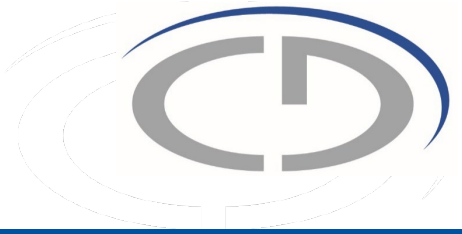
IWA

Institute of
Hydraulic Engineering
and River Research



New approaches for a sustainable hydropeaking management: The HEM-Peak model and the role of channel evolution, river morphology and sediment dynamics

Hauer C.

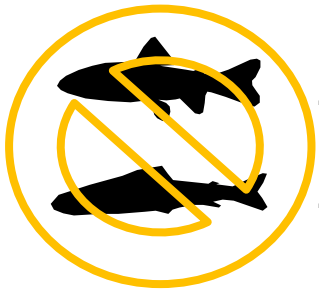
Outline

- „Hydraulic stable habitat conditions“
- HEM-PEAK Modell **NEW!**
- General points of discussion
- Summary & Conclusions

„Hydraulic Stable Habitat Conditions“

Why needed?

…….Over evolutionary time, organisms evolve traits that enable them to survive, exploit and even depend on disturbances (Lytle & Poff, 2004).



….0+ brown trout

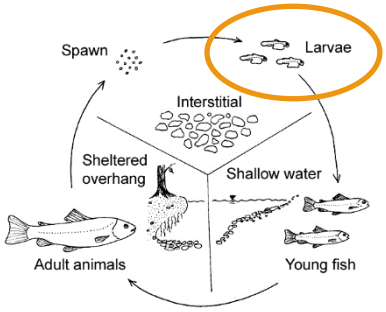
….0+ grayling

…..However, the pulsed-flows by turbines, labeled as hydropeaking (Sauterleute & Charmasson, 2014) are beyond the physiological possibilities of adaption!

„hydraulic stable habitat conditions“ at suitable habitats during hydropeaking are requested (bioenergetic, physiological)

„Hydraulic Stable Habitat Conditions“

Fish



(from Bostelmann 2003)

- **low changes in wetted width**
- **low flow velocities in terms of base and peak flow**

Hauer *et al.* (2017)

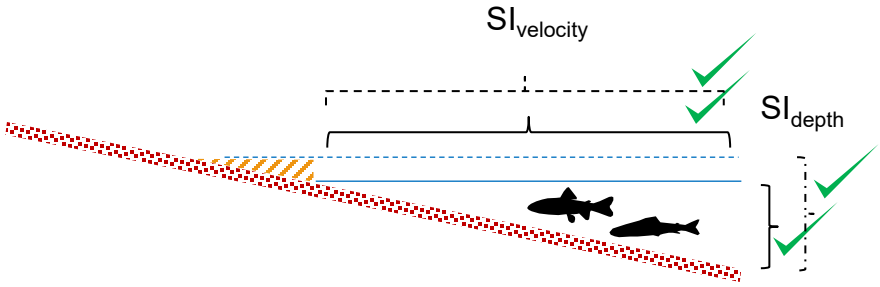
groins

Inn river

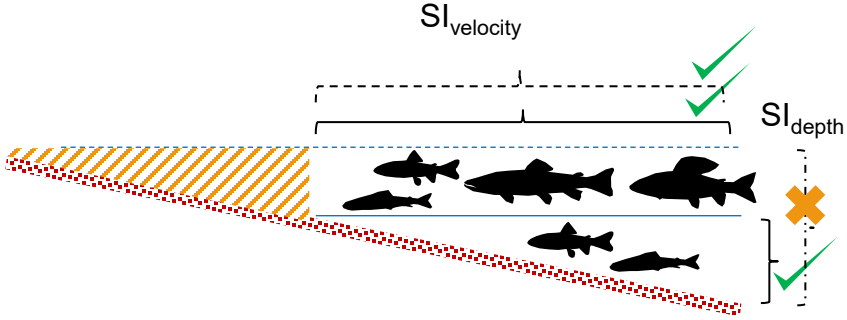
Point bar

Hydraulic Habitat Stability Analysis

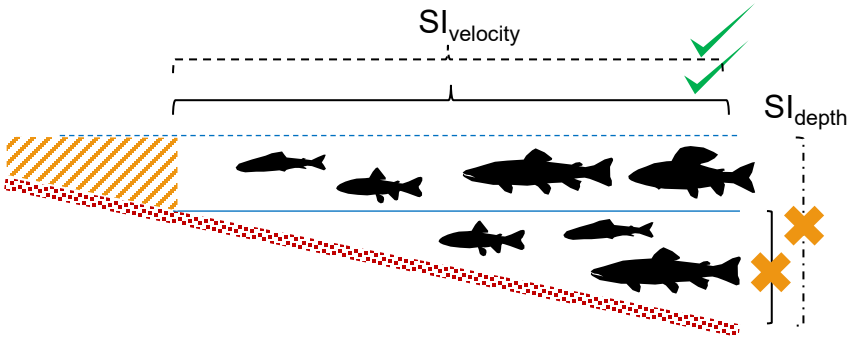
Category 1:



Category 2:



Category 3:



Legend:

….0+ brown trout

….0+ grayling

….adult brown trout

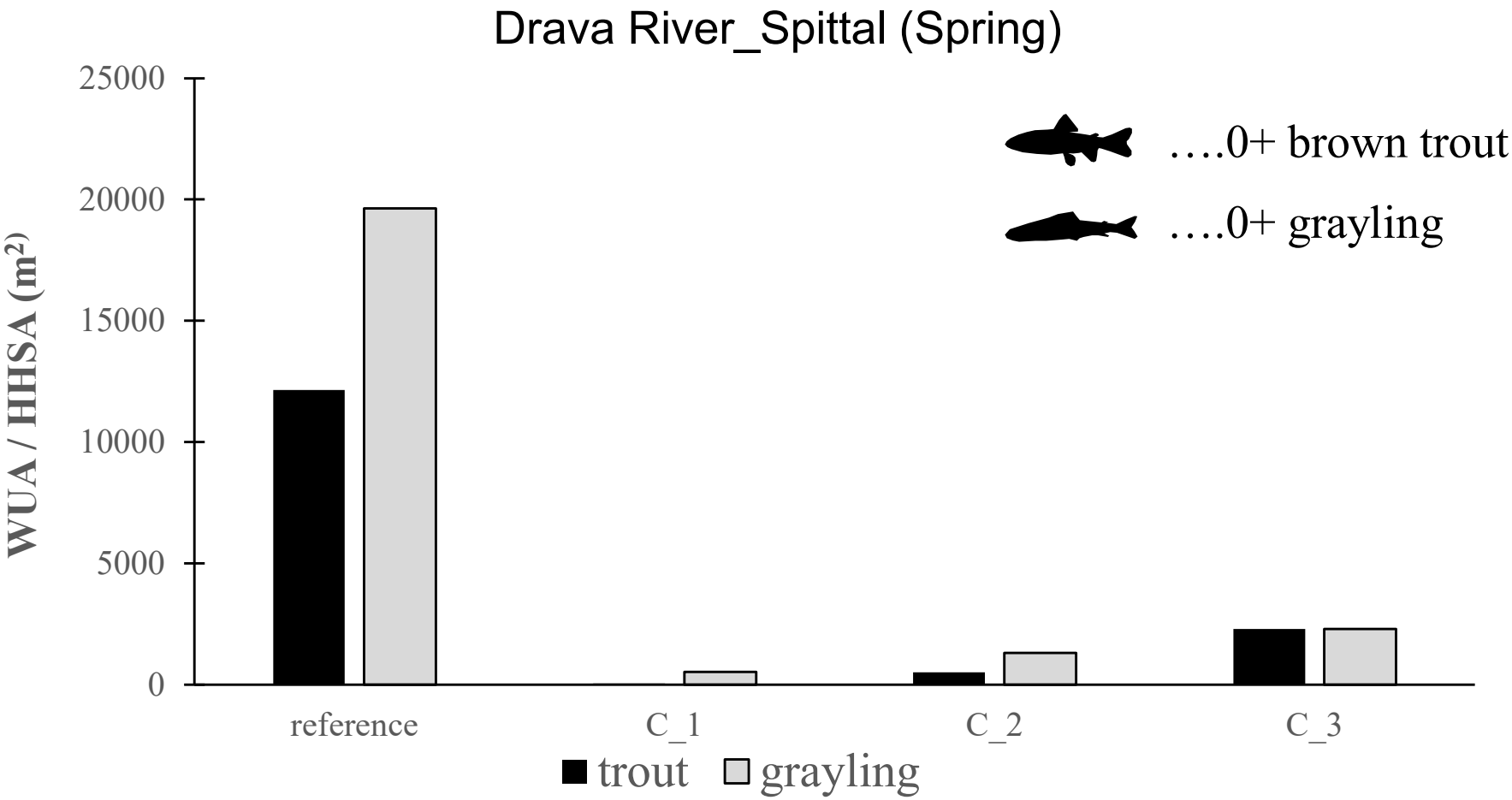
….adult grayling

….dewatering

Hauer *et al.* (2023b)

