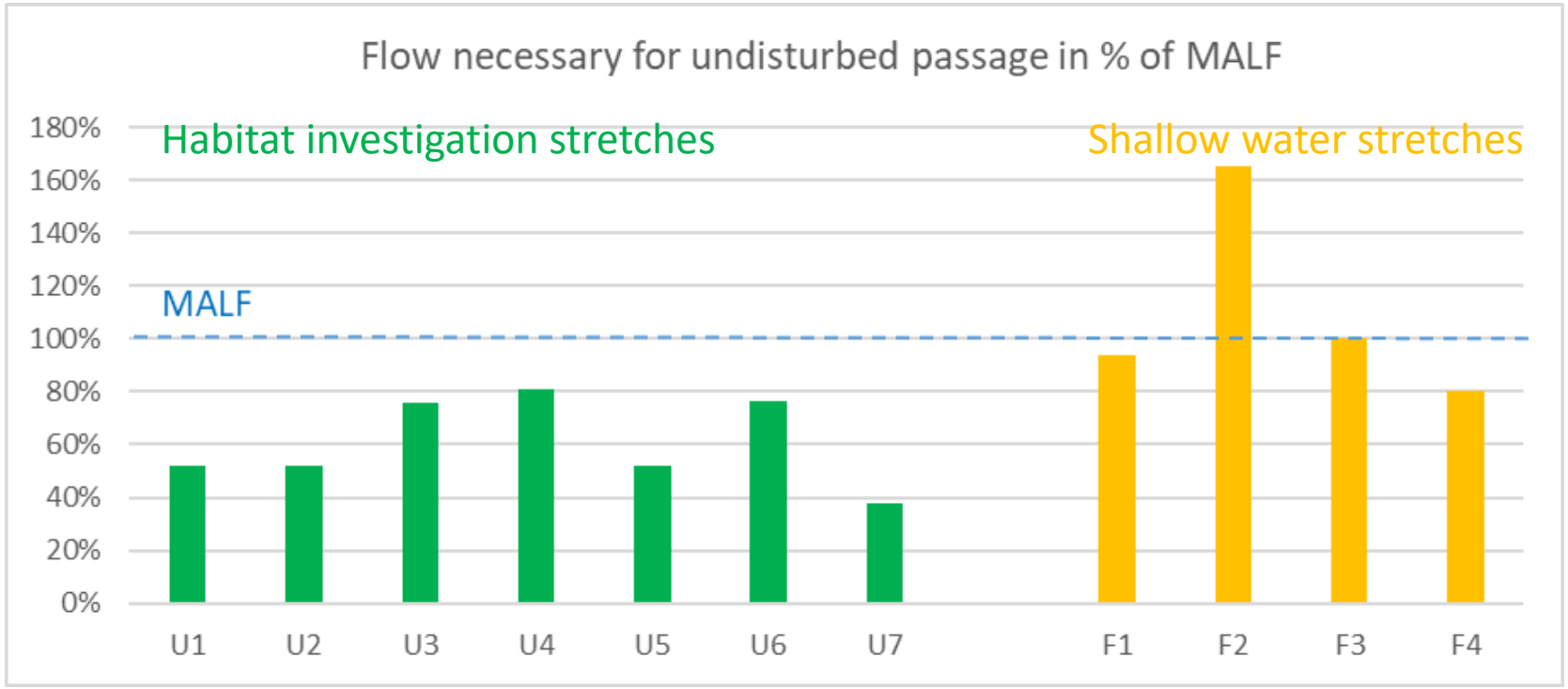


Q5=6,18 m³/s (approx. 1.3 MALF)



Flow for undisturbed passage

- Flows necessary for approx. 80% of the canoe agents passing without disturbance



Grayling and trout under disturbance impact

UW-cameras

- Permanently installed cameras
- Recording during several hours
- 4 reaches
- Recorded: fish behaviour during boat passages

Categories of behaviour

1) No movement
2) Slight movement/foraging not interrupted
3) Escaping/Panic
4) Fish leaves area of observation
5) Return after 70 sec or more

Duration of reaction on disturbance

Return time after disturbance (for grayling):	**5-10 min**
Recovery time = re-occupation of territory, re-foraging defined as twice the return time (assumption)	**10-20 min**
Duration between disturbance and re-foraging	**15-30 min**
Physiological background (largemouth bass *Micropterus salmoides,* Graham & Cooke, 2008) Normalised cardiovascular activity after disturbance by paddle	**ca. 15 min**

Reaction to disturbance is answer to a of disturbance duration, intensity and type

Little knowledge on:
- Interaction of these factors
- modifying factors as habituation/competing factors (hunger)
- individual differences

