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## Effect of water velocity on the drift probability of the preferred prey taxa of young salmonids: a laboratory study

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Annual Meeting  
11 – 14 December 2016  
Liverpool, United Kingdom

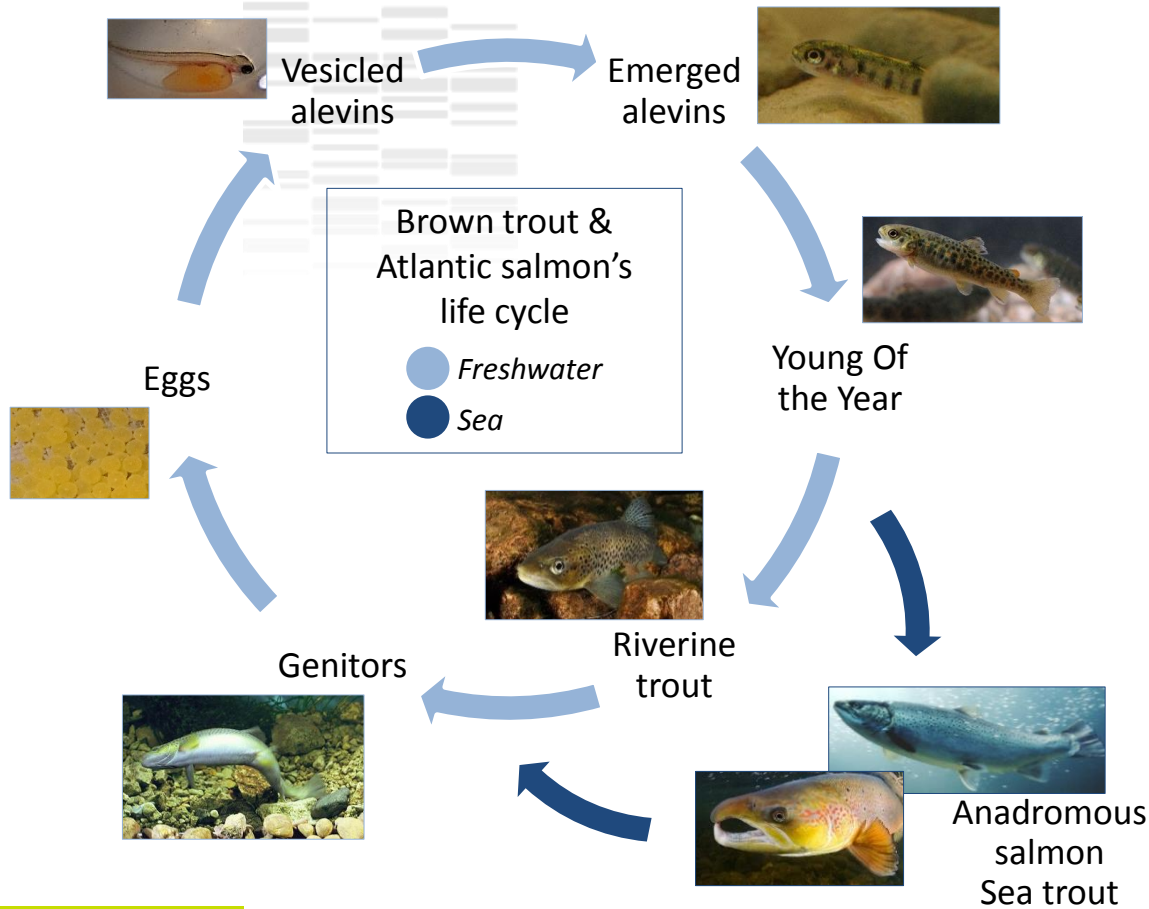
Effect of water velocity on the drift probability of  
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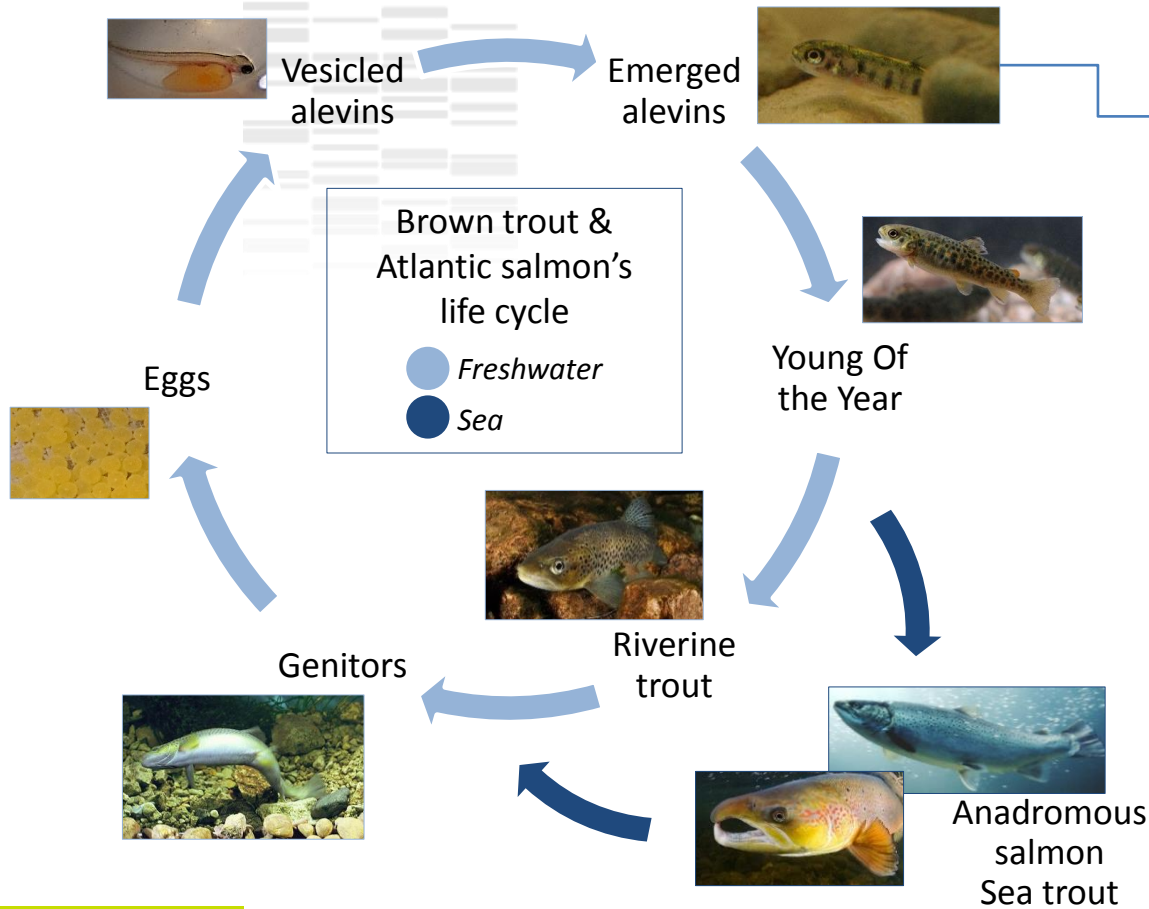