Hydraulic Habitat Stability Analysis

- **quantitative comparison to „reference conditions“ possible!**



Hydraulic Habitat Stability Analysis

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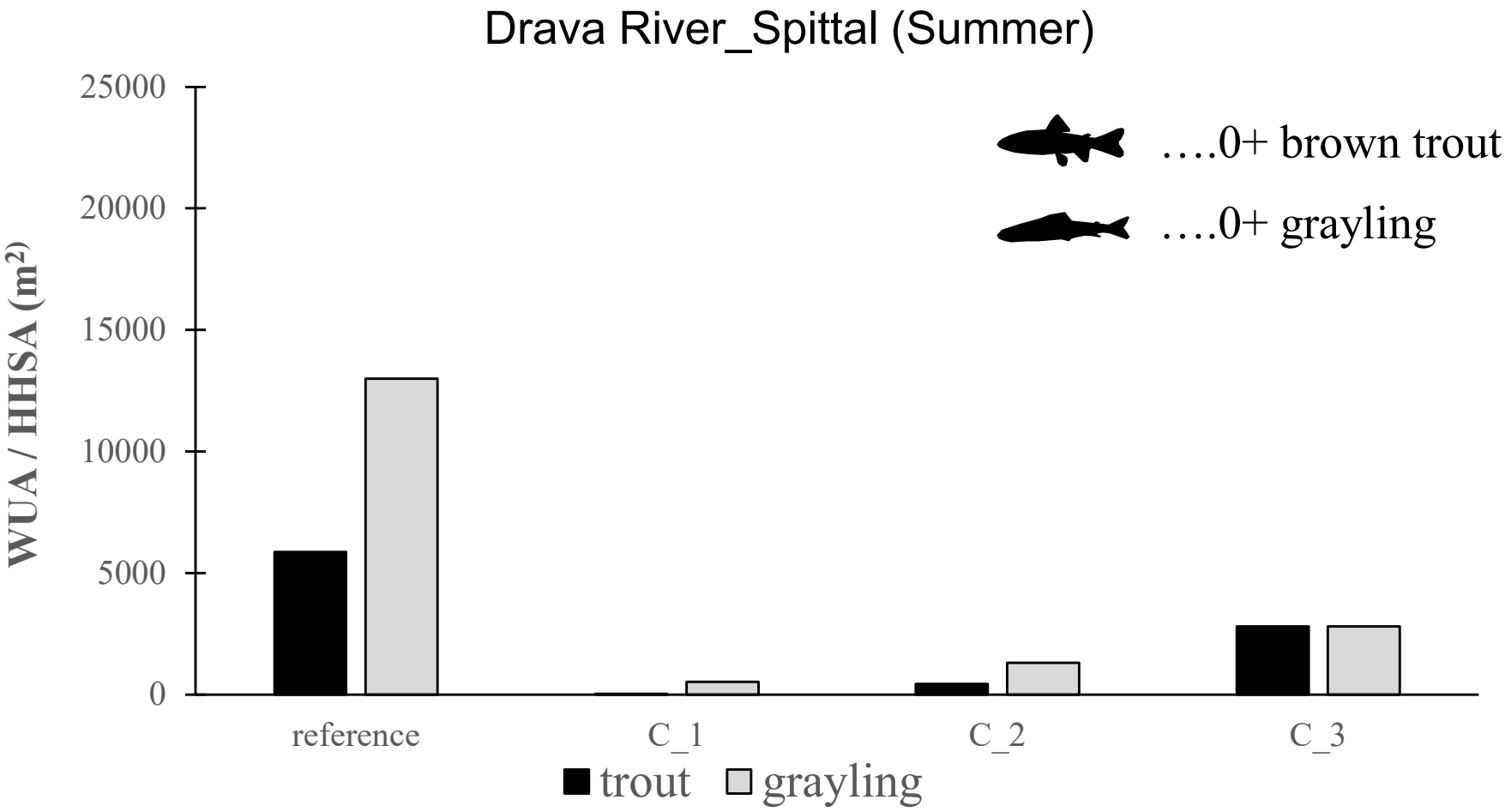
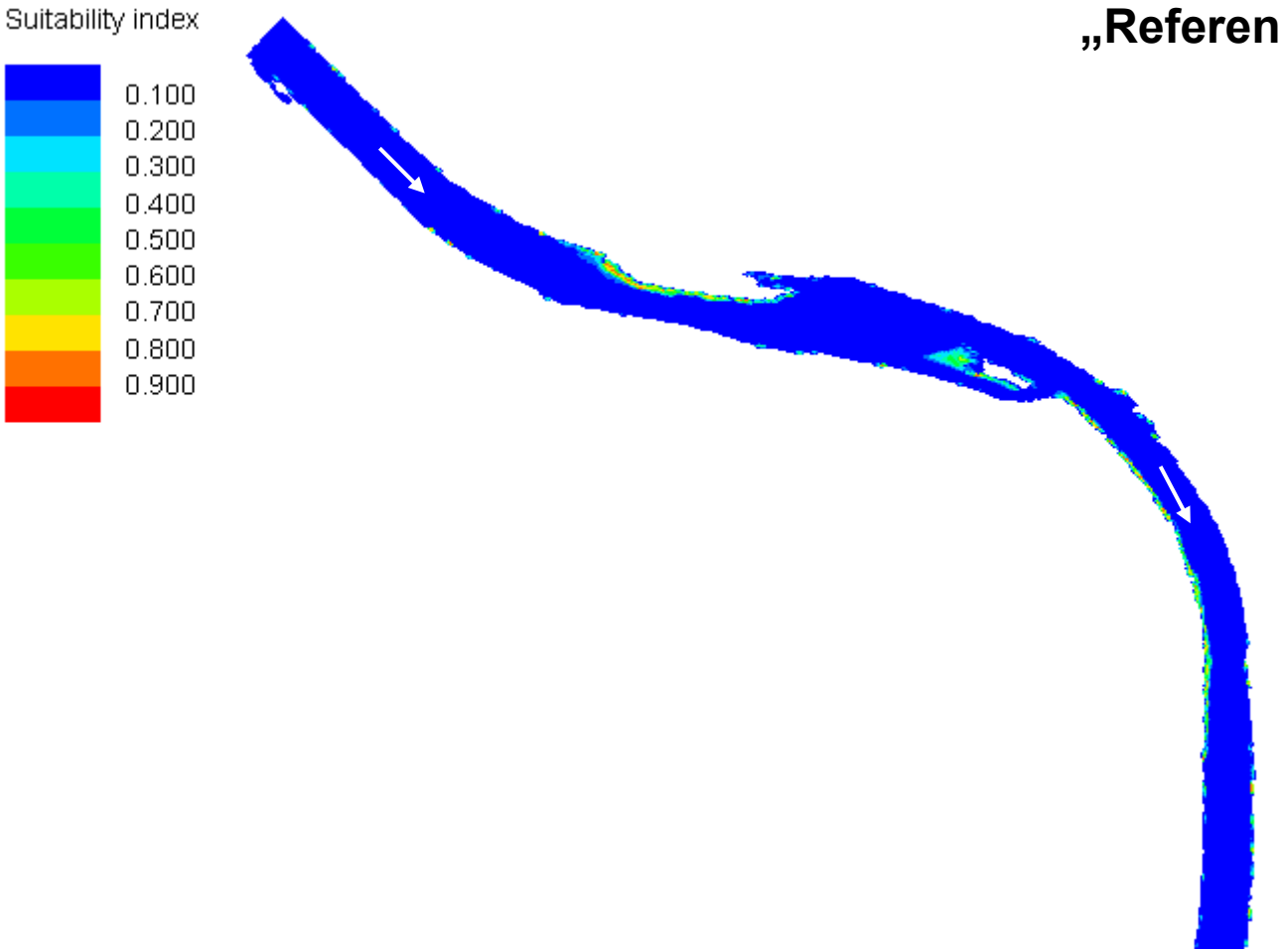


Hydraulic Habitat Stability Analysis

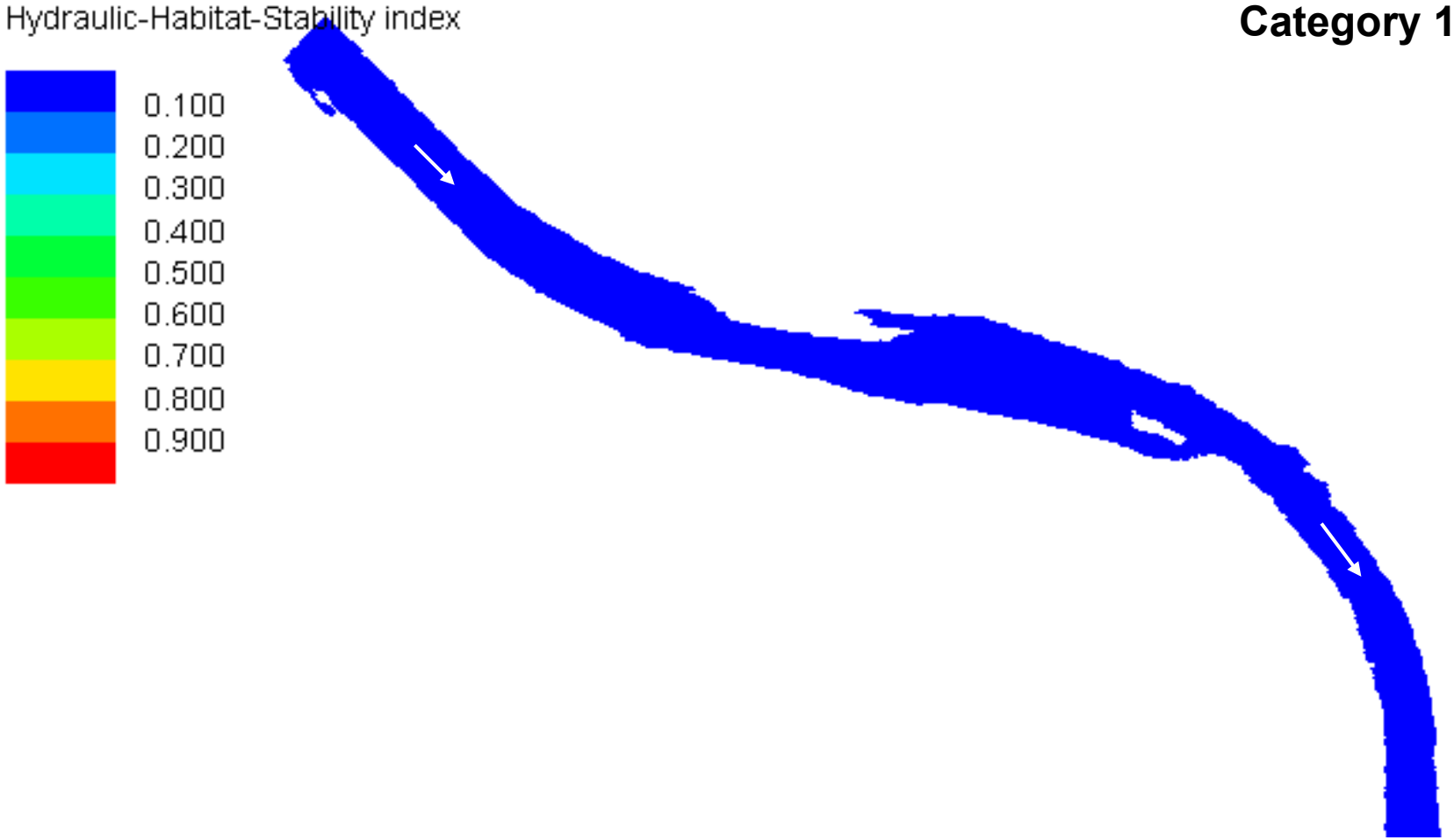
Drava River_Spittal (Spring) (Q_{base} = 59.3 m^3s^{-1}

