

Aguas que se mueven: lagos y ríos frente al cambio climático



INRAE

Sophie Cauvy-Fraunié



GLACIERS





Glacier

1850

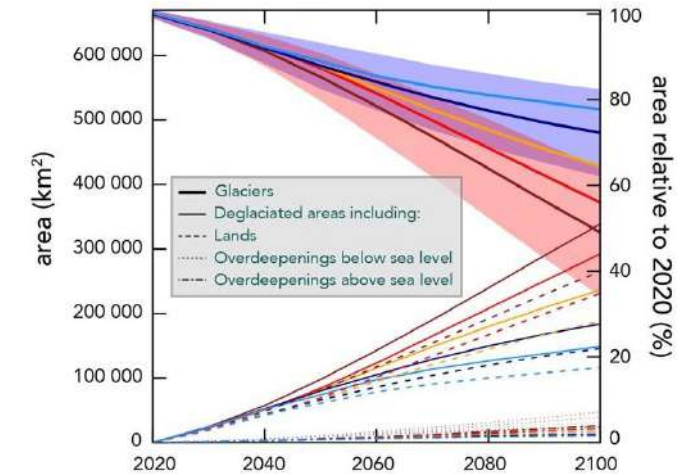
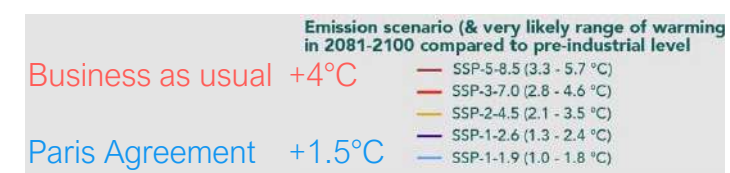
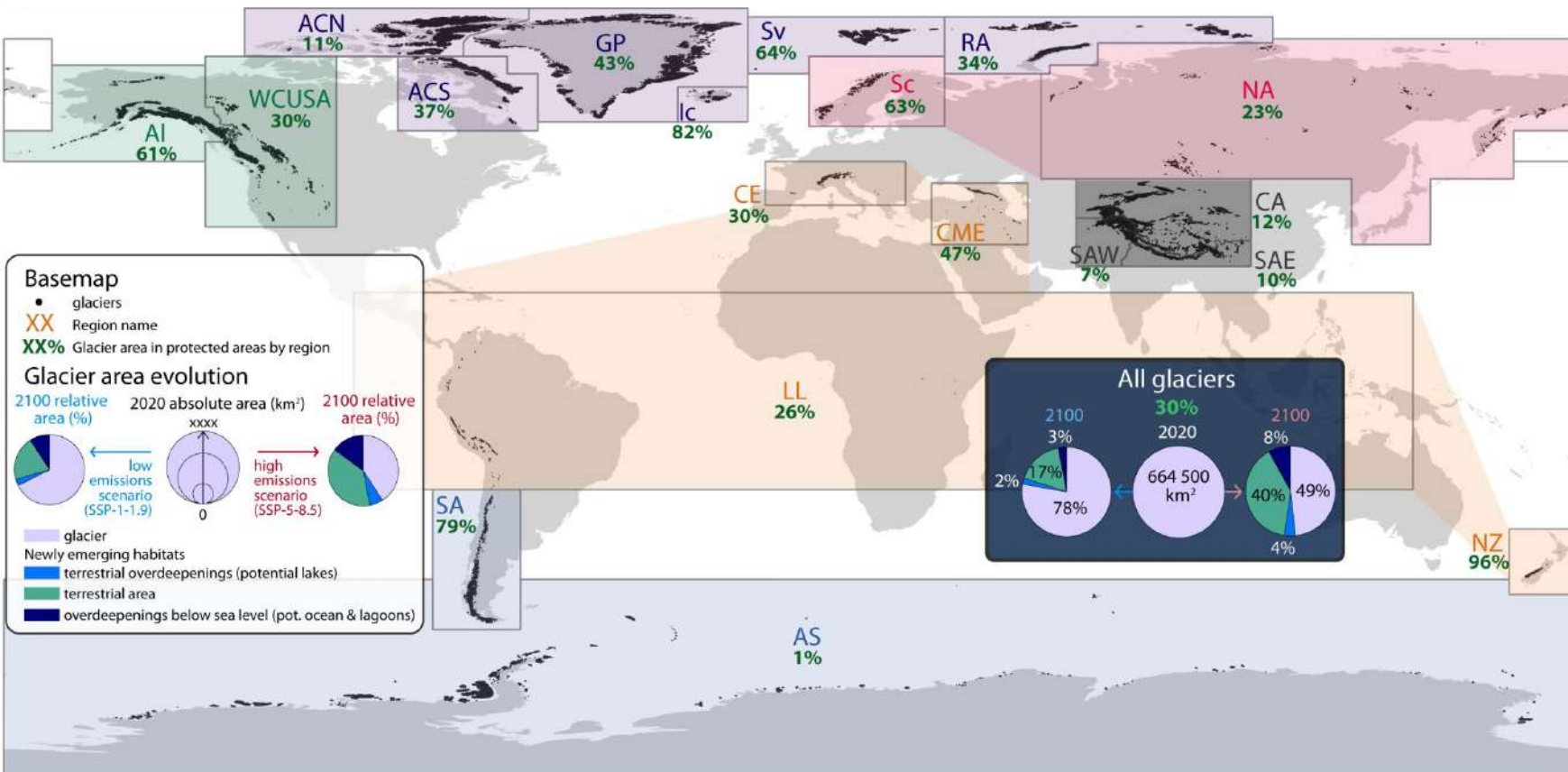
1980s