**Elorri AREVALO, Aitor LARRAÑAGA, Margaret LANG, Etienne PREVOST  
& Agnès BARDONNET**

Technical support from: COSTE Pascale, GUERAUD François, HUCHET Emmanuel, RIVES Jacques







**EMERGENCE:  
a critical stage**  
~ March/April

**Behavioural and physiological changes**

- Endogenous → exogenous feeding
- Competition for territory
- Predator vulnerability

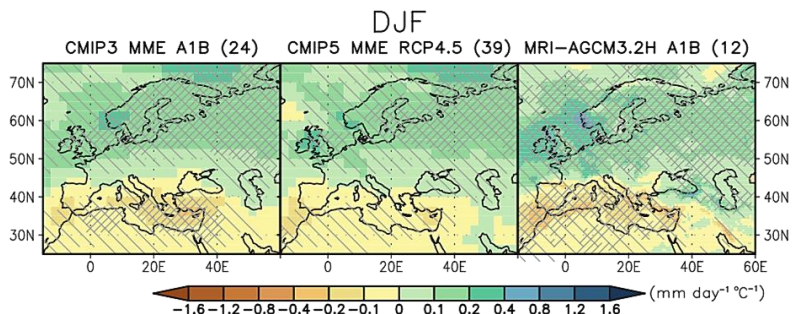
To ↑ growth and survival, alevins have to emerge

- When macroinvertebrate larvae are present at **high densities**
- When **well-sized** prey are available



# CLIMATE CHANGE

Atlantic coast of Europe:  
↑↑ precipitations in  
winter/spring



Maps of **precipitation changes** for Europe and Mediterranean in 2080–2099 in **December to February** – 3 scenarios: SRES A1B (left), RCP4.5 (middle) and SRES A1B (right).

