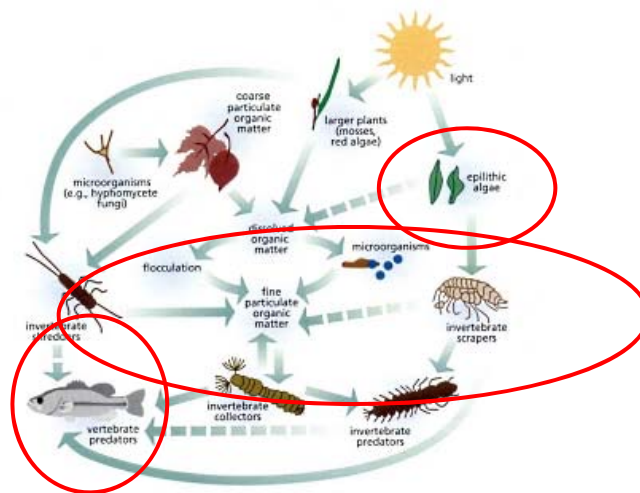


## Assessing ecological impacts of hydropеaking in Austrian rivers

Stefan Schmutz, Stefan Auer, Elisabeth Bondar-Kunze, Christian Feld, Wolfram Graf, Franz Greimel, Thomas Hein, Lisa Schülting, Günther Unfer, Bernhard Zeiringer

Institute of Hydrobiology and Aquatic Ecosystem Management  
Department of Water, Atmosphere and Environment  
BOKU - University of Natural Resources and Applied Life Sciences,  
Vienna, AUSTRIA

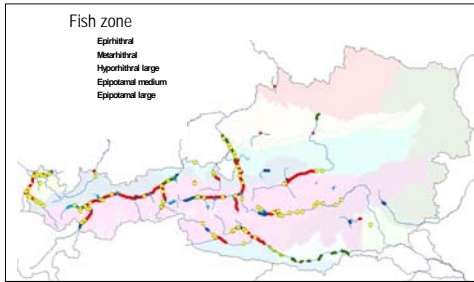
## Hydropеaking impacts on foodweb



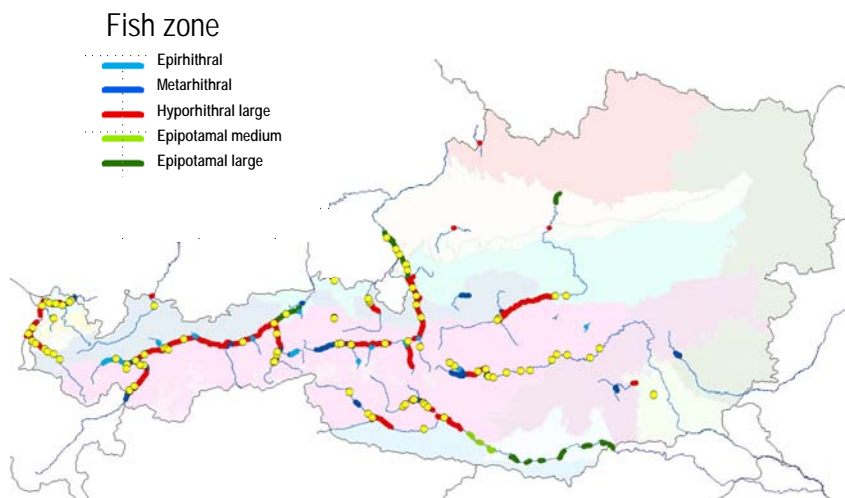
[http://www.leafpacknetwork.org/lpn/img/t2s\\_fig1.jpg](http://www.leafpacknetwork.org/lpn/img/t2s_fig1.jpg)