1850

2020

2006

GLACIERS & emerging ecosystems



Remaining glaciers

⇒ 78% to 49%

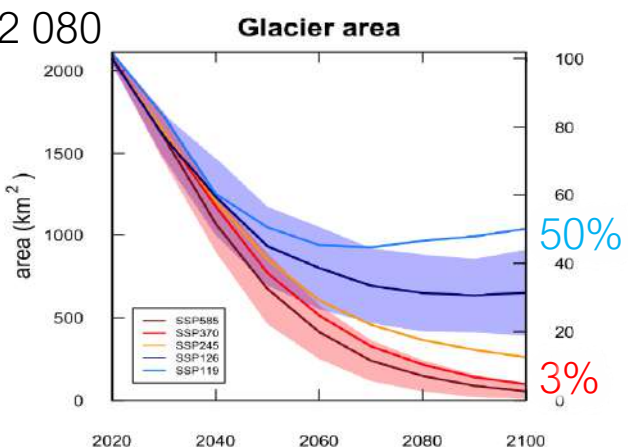
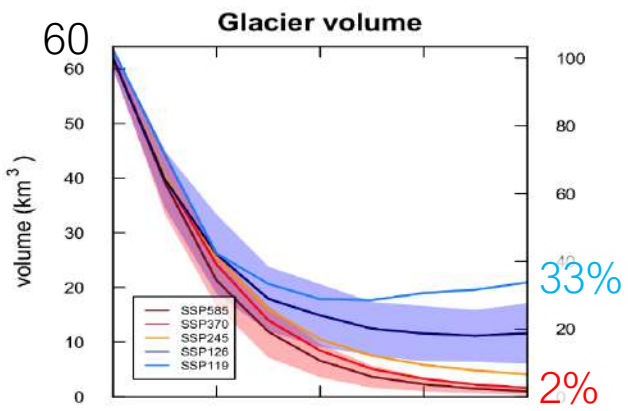
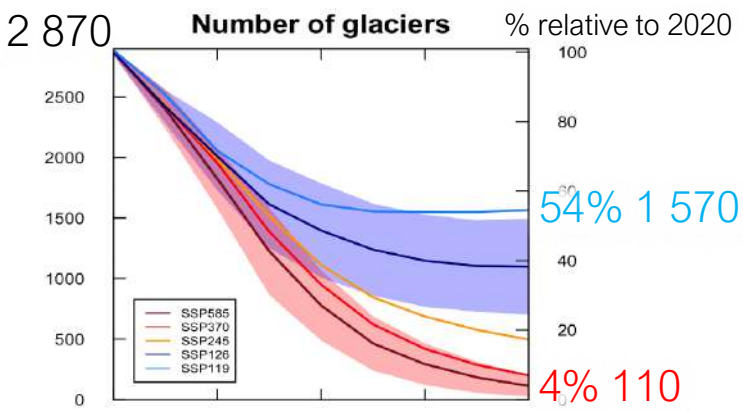
Deglaciated ecosystems