„Reference conditions“



Hydraulic Habitat Stability Analysis

Drava River_Spittal (Spring) (Q_{base} = 59.3 m^3s^{-1} / Q_{peak} = 144.9 m^3s^{-1})



Category 1

Hydraulic Habitat Stability Analysis

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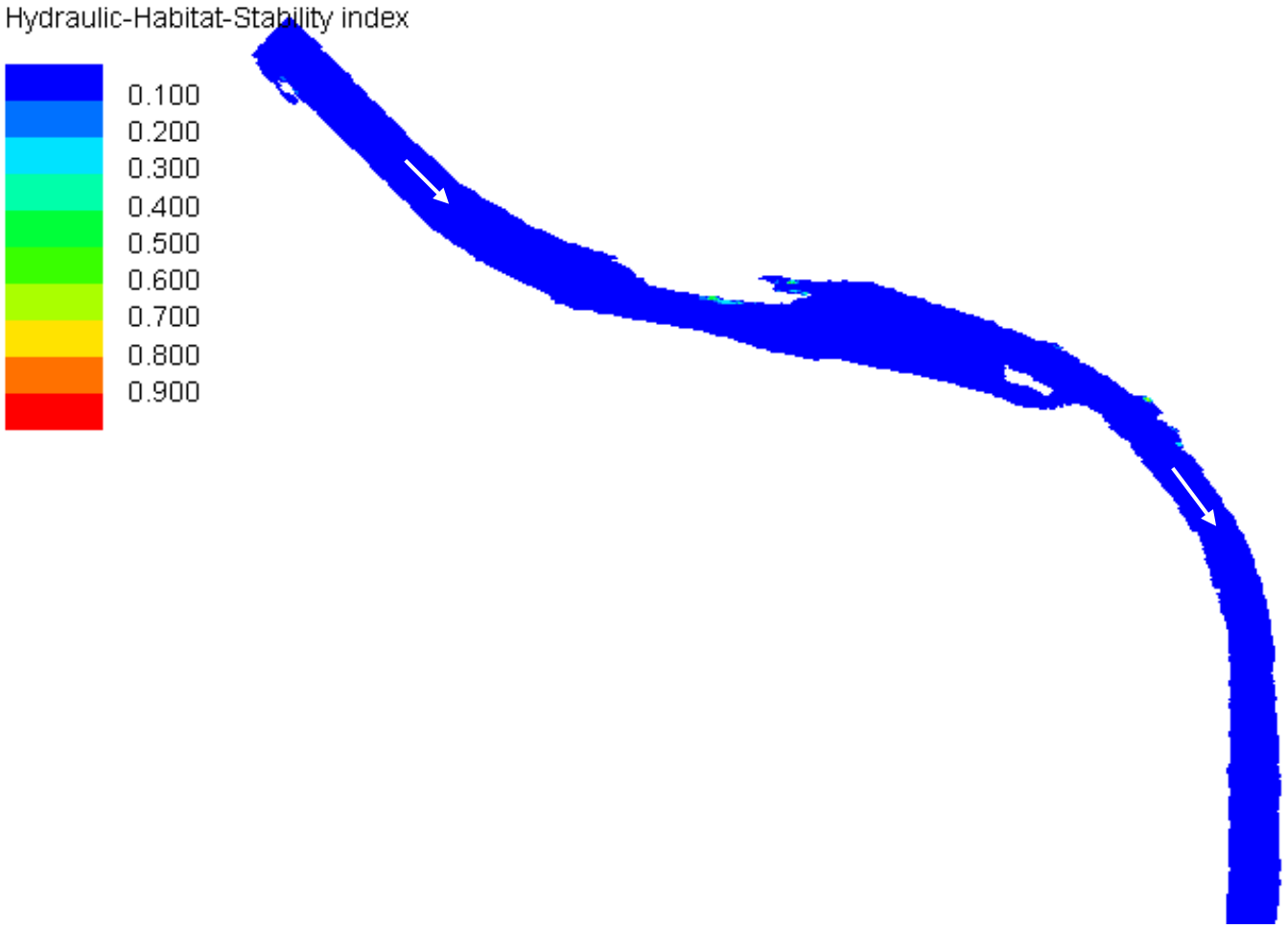

Category 2

Hydraulic Habitat Stability Analysis

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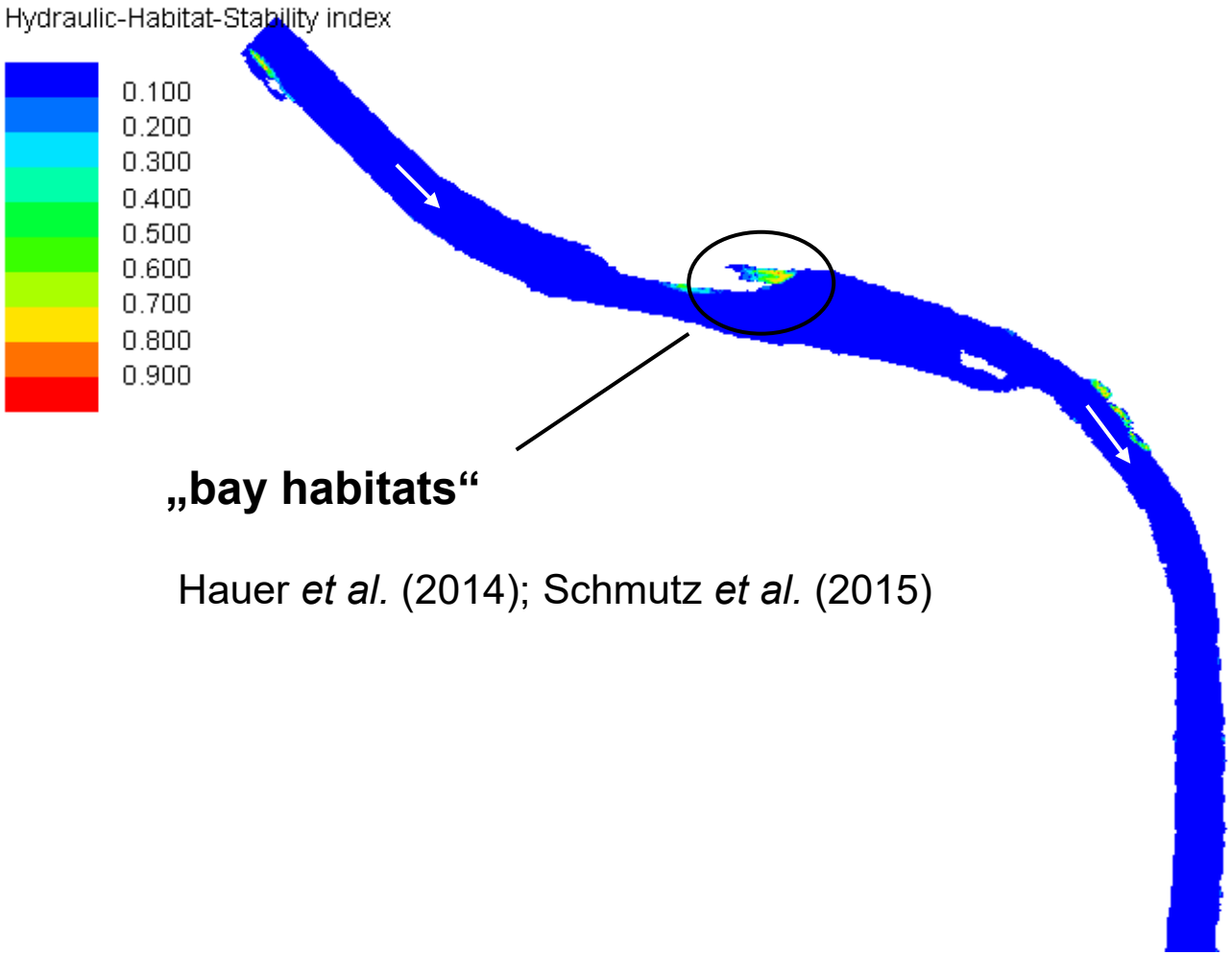


Category 3

„bay habitats“

Hauer *et al.* (2014); Schmutz *et al.* (2015)