Field studies  
Austrian wide

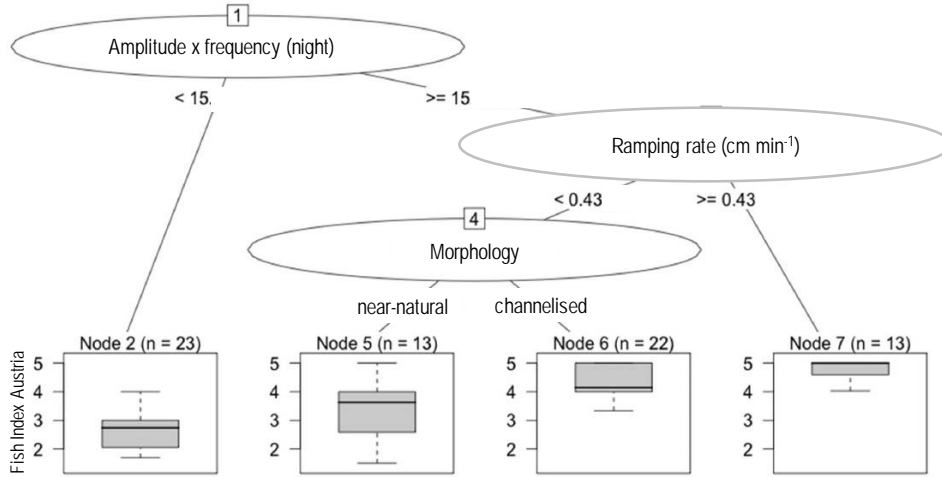
Experimental channel  
HyTEC



Fish sampling sites in hydropeaking river sections in Austria



*Empirical model:  
FIA vs. hydromorphological variables*



adapted from Schmutz et al. 2013

**Case study Drava river**

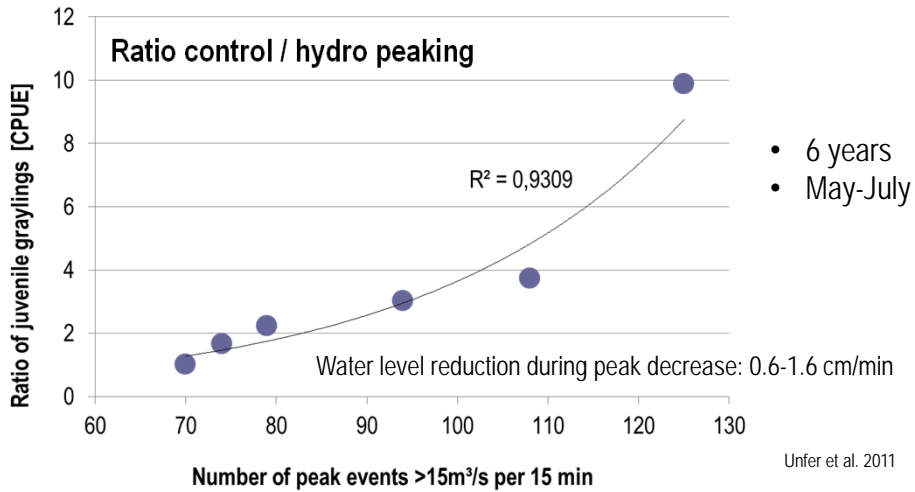


Unfer et al. 2011

## Response of juvenile grayling to multiple peak events in Drava river



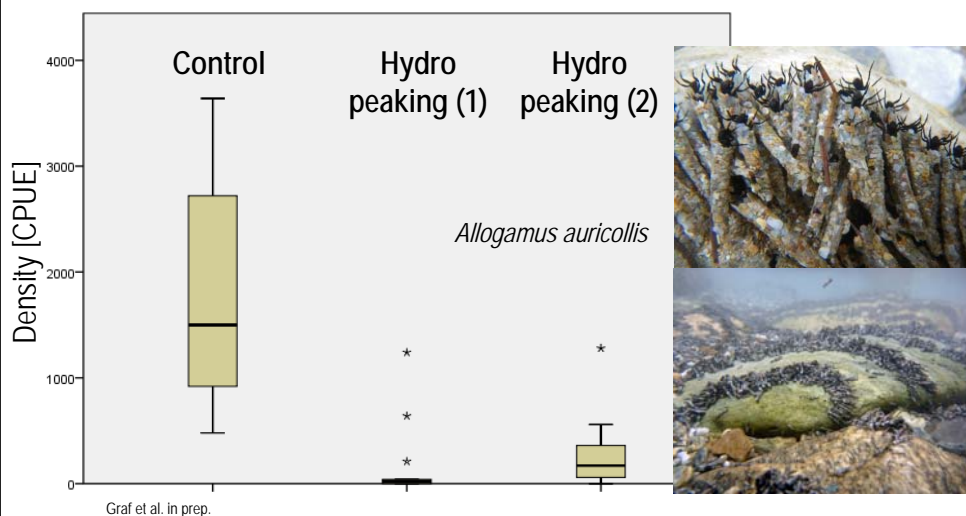
www.boku.ac.at/lhg



## Response of benthic invertebrates to hydro peaking – Enns River



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## Experiments



[www.boku.ac.at/lhg](http://www.boku.ac.at/lhg)

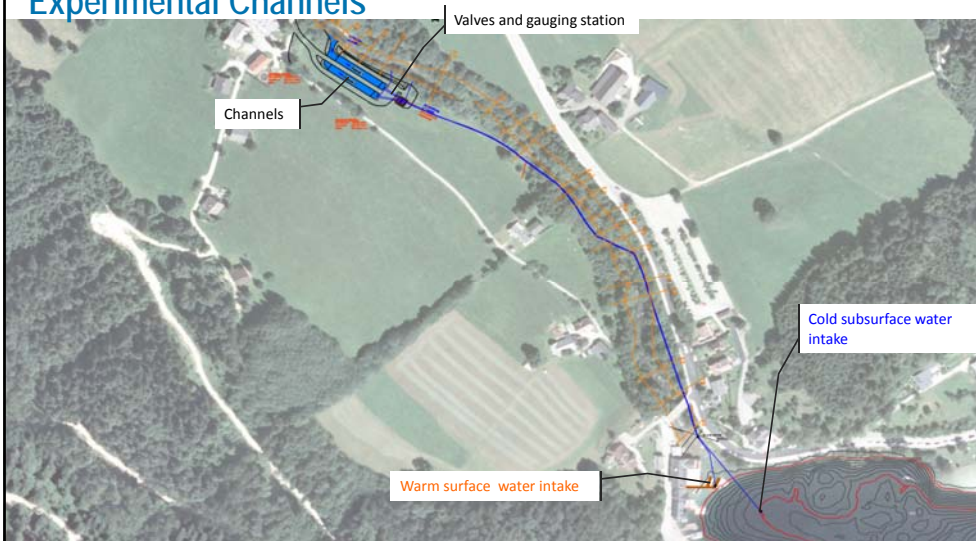
## HyTEC facility in Lunz am See



## HyTEC – Hydromorphology and Temperature Experimental Channels



[www.boku.ac.at/lhg](http://www.boku.ac.at/lhg)