IPCC, 2014



# CLIMATE CHANGE

Atlantic coast of Europe:  
↑↑ precipitations in winter/spring

Freshwater ecosystems

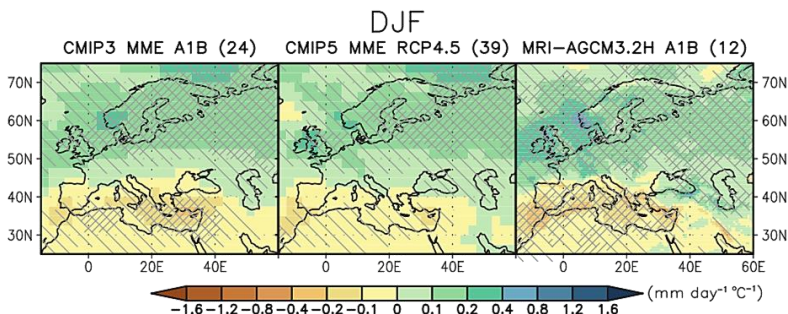
## FLOW

**Key variable:**

- *Geomorphology, habitat*
- *Organisms distribution*

↑↑ frequency and intensity of floods

↑↑ mean discharge



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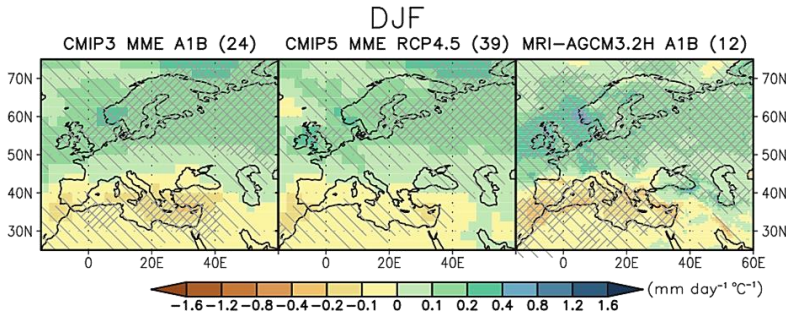
**Key variable:**

- *Geomorphology, habitat*
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↑↑ frequency and intensity of floods

↑↑ mean discharge ?

**Disruption of stream biota**



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**BES Annual Meeting**

11 – 14 December 2016

Liverpool, United Kingdom

**Elorri AREVALO**

PhD Student – ECOBIOP

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**Extreme hydrological events**

↑↑ frequency & intensity of FLOODS

*CLIMATE CHANGE*

**Macroinvertebrates:**  
Main food items of many  
running-water salmonids

↓↓ abundance and diversity

Up to 95%

Argerich et al., 2004  
Mesa, 2010  
Mundahl & Hunt, 2011  
Robinson et al., 2014





Extreme hydrological events

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CLIMATE CHANGE

### Macroinvertebrates:

Main food items of many running-water salmonids

Argerich et al., 2004  
Mesa, 2010  
Mundahl & Hunt, 2011  
Robinson et al., 2014

↑↑ average flow level  
& water velocity

Effects on communities??  
Lack of knowledge for non-scouring floods

Theodoropoulos et al., 2017



Extreme hydrological events

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CLIMATE CHANGE

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### Our Objectives

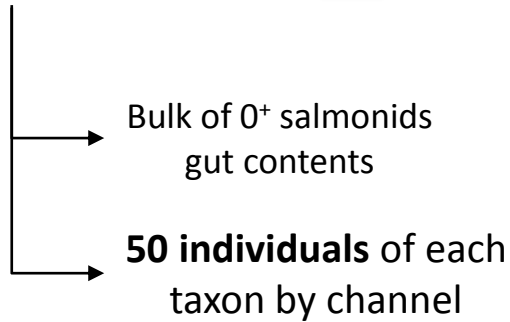
Propensity of invertebrates to drift/be scoured according to:

- Taxon?
- Water velocity?
- Gravel bed quality?
- Individual size?

