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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

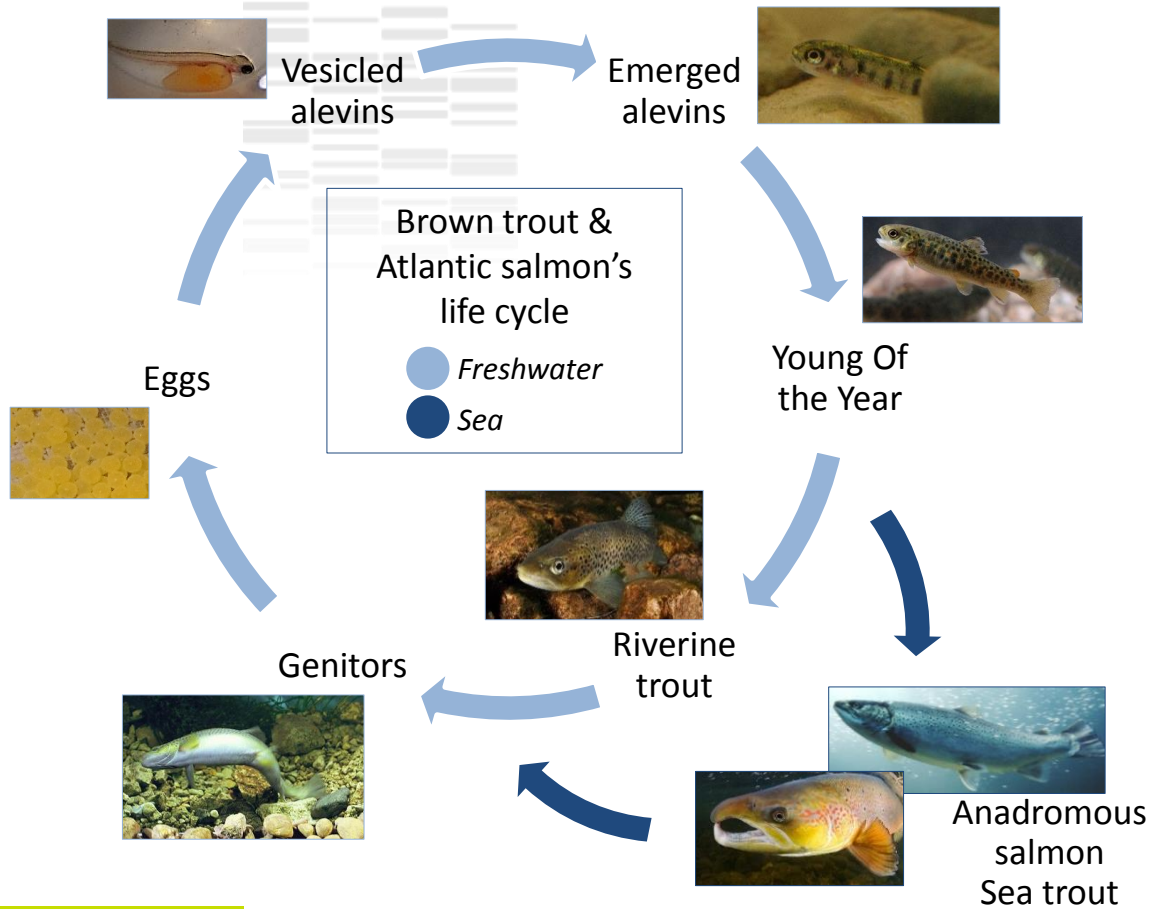