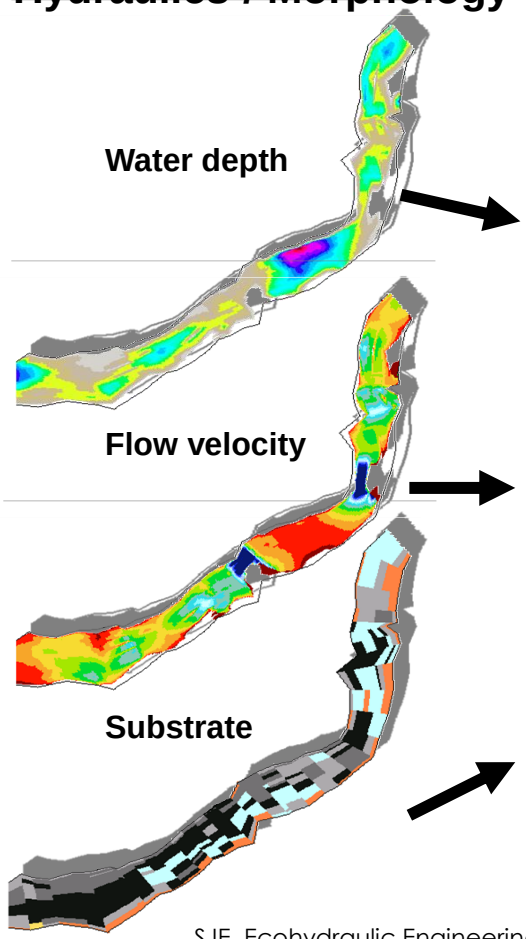
Reaction is stronger the smaller distance between fish and boat

→ **depth as habitat reduction factor**

Fuzzy rule-based habitat model CASiMiR

www.casimir-software.de

Hydraulics / Morphology



Habitat requirements

Expert rules

IF water depth SUITABLE
AND flow velocity SUITABLE
AND substrate size SUITABLE
THEN suitability VERY HIGH

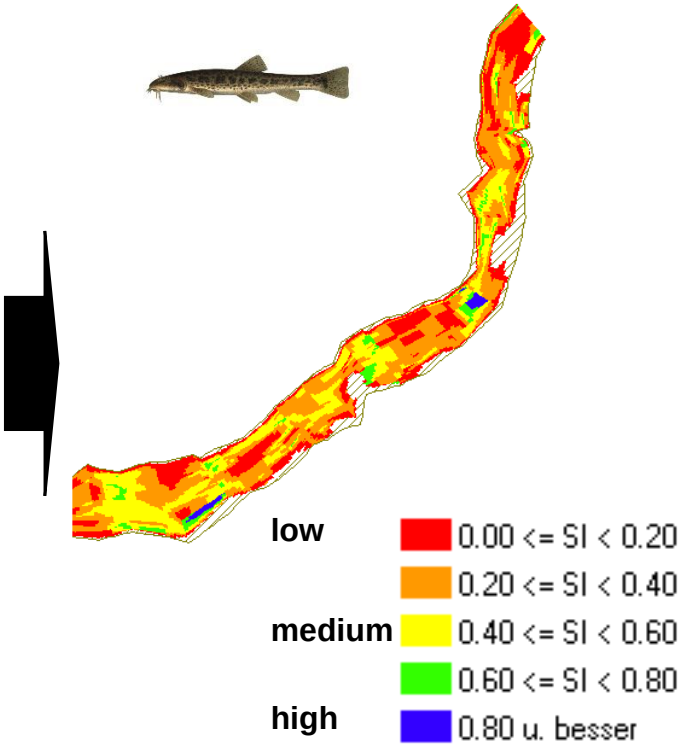
IF water depth SUITABLE
AND flow velocity RATHER LOW
aND substrate size GOOD
THEN suitability MEDIUM

IF water depth TOO HIGH
AND flow velocity SUITABLE
AND substrate size SUITABLE
THEN suitability HIGH

IF water depth CLEARLY TOO LOW
AND flow velocity SUITABLE
AND substrate size SUITABLE
THEN suitability LOW

⋮

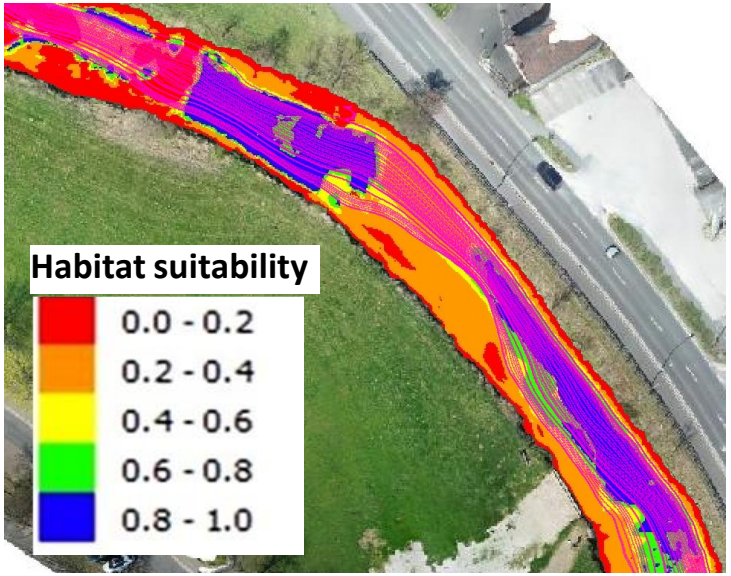
Habitat suitability



Habitat suitability and canoe impact

- Canoe paths overlap largely with high suitability habitats, almost independent of river flow
- Disturbance intensity is closely related to distance between boat and fish