Infer consequences on food availability for fish

### 3 invertebrate taxa distributed in 6 experimental channels:

- *Baetis sp.*
- *Simulium sp.*
- *Chironomus sp.*

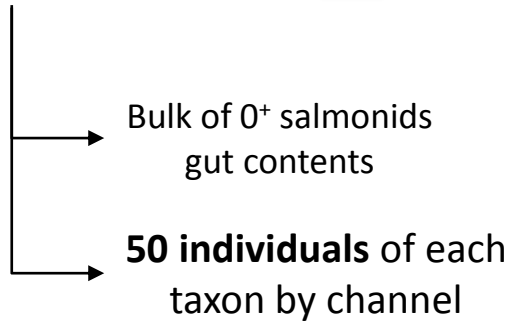


### 3 invertebrate taxa distributed in 6 experimental channels:

- *Baetis sp.*
- *Simulium sp.*
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- 3 modalities of **near-bed** water velocity
- 2 types of gravel



**High velocity**

$\sim 40 \text{ cm.s}^{-1}$

**Medium velocity**

$\sim 30 \text{ cm.s}^{-1}$

**Low velocity**

$\sim 15 \text{ cm.s}^{-1}$

*Law of the wall:*  
 $1 < \text{Water column velocity} < 4 \text{ m.s}^{-1}$

Fine gravel



~ 25 cm

Coarse gravel

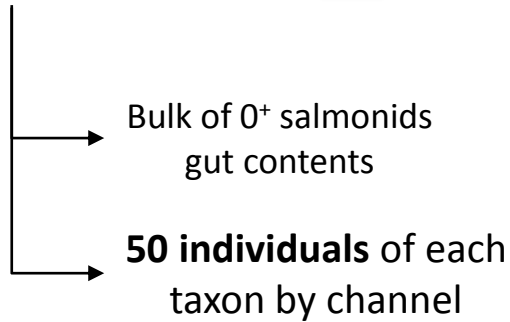


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2 trials: March & October 2015

*Law of the wall:*  
 $1 < \text{Water column velocity} < 4 \text{ m.s}^{-1}$

Experimental channels



❖ 24 H of experiment

❖ Drift samples

- Every hour
- Dawn + Dusk

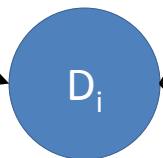
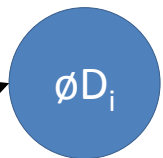
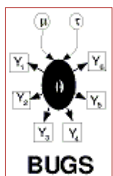
❖ At the end, recovery of remaining invertebrates



Invertebrate hunt







$D_i \sim \text{Bernoulli}(p.D_i)$

$$\text{Logit}(p.D_i) = \mu_{j[i]} + \alpha_{j[i]} V_i + \beta_{j[i]} H_i + \gamma_{j[i]} HW.C_i + \delta_{k[i]}$$

3 chains

Burn-in: 10 000 iterations

10 000 iterations ; thin = 10

Mean drift probability?

$\mu_{j[i]}$

Biotic factors

Individual size?

Head capsule widths (mm)

$V_{j[i]}$

Gravel bed quality?

Coarse vs. Fine

$\beta_{j[i]}$

Abiotic factors

Water velocity?

Near-bed velocities (cm.s<sup>-1</sup>)

$\alpha_{j[i]}$

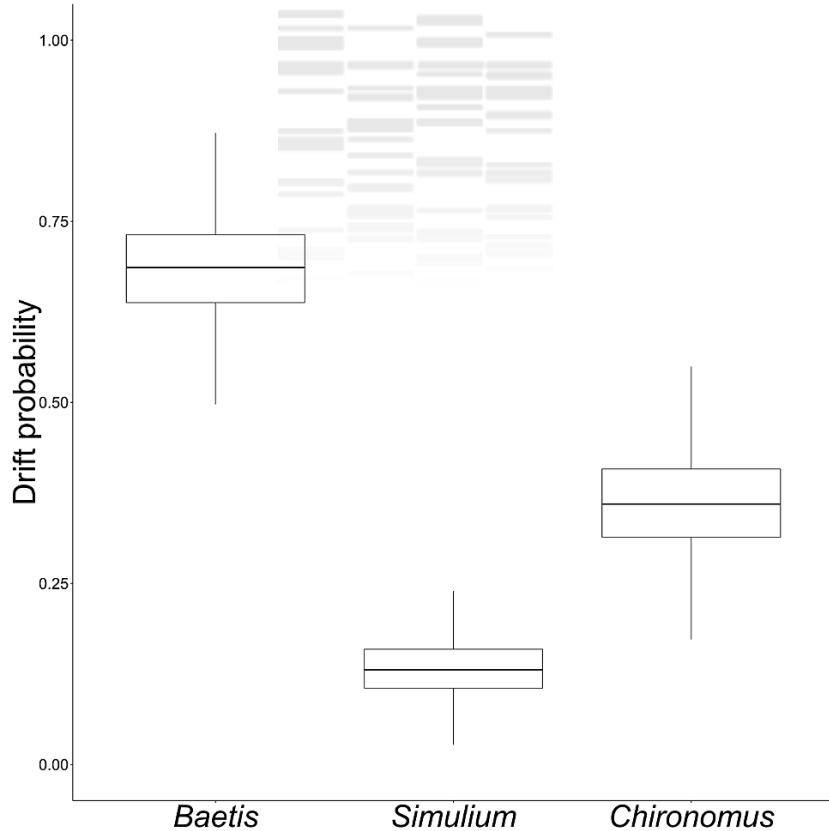
Other unexpected sources of variation?