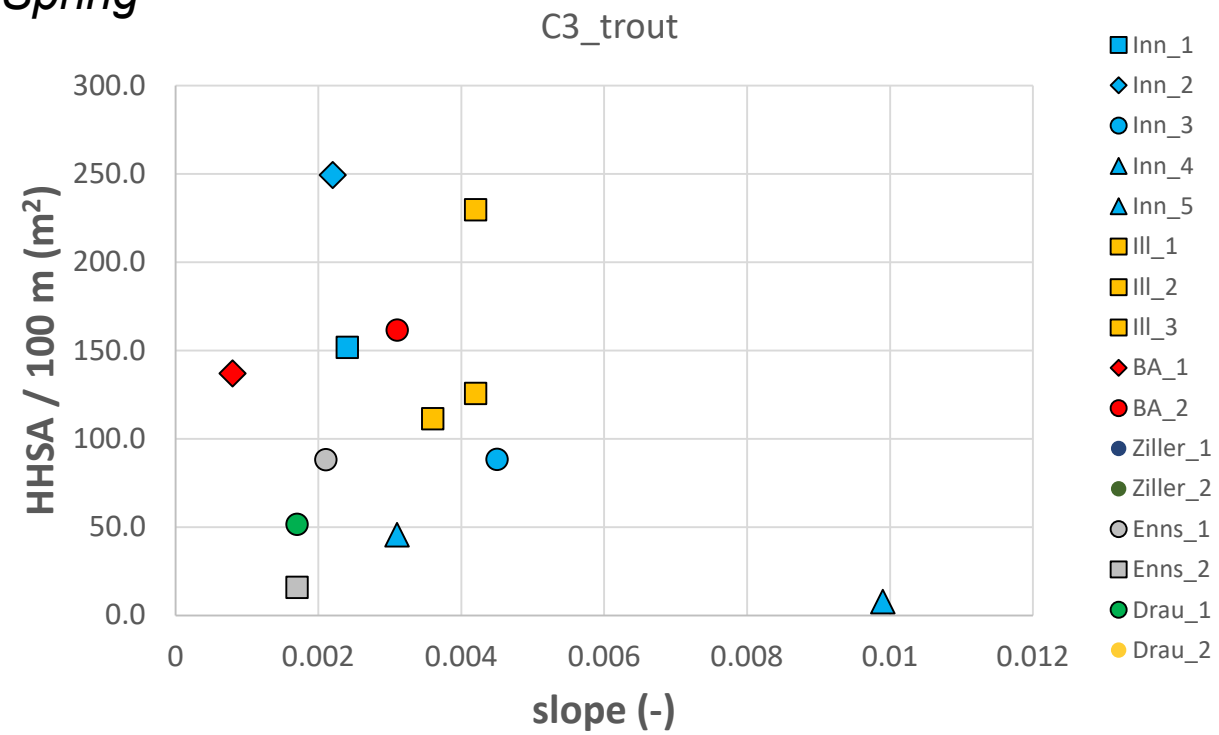
Hydraulic Habitat Stability Analysis

Analysis for 12 different hydropeaking river reaches

Hydraulic Habitat Stability Analysis

Category 3 („bay habitat“)

Spring



Legend:

□ ….straight (plane bed)

◇ ….straight (alternating gravel bar)

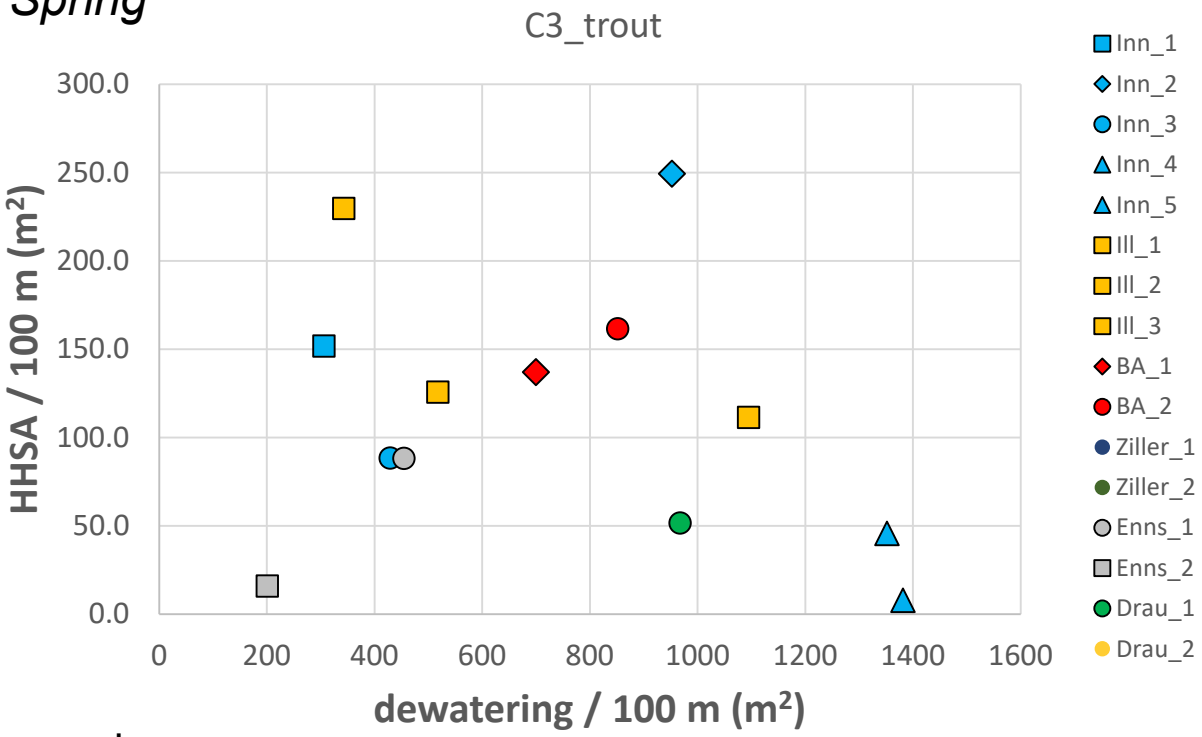
○ ….winding (riffle-pool)

△ ….straight / winding (bifurkation / island)

Hydraulic Habitat Stability Analysis

Category 3 („bay habitat“)

Spring



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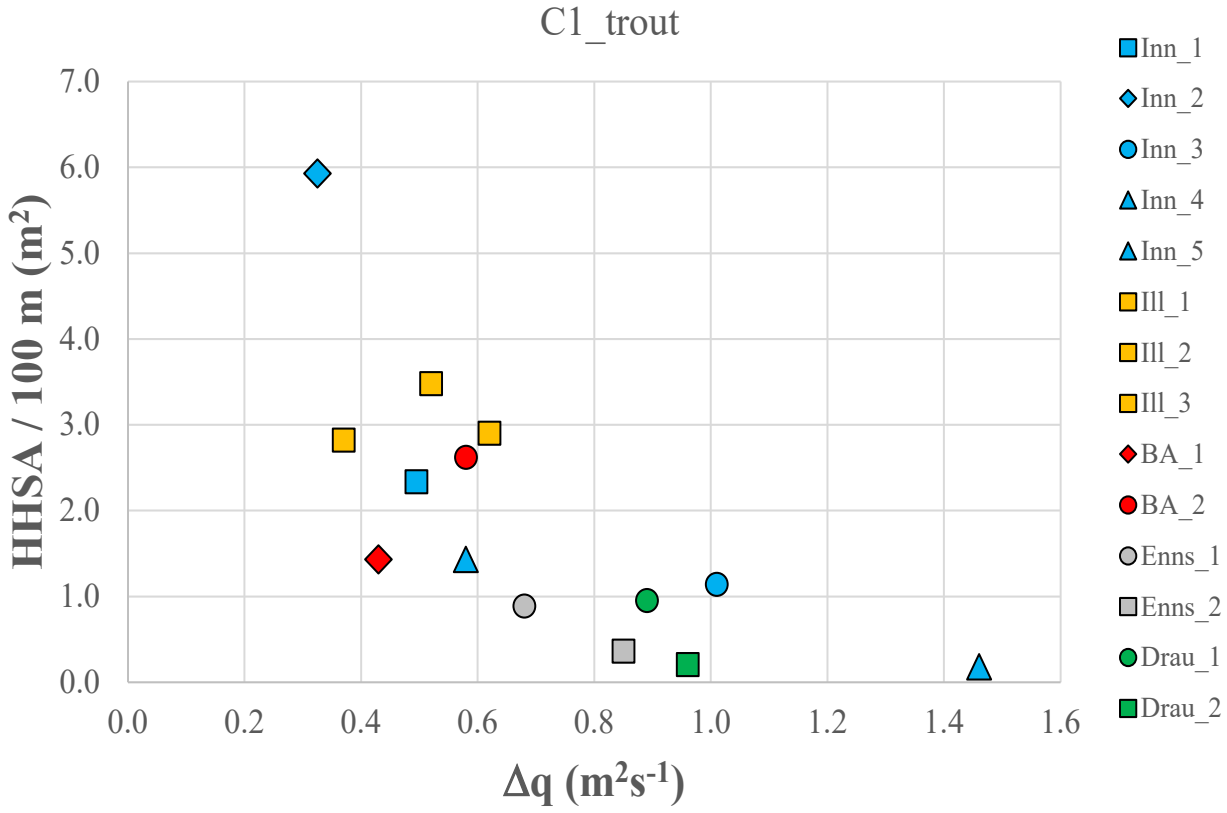
Hydraulic Habitat Stability Analysis

Comparison of hydraulic stable habitat conditions and „specific discharge“ (changes due to peak flow in relation to bankfull width)



Hauer *et al.* (2023b)

Hydraulic Habitat Stability Analysis

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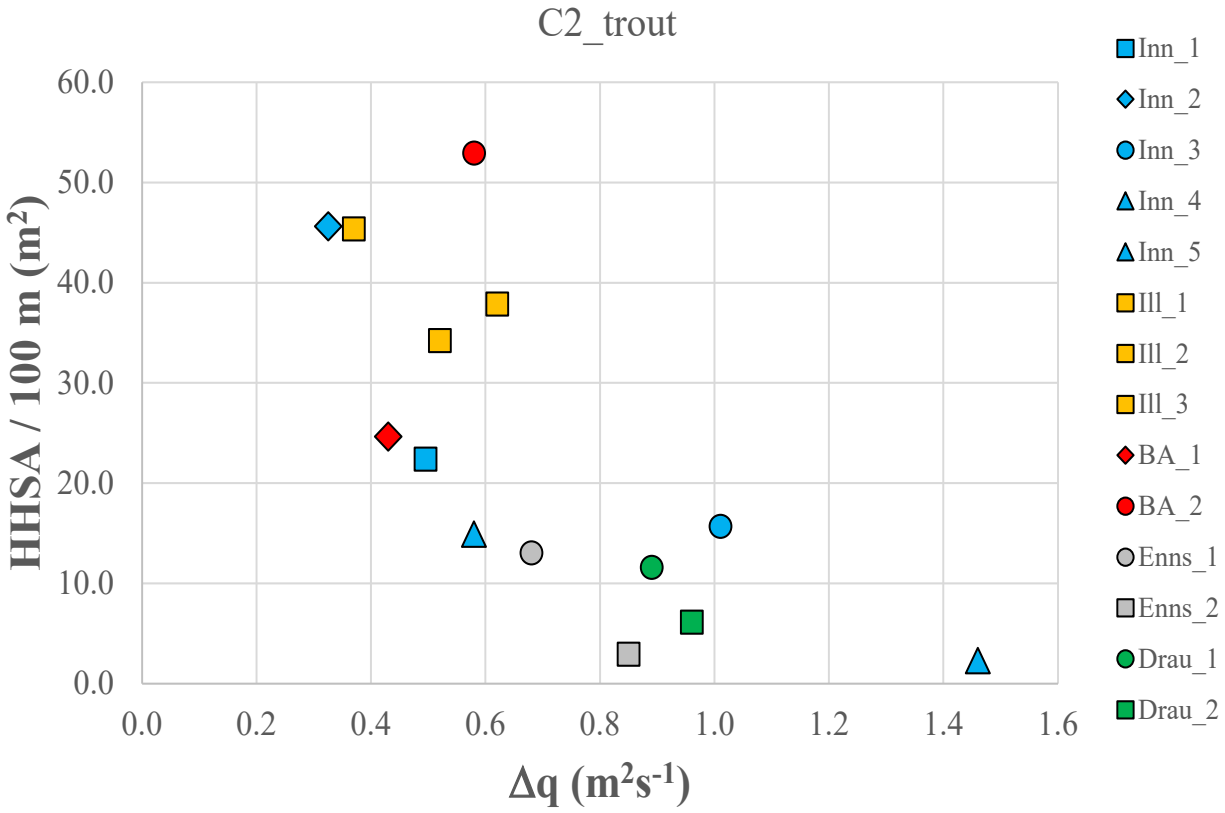