Effect of water velocity on the drift probability of
the preferred prey taxa of young salmonids:
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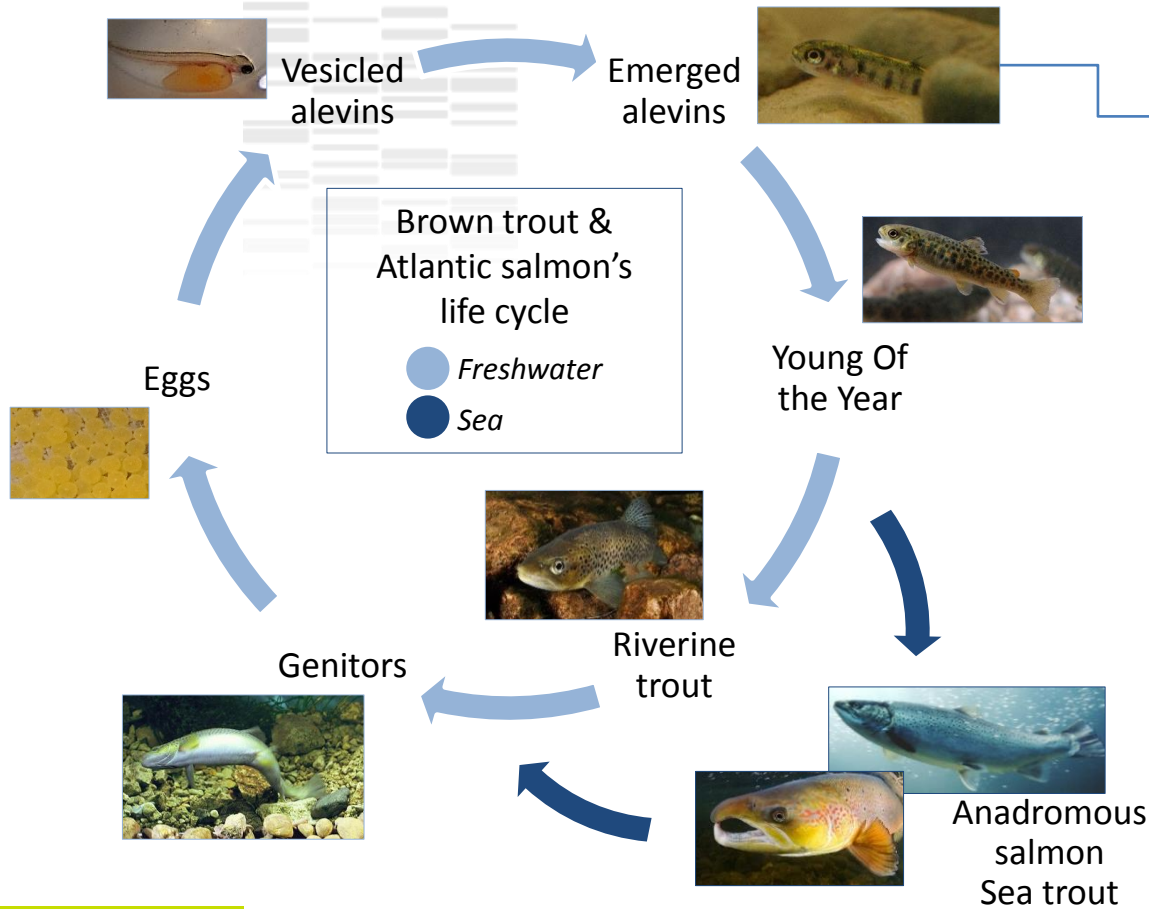