$\delta_{k[i]}$

Taxon







Estimates of drift probabilities of the three invertebrate taxa undergoing a water velocity of  $30 \text{ cm.s}^{-1}$  in a fine substrate for medium width individuals.

❖ Results resonate with taxa's **ecological features**

❖ **Baetis**

- Located above the gravel bed
- Exposed to the current
- Highest drift probability



❖ **Simulium**

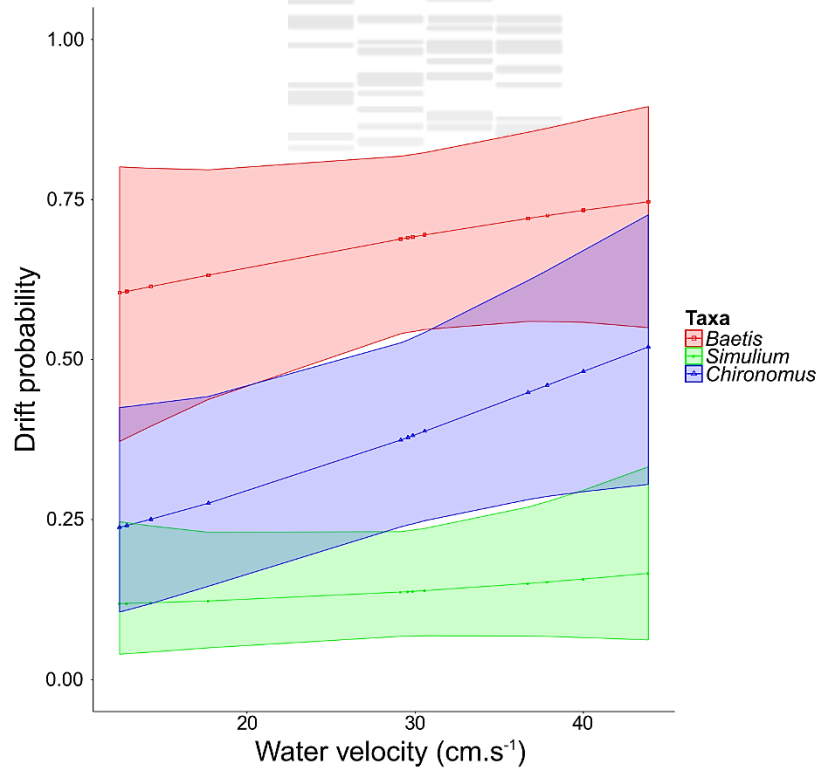
- Most rheophilic taxon
- Able to withstand high flows
- Lowest drift probability