Hauer *et al.* (2023b)

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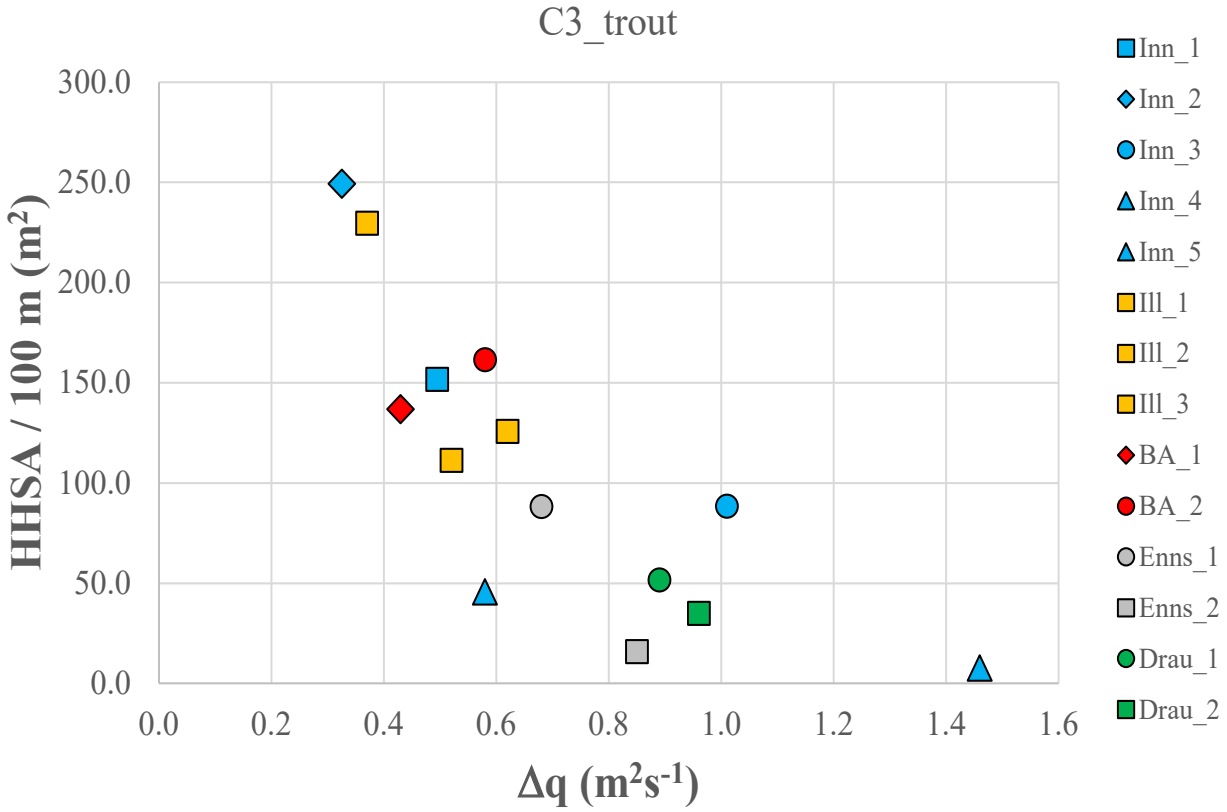
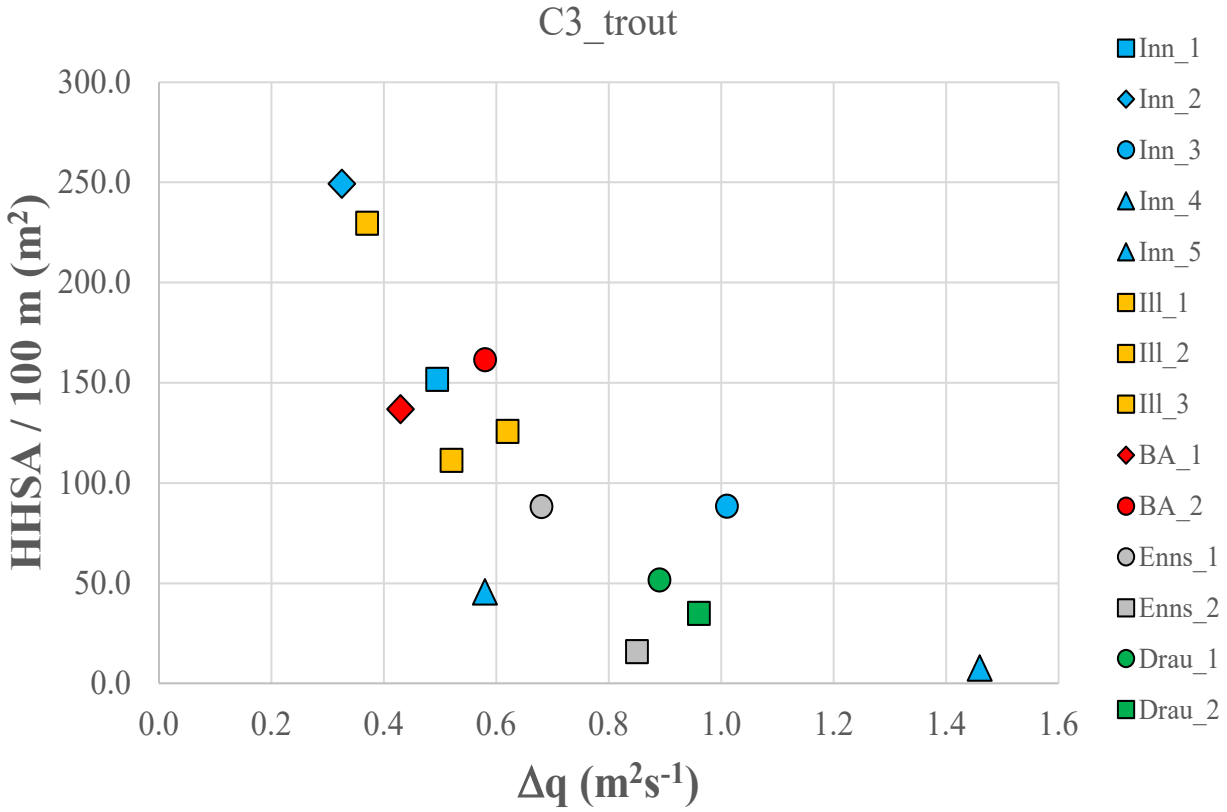


Hauer *et al.* (2023b)

Hydraulic Habitat Stability Analysis

Comparison of hydraulic stable habitat conditions and „specific discharge“ (changes due to peak flow in relation to bankfull width)



Hauer *et al.* (2023b)

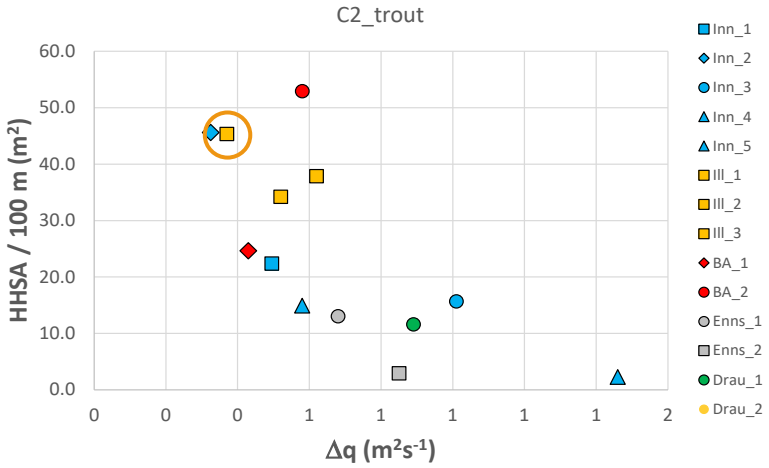
the lower Δq the more ´hydraulic stable habitat conditions´ are possible independent of the morphological type!