## Experiments with benthic algae

### Benthic algae - Experimental setup

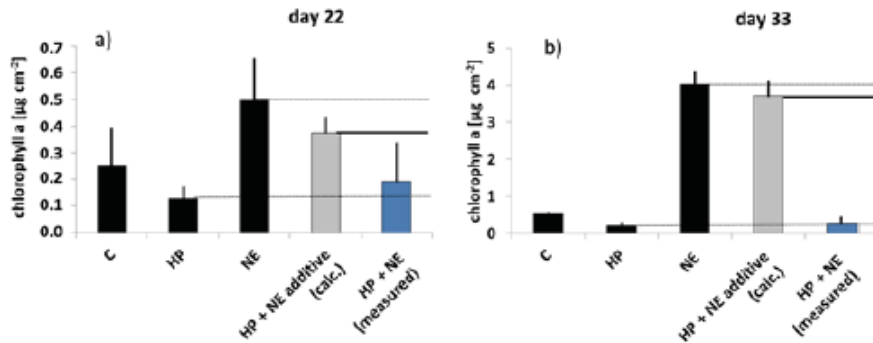
- Treatment flumes: 1 time a day hydropeaking event (duration of 60 minutes)
- Control flumes: same morphological settings as treatment flume, but no hydropeaking, only base flow
- each flume is divided in 3 sub-flumes = 3 replicates with 2 pool and 2 riffle sequences to obtain patches with different current flow velocities
- peak flow velocities between 1 and 1.5 m s<sup>-1</sup> (base flow ~ 0.2 m s<sup>-1</sup>)



## Results benthic algae



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- One hour of hydropeaking each day cancelled out any potential algal growth following nutrient enrichment.
- For multiple stressor studies the time factor (successional stage), frequency of the stressors (pulsed or continuous impact) and community composition is important.