~150 000 to 340 000 km²

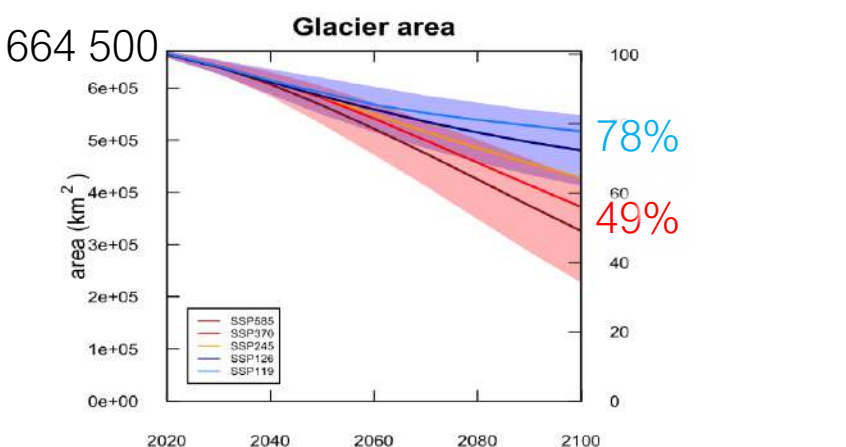
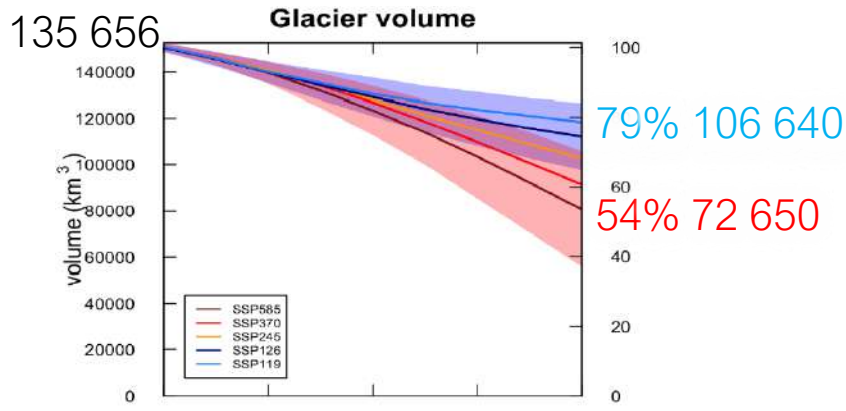
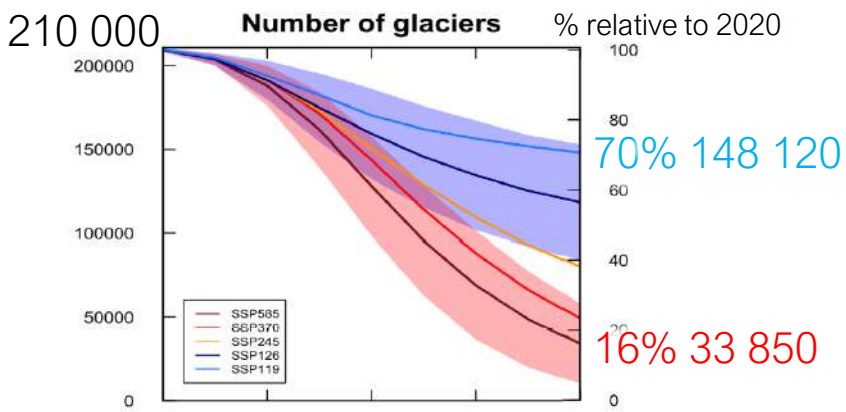
Nepal to Finland