**Elorri AREVALO, Aitor LARRAÑAGA, Margaret LANG, Etienne PREVOST
& Agnès BARDONNET**

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

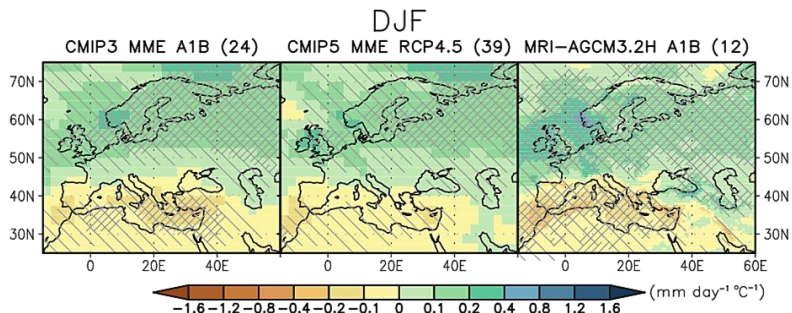
To ↑ growth and survival, alevins have to emerge

- 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:

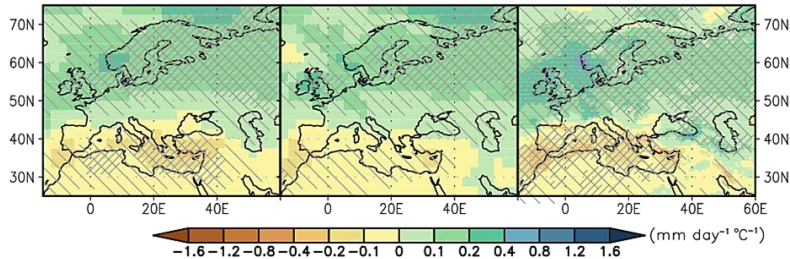
- *Geomorphology, habitat*
- *Organisms distribution*

↑↑ frequency and intensity of floods

↑↑ mean discharge

DJF

CMIP3 MME A1B (24) CMIP5 MME RCP4.5 (39) MRI-AGCM3.2H A1B (12)



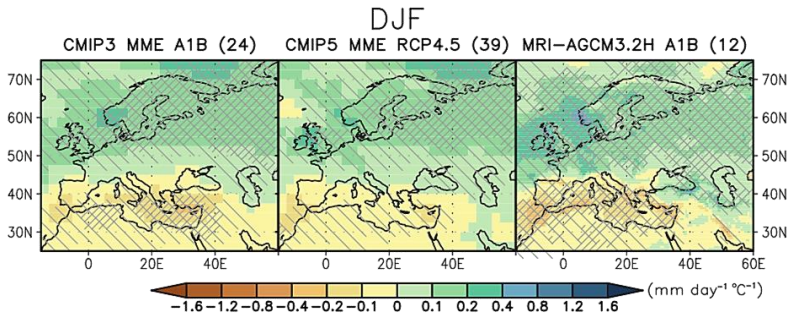
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- *Geomorphology, habitat*
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↑↑ frequency and intensity of floods

↑↑ mean discharge ?



Disruption of stream biota

BES Annual Meeting

11 – 14 December 2016

Liverpool, United Kingdom

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



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↑↑ average flow level
& water velocity

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

Theodoropoulos et al., 2017



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↑↑ frequency & intensity of FLOODS

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Our Objectives

Infer consequences
on food availability
for fish

Propensity of invertebrates to
drift/be scoured according to:

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

BES Annual Meeting

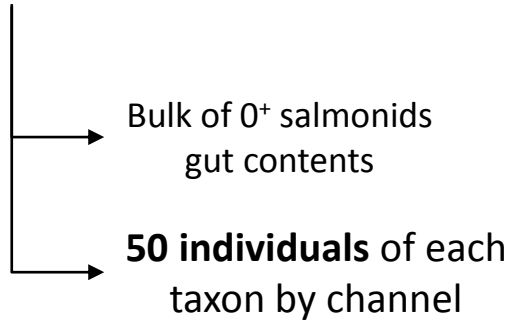
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3 invertebrate taxa distributed in 6 experimental channels:

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

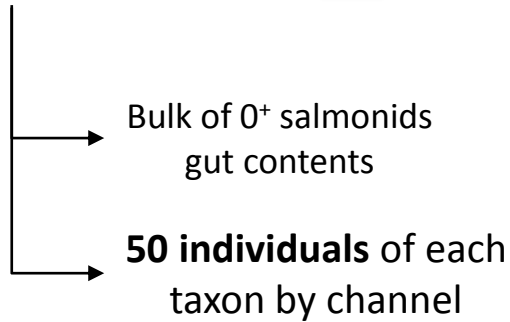


3 invertebrate taxa distributed in 6 experimental channels:

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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

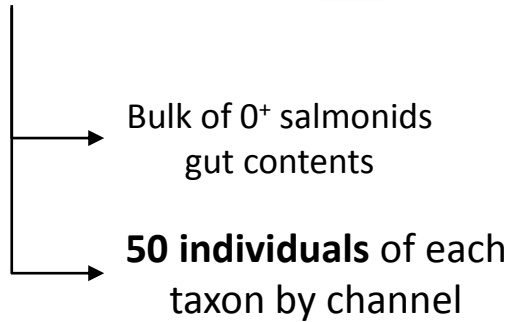


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2 trials: March & October 2015

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

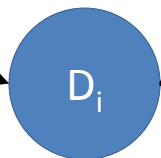
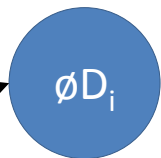
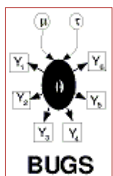
❖ At the end, recovery of remaining invertebrates