❖ **Chironomus**

- Buried in the substrate
- No morphological adaptations to cope with flow





## ❖ Results resonate with taxa's ecological features

### ❖ *Baetis*

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### ❖ *Simulium*

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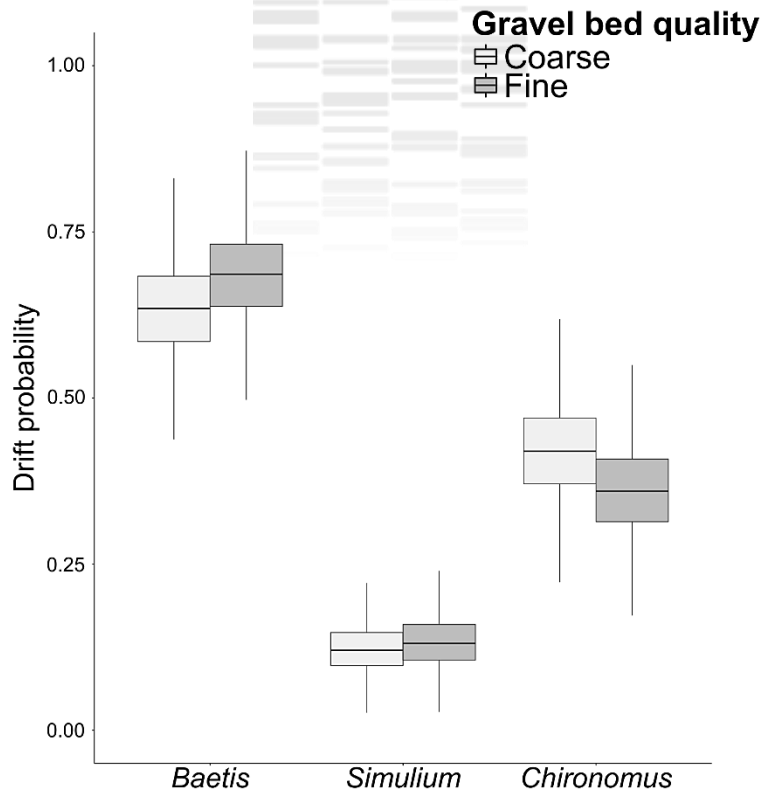
### ❖ *Chironomus*

- Buried in the substrate
- No morphological adaptations to cope with flow



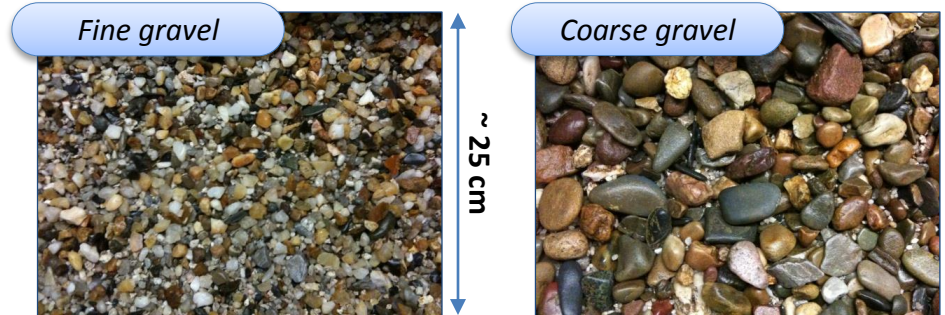
## ❖ Only *Chironomus* drifted significantly more when water velocity increased

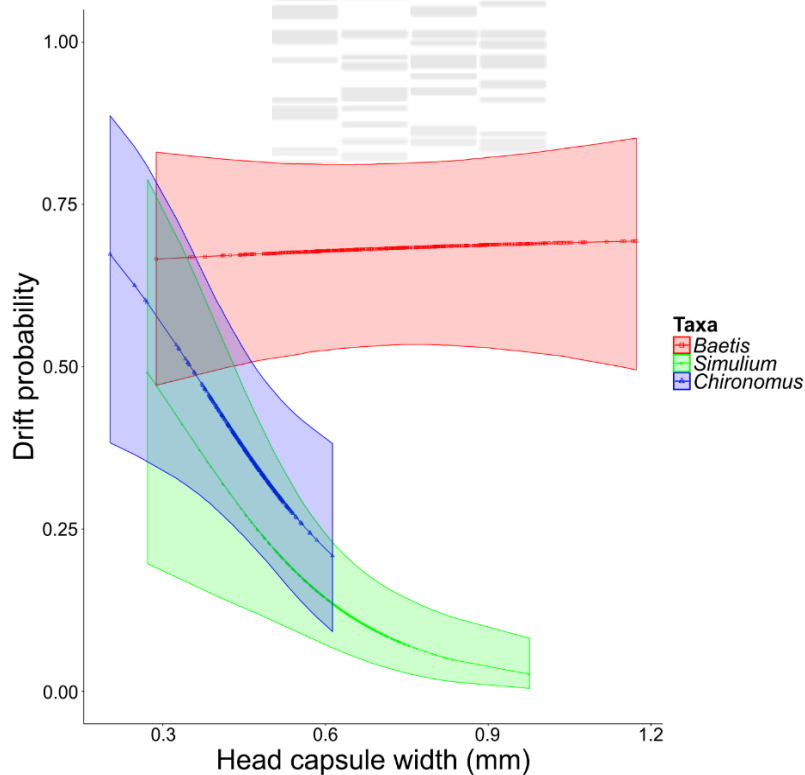
Estimates of the drift probabilities of the three invertebrate taxa according to water velocity (cm.s<sup>-1</sup>) in a fine substrate for medium width individuals.