Bondar-Kunze et al (2016): Science of The Total Environment 573 (594-602)

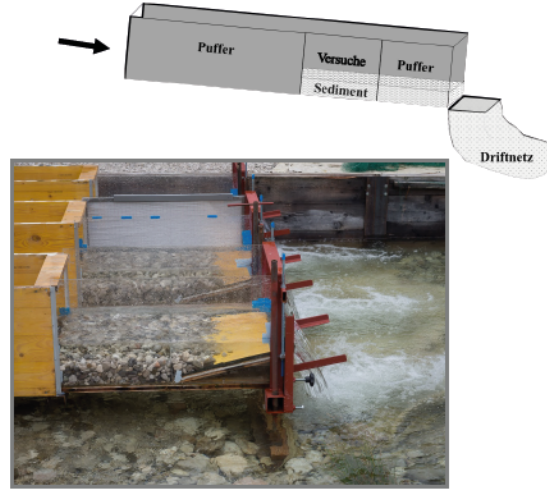
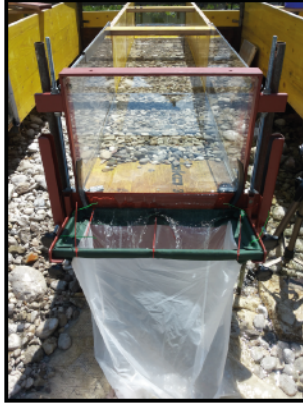


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## Experiments with benthic invertebrates

## Benthos

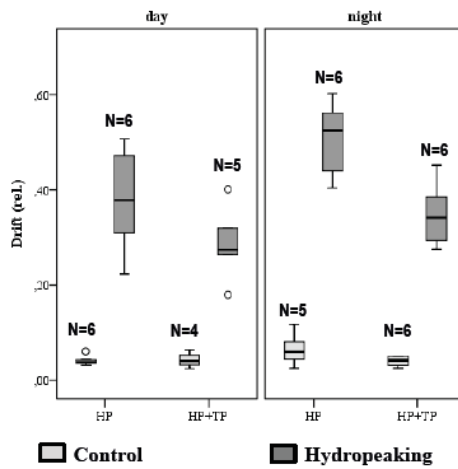
### Flumes



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## Benthos

### Drift in Controls and Treatments



• **Significant higher drift** during hydropeaking and night

• **Reduced drift** when hydropeaking is combined with thermopeaking

Schülting et al. 2016



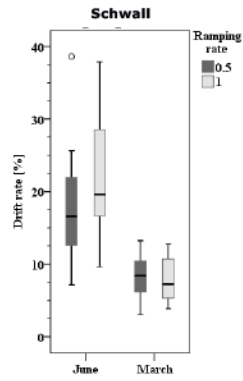
www.boku.ac.at/ihg

## Benthos

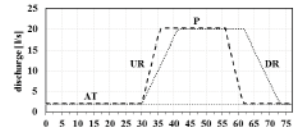


[www.boku.ac.at/ihg](http://www.boku.ac.at/ihg)