Drift samples



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^{-1})

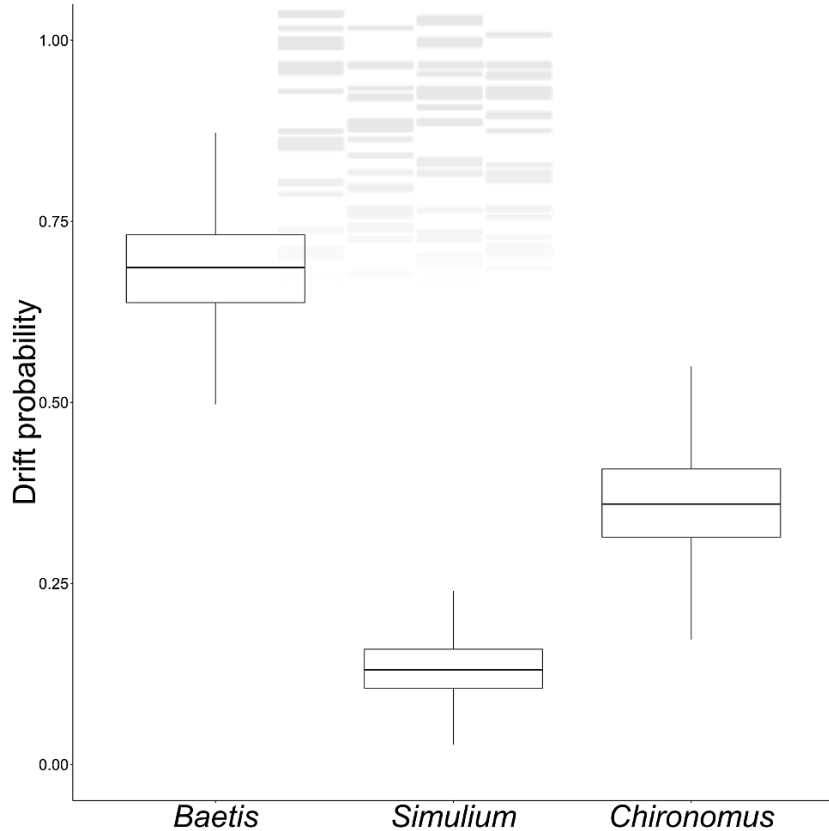
$\alpha_{j[i]}$

Other unexpected sources of variation?

$\delta_{k[i]}$

Taxon





Estimates of drift probabilities of the three invertebrate taxa undergoing a water velocity of 30 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**

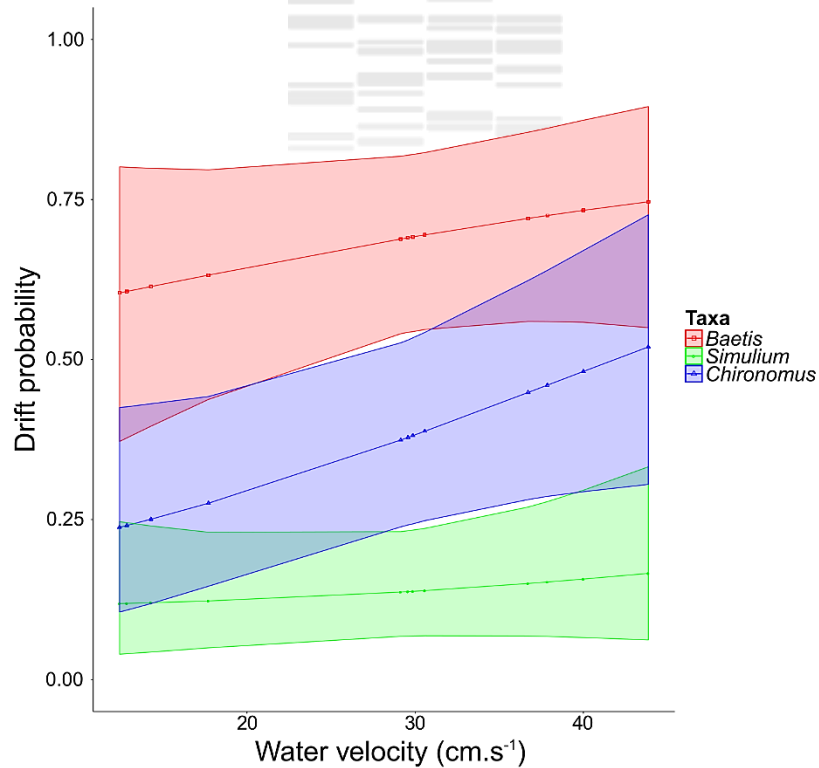
- Most rheophilic taxon
- Able to withstand high flows
- Lowest drift probability