Estimates of drift probabilities of the three invertebrate taxa according to gravel bed quality for mean width individual and mean water velocity.

- ❖ No significant differences
  - Granulometry = first-feeding trout areas
  - No dissimilarity in sheltering opportunities



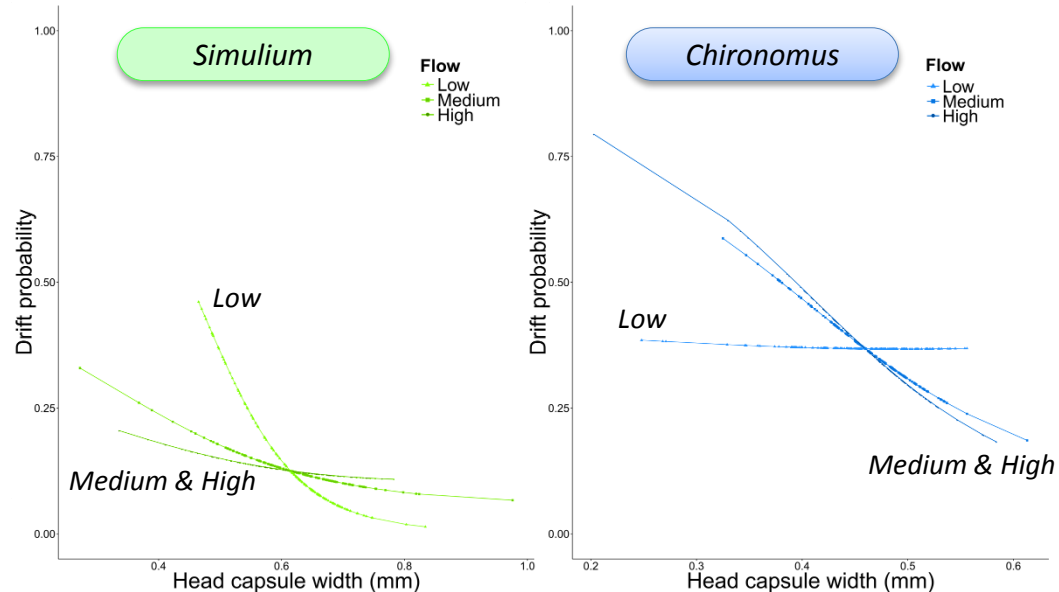


Estimates of the drift probabilities of the three invertebrate taxa according to head capsule width (mm) in a fine substrate and mean water velocity.

## ❖ Nothing for *Baetis*

## ❖ Small individuals drifting more

- *Simulium*: high organic concentration needed to optimize their food acquisition?
- *Chironomus*: not able to resist the drag force of the current? Carried away by flow?



## To sum up ...

Mean drift probability

Water velocity  
[14 ; 40] cm.s<sup>-1</sup>

Gravel bed

Individual size

*Baetis*

0.684

-

-

-

*Simulium*

0.128

-

-

Small individuals drift more

*Chironomus*

0.363

↗ water velocity  
↗ drift rate

-

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## To sum up ...

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### Implications for fish:

- ↘ of 2 preferred 0+ salmonids prey
  - Starvation?
  - Diet shifts?
  - Switch in the hunting mode?

Resilience?

Recolonisation?

### ↘ Growth & Survival

- ↗ foraging activity = ↗ locomotor costs
- ↘ food intake
- ↗ vulnerability to predation





Thank you for your attention!  
Any question?



Photo credit: Stéphane GLISE (INRA) & [www.arkive.org](http://www.arkive.org)  
*Baetis*: <http://www.dfg.ca.gov/abl/Reference/California/>  
*Simulium*: <http://www.west-fly-fishing.com/>  
*Chironomus*: <http://w3.marietta.edu/~biol/tol/insecta.html>