### Drift during upramping

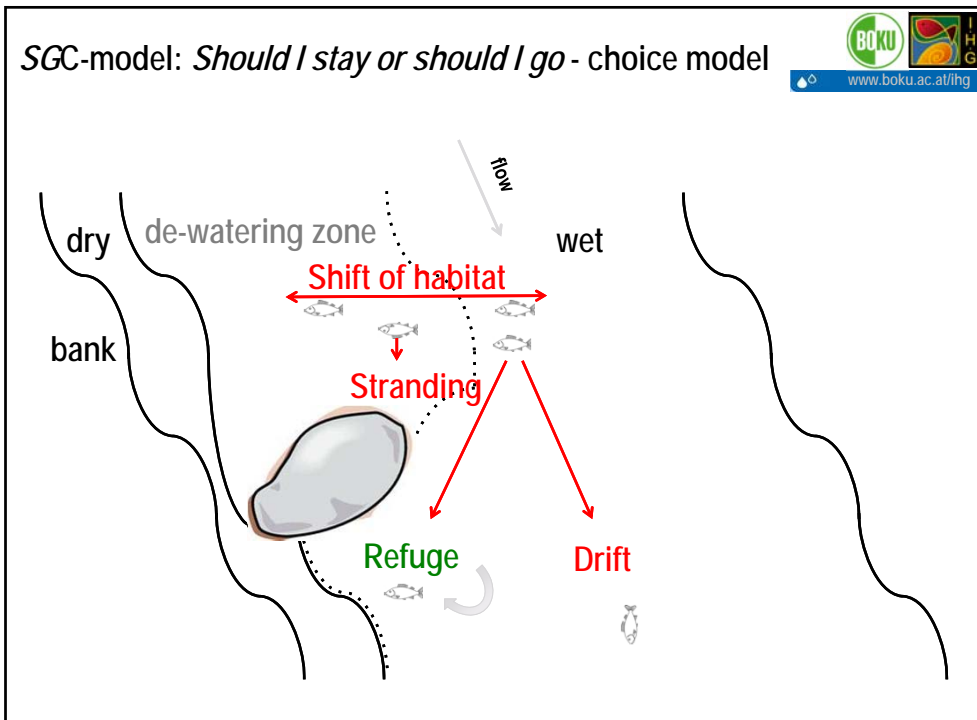
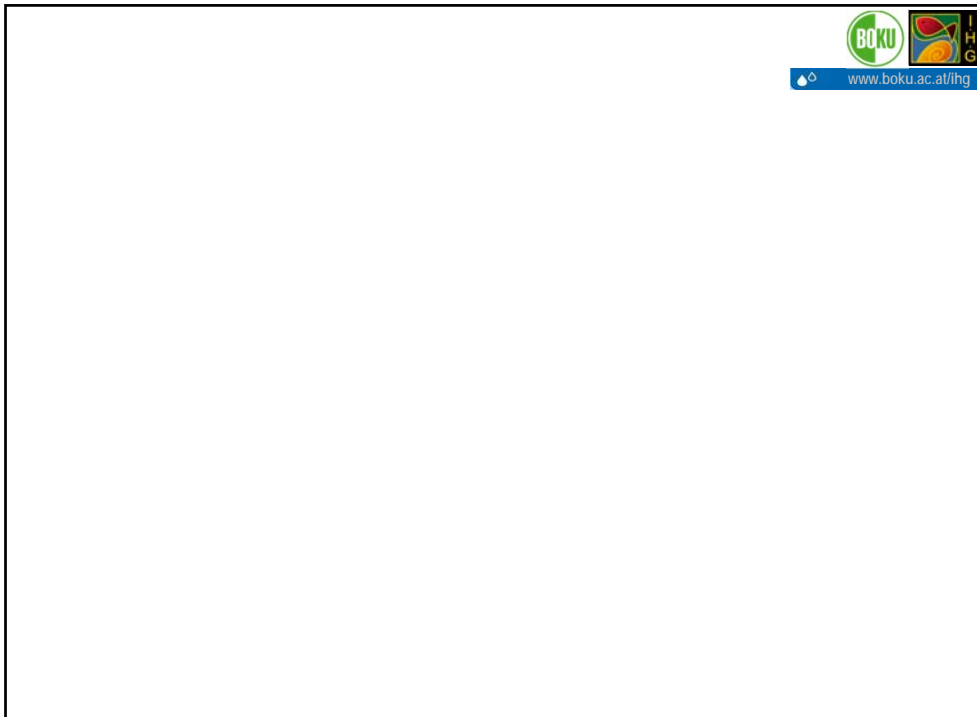


- *Effects of reduced upramping rate depend on season*



[www.boku.ac.at/ihg](http://www.boku.ac.at/ihg)