- **Approach for habitat disturbance model**
  - → **Disturbance intensity is reduced proportionally to distance from fish**



Habitat type	Max disturbance Reduction of suitability 100%)	Disturbance reduction range Reduction of suitability decreasing from 100 to 0%	No disturbance Reduction of suitability = 0%
Summer habitat grayling	Depth = 0,4 m and less	Depth = 0,4 m to 1,2 m	Depth = 1,2 m and more

Habitat suitability without and with disturbance

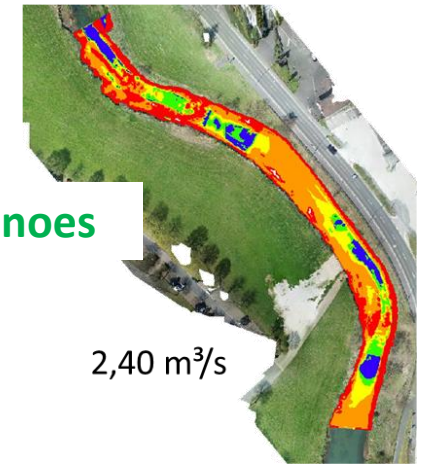
Modelled grayling summer habitats (feeding) and impact of canoes

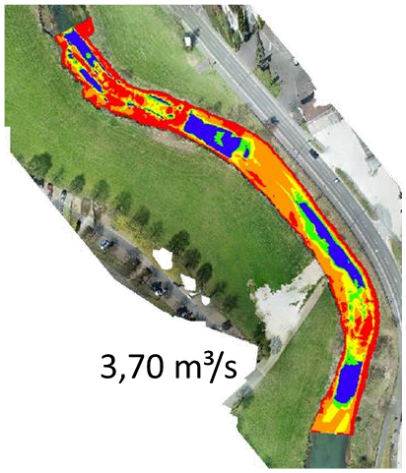
- Example: reach 6

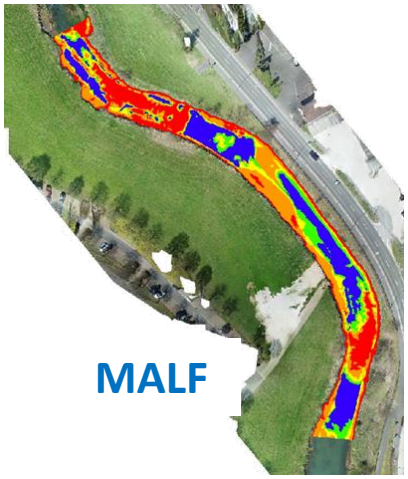
Habitat suitability

0.0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0

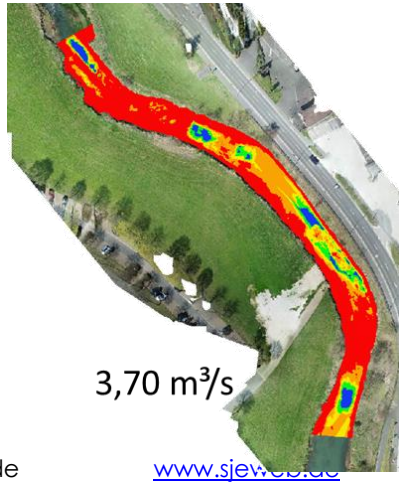
No canoes

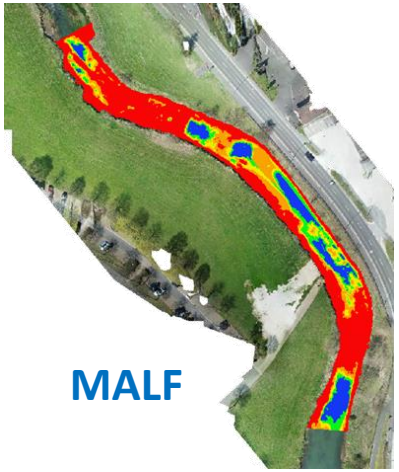






Reduced due to canoe disturbance





→ **Min flow for habitat conservation under disturbance is MALF**

Recommendations for canoeing management

- **Prevention of mechanical disturbance:**
  Min water depth (MALF) + Portage at critical shallow reaches
- **Limiting disturbance intensity and duration:**
  Limited boat group size (4 boats per group)
- **Limiting frequency of boat disturbance:**
  Limited number of boats per day (28 disturbances per day)
- **Conservation of habitat despite disturbance:**
  Minimum availability of good habitats (MALF as min flow)
- **Restricting access times:**
  Limited access times (not during dusk, dawn, night, spawning, larval periods)