❖ **Chironomus**

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





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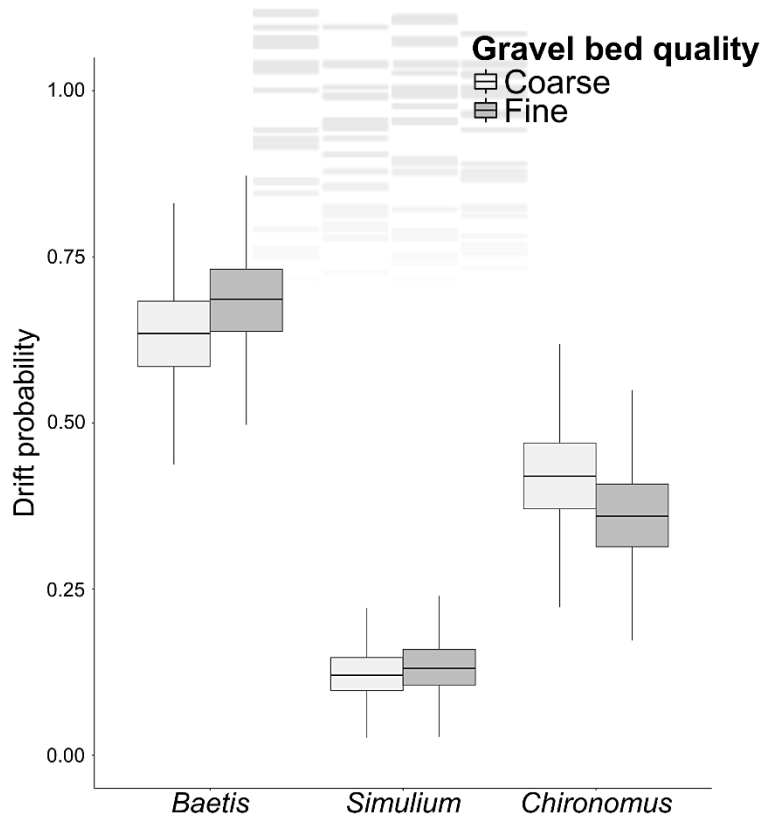
❖ **Chironomus**

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



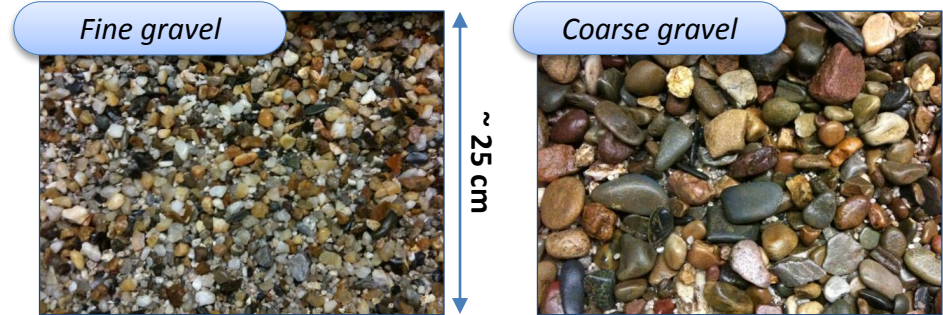
❖ Only **Chironomus** drifted significantly **more** when water velocity increased