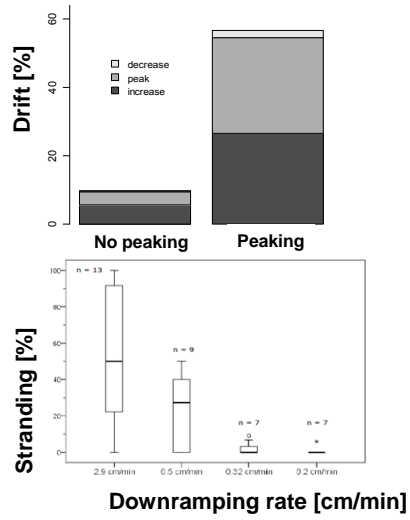
## Experiments with fish



## Drift and stranding of larval grayling



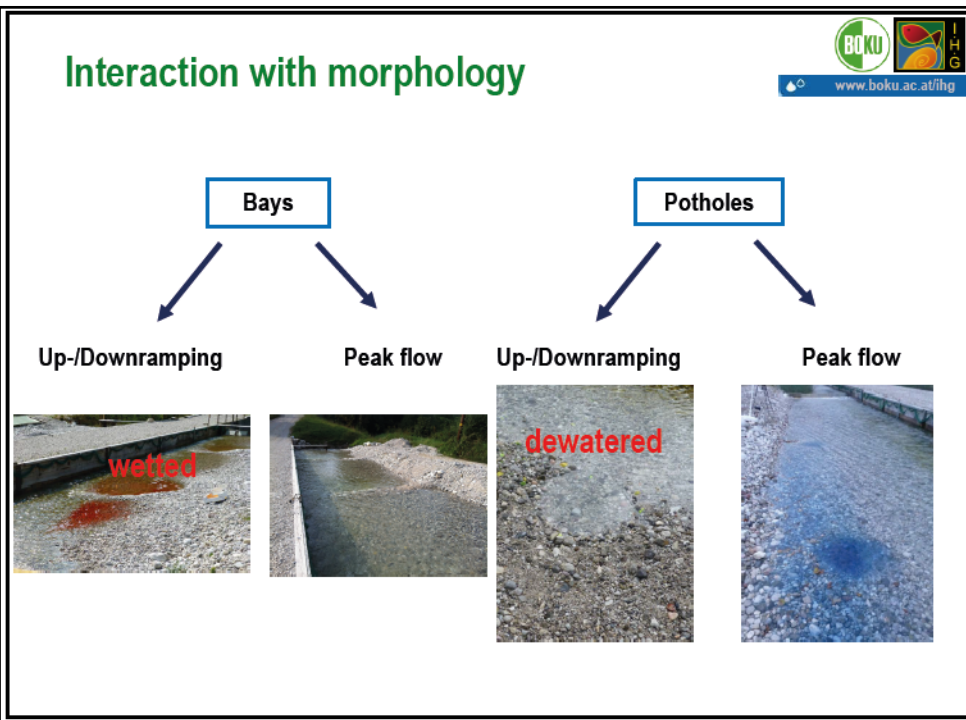
www.boku.ac.at/ihg



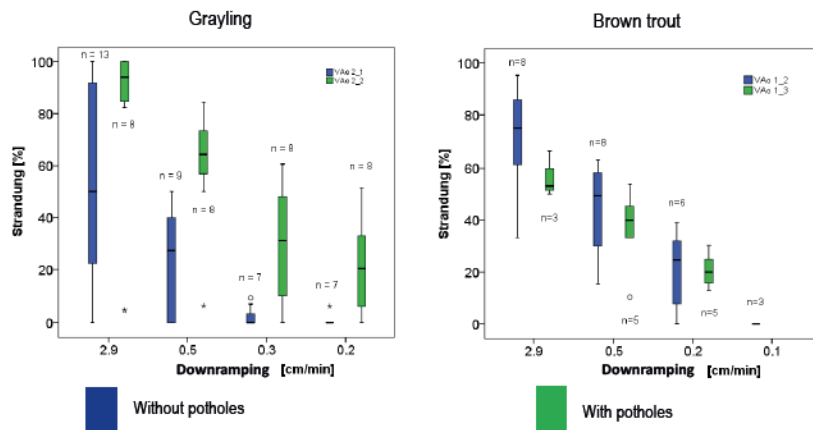
## Interaction with morphology



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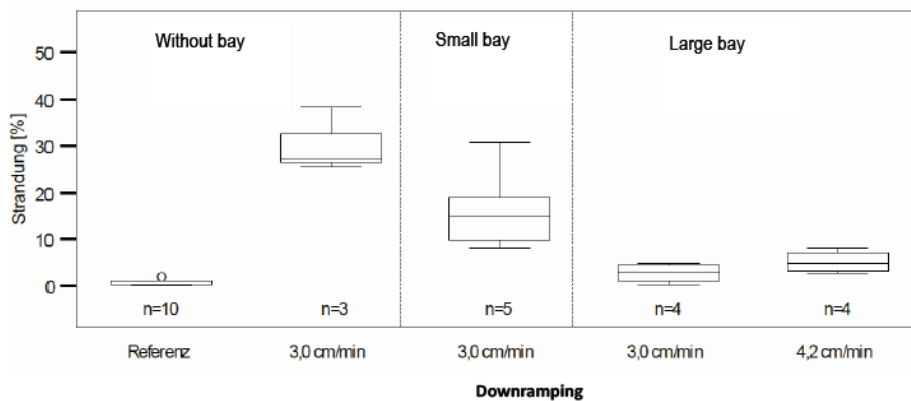


## Stranding of larvae in potholes



■ Potholes increase stranding of grayling

## Stranding of larvae in bays

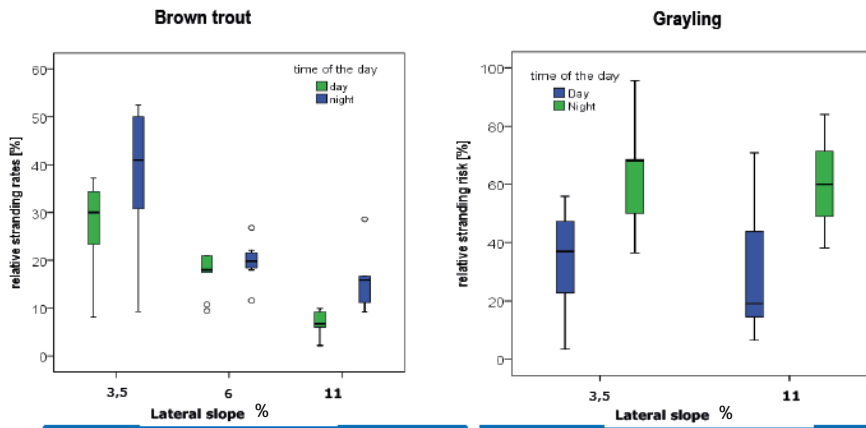


■ Reduced stranding in bays

## Effects of river bank inclination & photoperiod on larvae stranding



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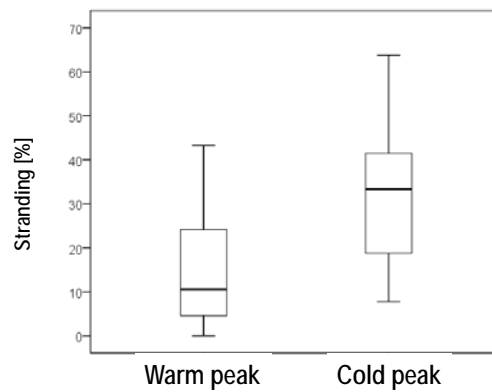
▪ Stranding linked to bank inclination

▪ Stranding linked to photoperiod

## Thermopeaking juvenile grayling



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▪ Stranding risk with cold peak significantly higher

## Summary fish



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### Larvae

- High drift and stranding risk already with low downramping rates (>0.1-0.2 cm/min)
- Attractive habitat structures without continuous connection to main channel (potholes) create **traps** for fish (grayling)
- Permanent connected habitats represent **refuge habitats** and reduce stranding risk.
- Higher risk during night