Hydraulic Habitat Stability Analysis

Category 3 („bay habitat“)

Spring:

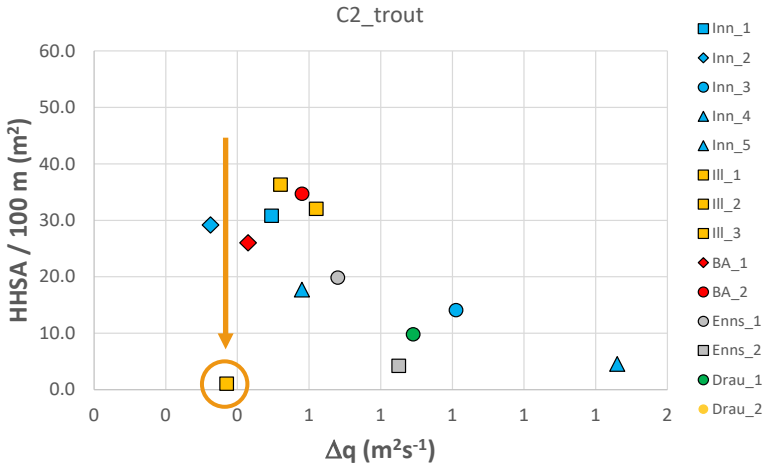
Q_{Sunk} = 7 m^3s^{-1}



Ill (reach 1)

Summer:

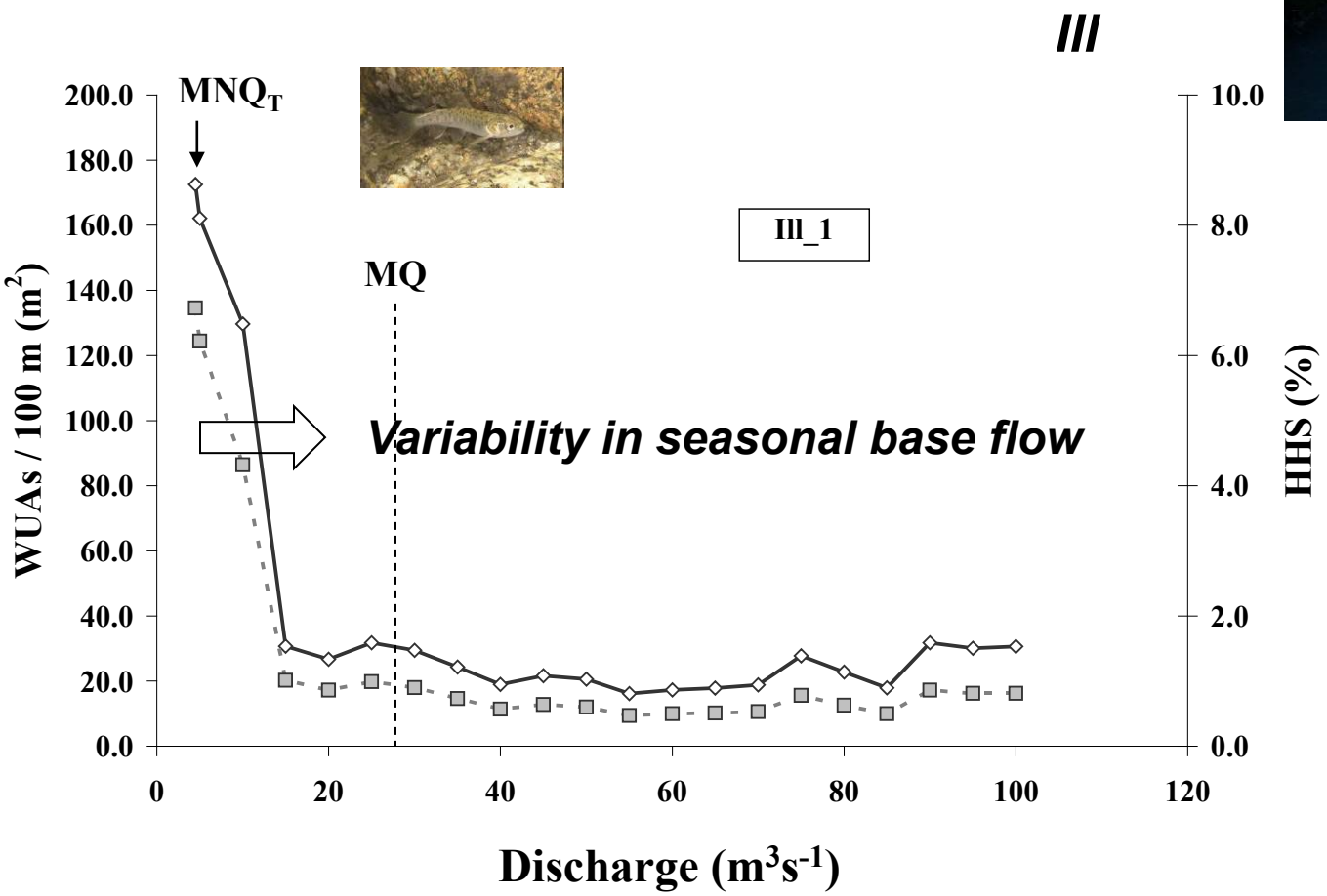
Q_{Sunk} = 36.6 m^3s^{-1}



BUT!

General points of discussion

- **Overall comparison with variable base-flow conditions and morphological boundary conditions is necessary!**



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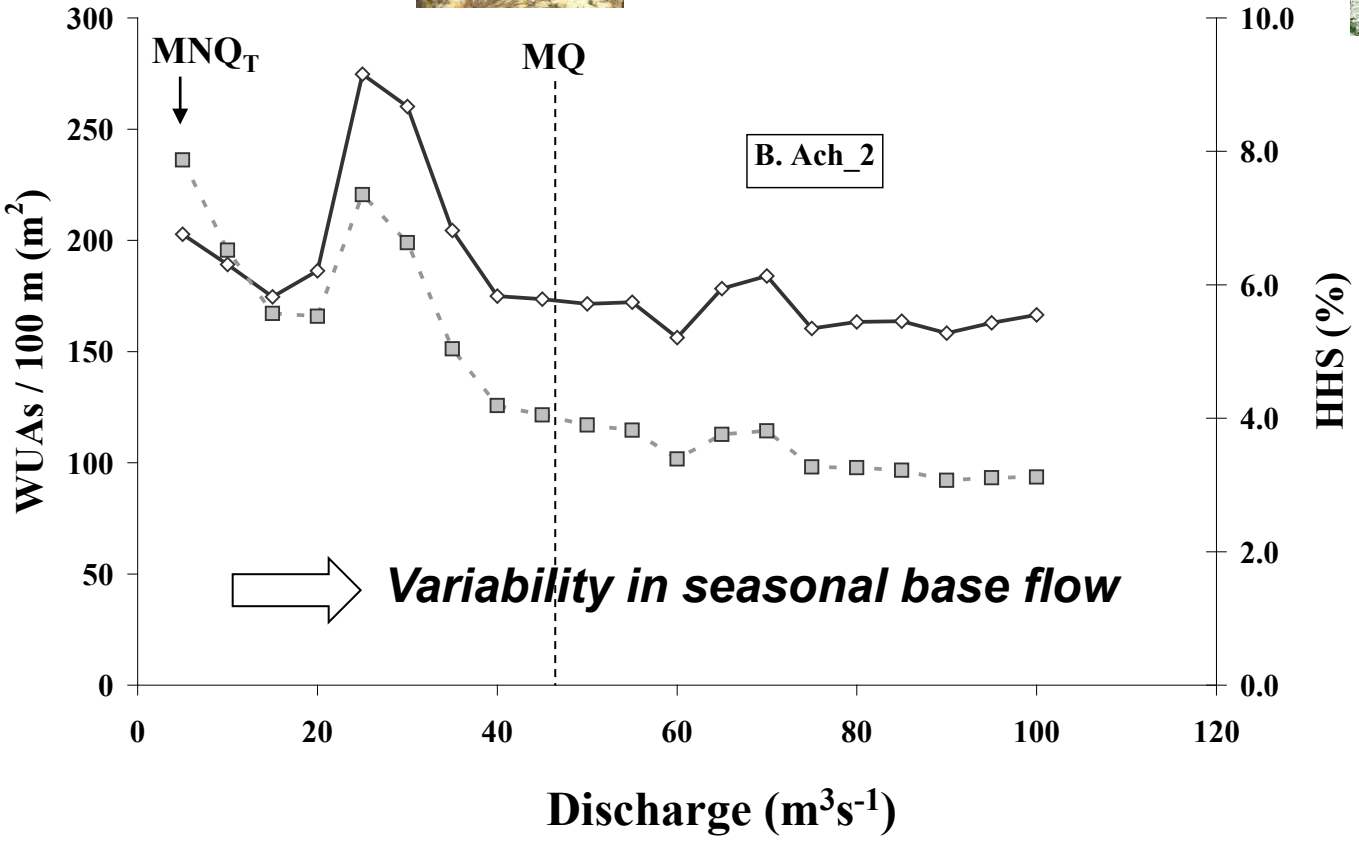
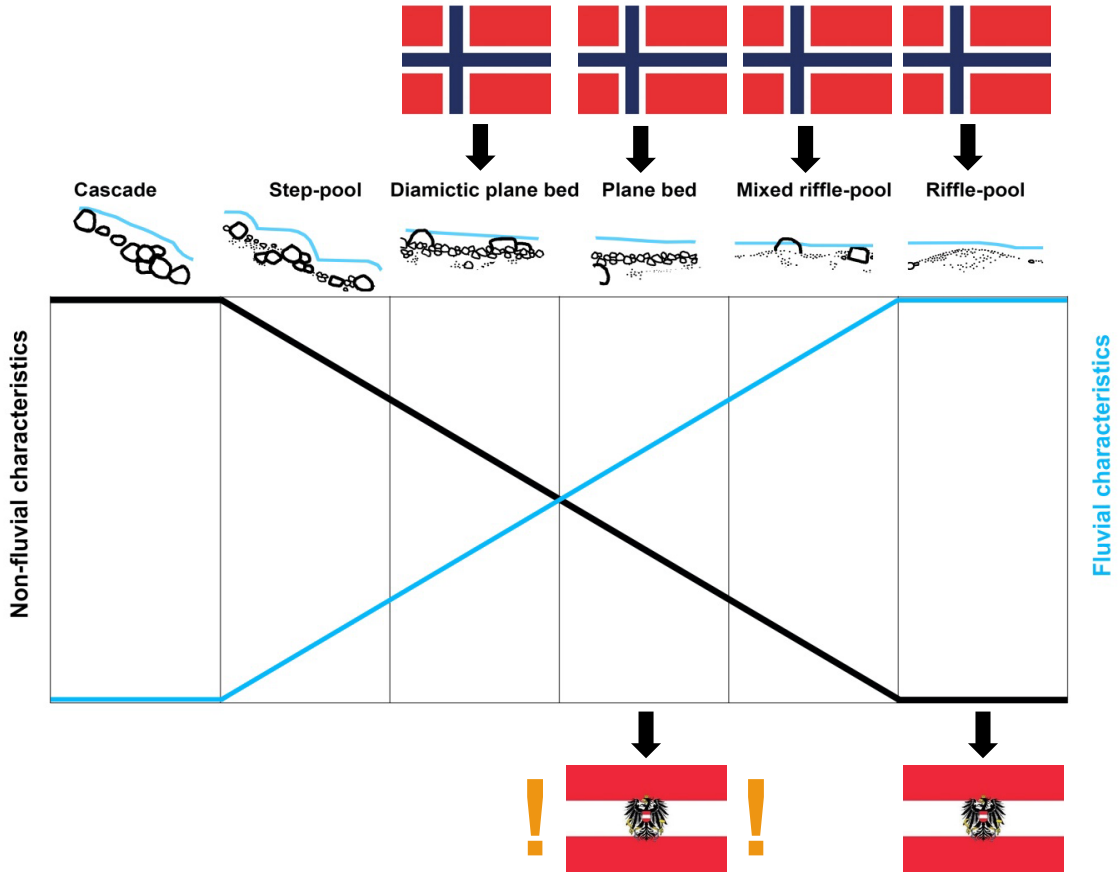