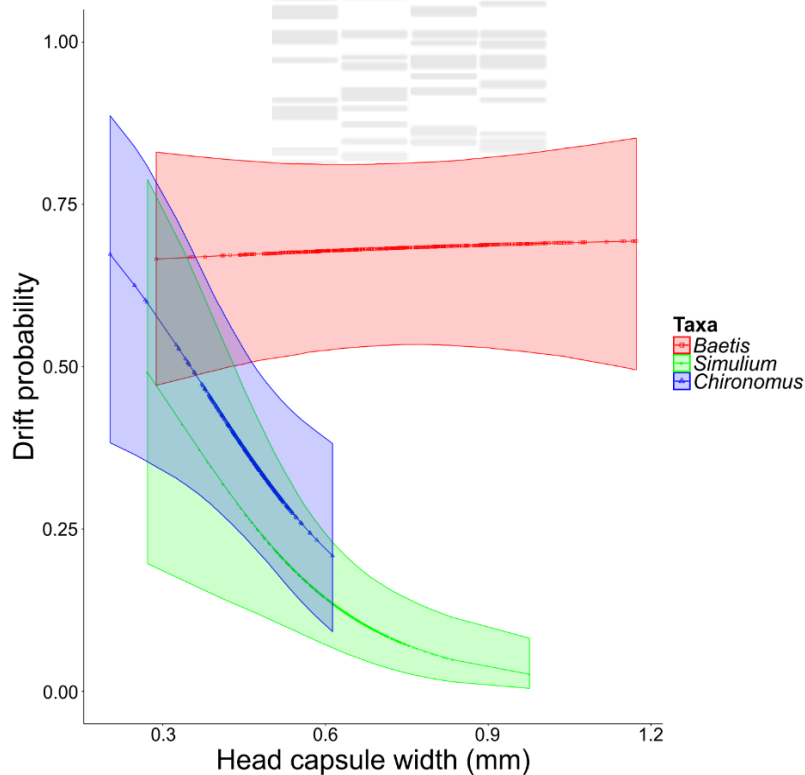
Estimates of the drift probabilities of the three invertebrate taxa according to water velocity (cm.s⁻¹) in a fine substrate for medium width individuals.



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



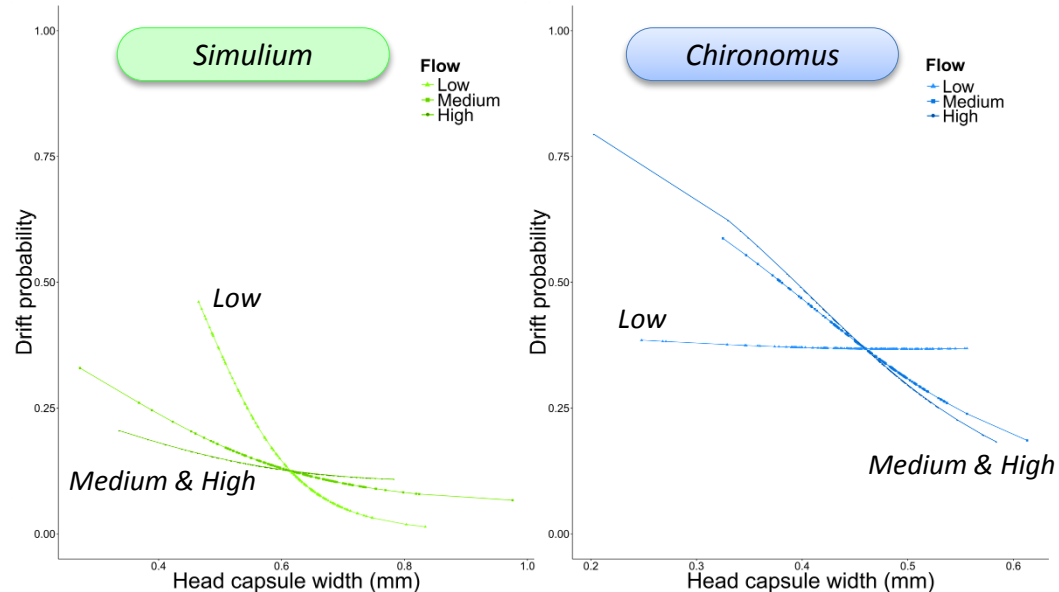


Estimates of the drift probabilities of the three invertebrate taxa according to head capsule width (mm) in a fine substrate and mean water velocity.

❖ 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⁻¹

Gravel bed

Individual size

Baetis

0.684

-

-

-

Simulium

0.128

-

-

Small individuals drift more

Chironomus

0.363

↗ water velocity
↗ drift rate

-

Small individuals drift more



To sum up ...

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Water velocity
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↗ water velocity
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-

Small individuals drift more



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
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>