### Juvenile

- In general, lower drift- und stranding risk
- However,
  - during night still stranding risk
  - Potholes represent **traps** at high downramping rate
  - Lower bank gradient increases stranding risk (brown trout)
- Thermopeaking (decrease of temperature) increases drift and stranding risk (grayling)

## SUMMARY



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### S...stranding, D...drift, P...production

	Hydropeaking		Interaction with					
	Up-ramping	Down-ramping	Photoperiod	River morphology	Sediment	Water temperature	Nutrients	Long term effects
Benthic algae		↓ P	-	?	?	?	↓ P	↓ P

## SUMMARY



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### S...stranding, D...drift, P...production

	Hydropeaking		Interaction with					
	Up-ramping	Down-ramping	Photoperiod	River morphology	Sediment	Water temperature	Nutrients	Long term effects
Benthic algae	↓ P		-	?	?	?	↓ P	↓ P
Macro-invertebrates	↑ D	↑ S	Night ↑ D	?	?	(↓ T ⇒ ↓ D)	?	?

## SUMMARY



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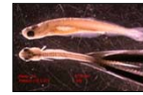
### S...stranding, D...drift, P...production

	Hydropeaking		Interaction with					
	Up-ramping	Down-ramping	Photoperiod	River morphology	Sediment	Water temperature	Nutrients	Long term effects
Benthic algae	↓ P		-	?	?	?	↓ P	↓ P
Macro-invertebrates	↑ D	↑ S	Night ↑ D	?	?	(↓ T ⇒ ↓ D)	?	?
Fish (trout,graying)	↑ D	↑ S	Night ↑ S	↑ S, ↓ S	?	(↓ T ⇒ ↑ S, ↑ D)	?	?

## Open questions fish species and life stages

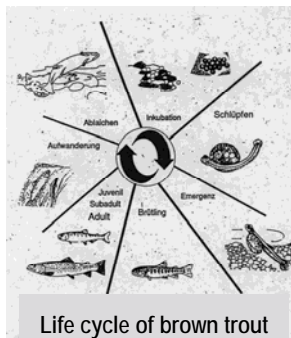
### Fish species

- ✓ Brown trout
- ✓ Grayling
- Bullhead
- Cyprinids



### Life stages

- Spawning
- Eggs
- ✓ Larvae
- ✓ Juvenile (0+ life stage)
- Subadult
- Adult



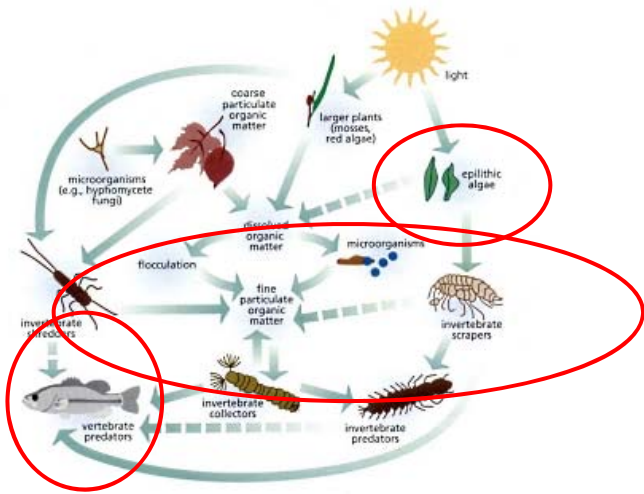
## Open questions benthos

- Upramping
  - Ramping rates
  - Larval stages
  - Substrate
- Peak flow
  - Taxa specific sheer stress limits
- Stranding

# Hydropeaking impacts on foodweb



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[http://www.leafpacknetwork.org/lpn/img/t2s\\_fig1.jpg](http://www.leafpacknetwork.org/lpn/img/t2s_fig1.jpg)

HyTEC  
Hydromorphological and Temperature Experimental Channel



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In Cooperation with



lebensministerium.at  
Bundesamt für Wasserwirtschaft  
Institut für Wasserbau und hydrometrische Prüfung



Thank's to

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