General points of discussion

- **Strong dependence of habitat descriptions according to river type and sediment regime „supply vs. transport limited“**

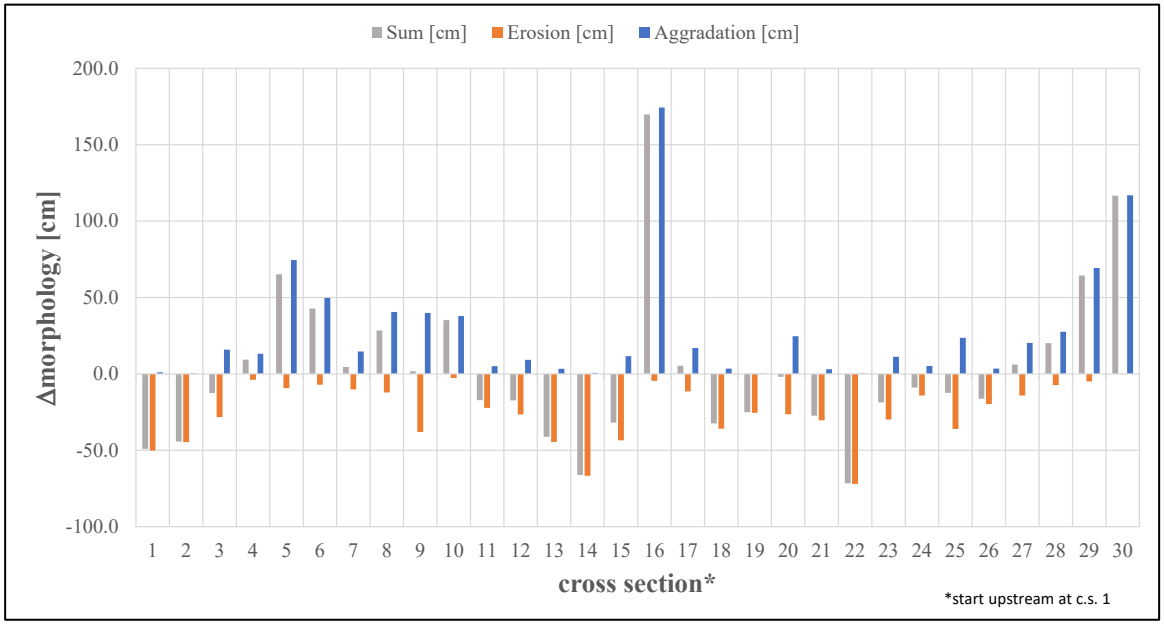


Hauer & Pulg (2018)

General points of discussion

⇨ mid- and longterm morphological development!

Results:



Bregenzerach

Periods:
1995 - 2005

Hauer *et al.* (2023a) STOTEN publlshed online

General points of discussion

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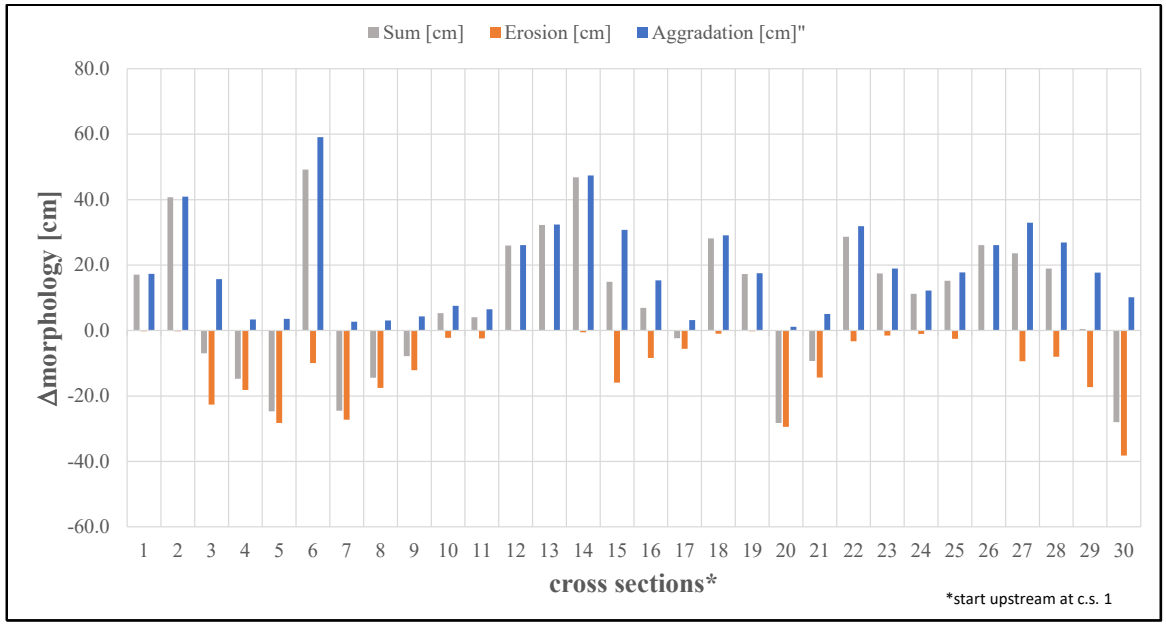

Bregenzerach

Periods:

1995 - 2005

2005 - 2009

Hauer *et al.* (2023a) STOTEN publlshed online

General points of discussion

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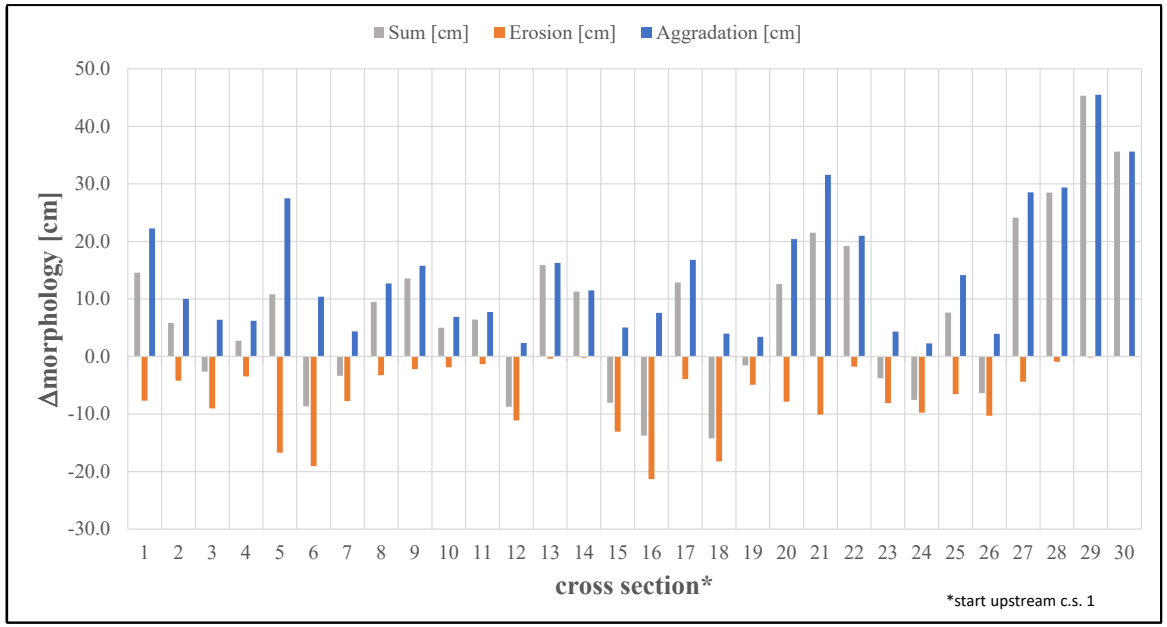

Bregenzerach

Periods:

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2005 - 2009

2009 - 2011

Hauer *et al.* (2023a) STOTEN publlshed online

General points of discussion

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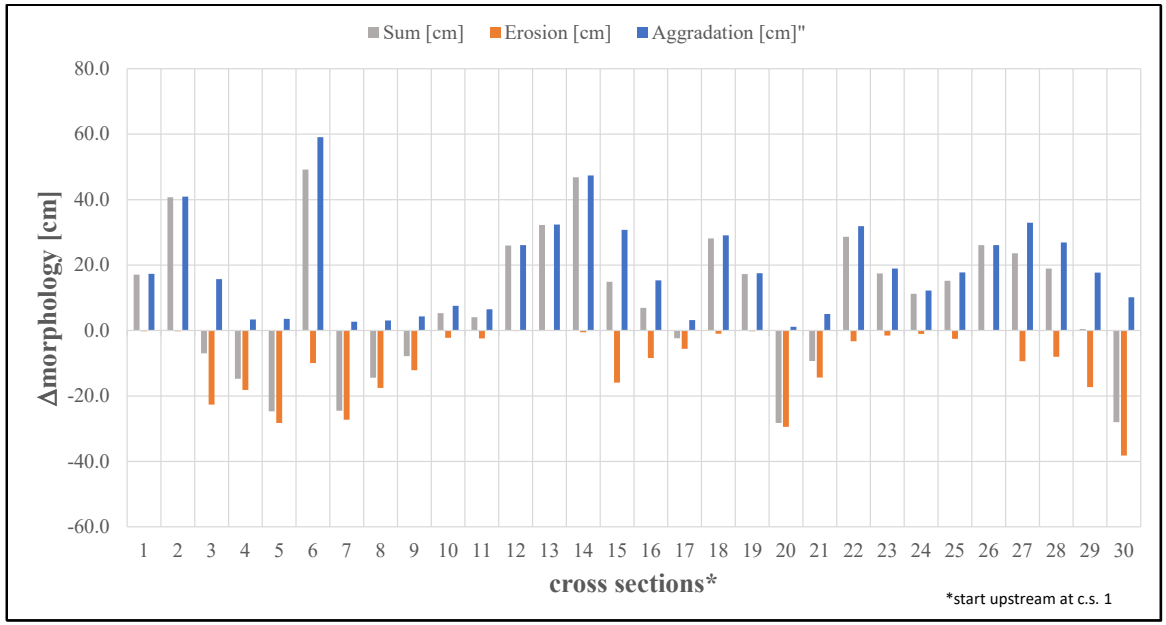
Results:



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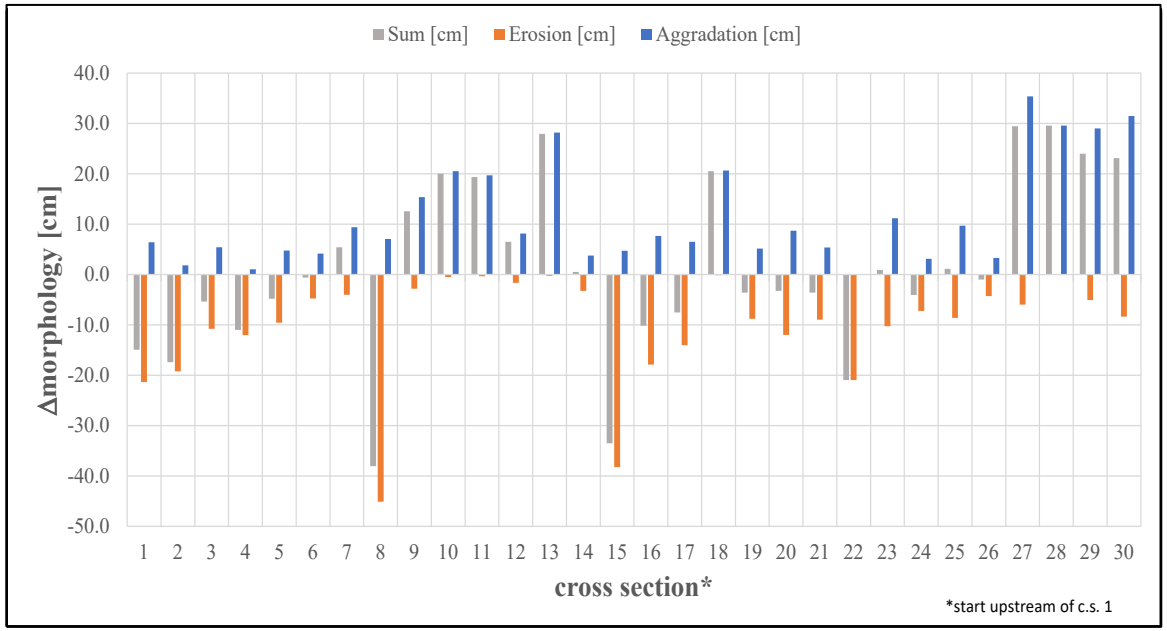

Bregenzerach

Periods:

1995 - 2005

2005 - 2009

2009 - 2011

2011 - 2013

Hauer *et al.* (2023a) STOTEN publlshed online

General points of discussion

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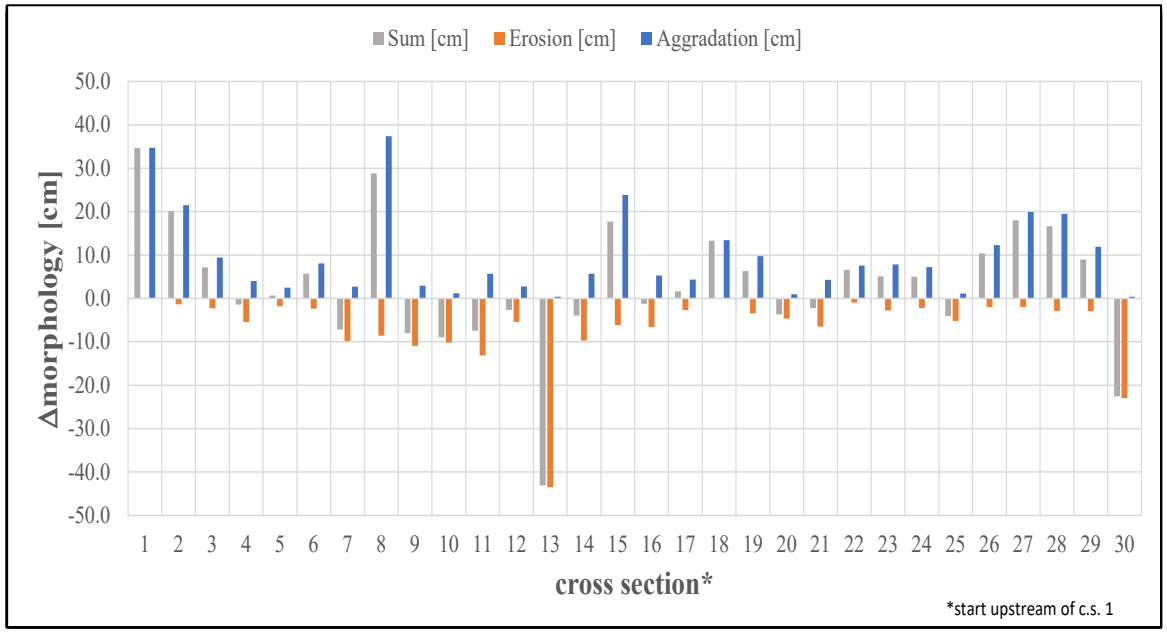
Results:



Bregenzerach

Periods:

1995 - 2005
2005 - 2009
2009 - 2011
2011 - 2013
2013 - 2015

Hauer *et al.* (2023a) STOTEN publlshed online

General points of discussion

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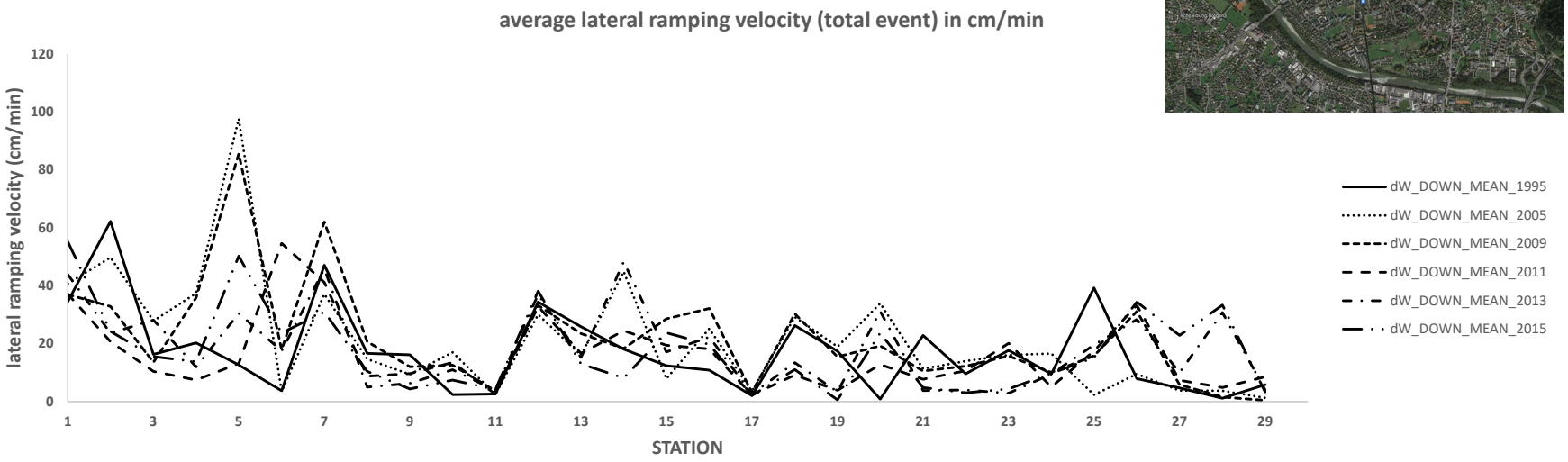
Results:

Bregenzerach



➡ **no significant changes according to the stranding risk**

Hauer *et al.* (2023a) STOTEN publlshed online

Summary & Conclusions

- ***Hydraulic stable habitat conditions*** in different qualities for the ***sensitive*** and ***potential bottleneck life stages*** of fish are possible for alpine rivers ***independent of the morphological type*** (straight vs. alternating gravel bars).

- ***Hydraulic stable habitat conditions only occur*** if a certain ***habitat quality*** is ***given during base flow conditions***. In terms of heavily regulated river morphology and high natural base flow (e.g. summer) the availability of hydraulic stable habitats decreases to almost zero.

- ***The quantity*** of ***hydraulic stable habitat conditions*** was related to the ***changes in discharge during peak flow*** in relation to the ***bankfull width*** independent of the morphological type. This means for restoration, that river ***widening in combination with a near-natural habitat composition during base flow is mandatory*** and should be target to ***increase the availability of hydraulic stable habitat conditions*** and to overcome the need for ***larvae and juvenile fish*** to ***shift actively*** into the ***dewatering areas*** and thus having the ***risk for stranding***.

Thank you for your attention!