- 17% to 40% terrestrial
- 2% to 4% freshwater
- 3% to 8% marine

Low Latitude glaciers



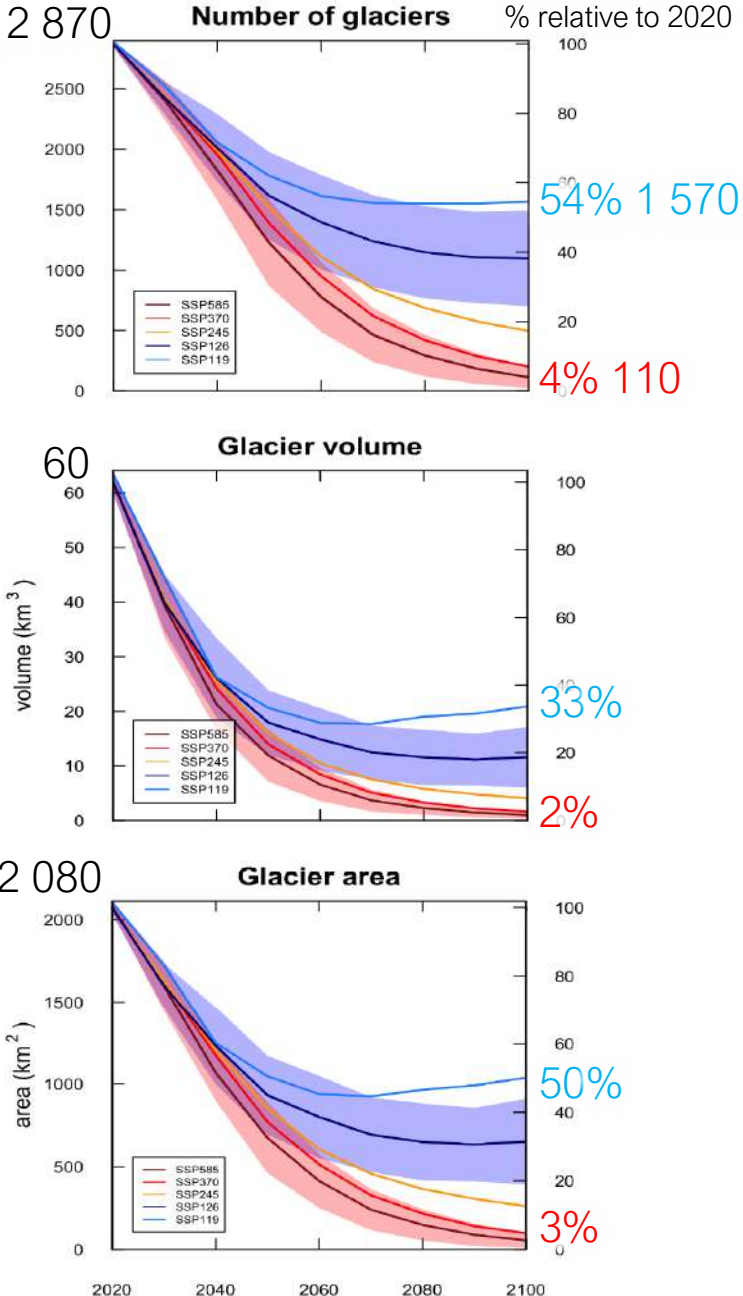
Worldwide



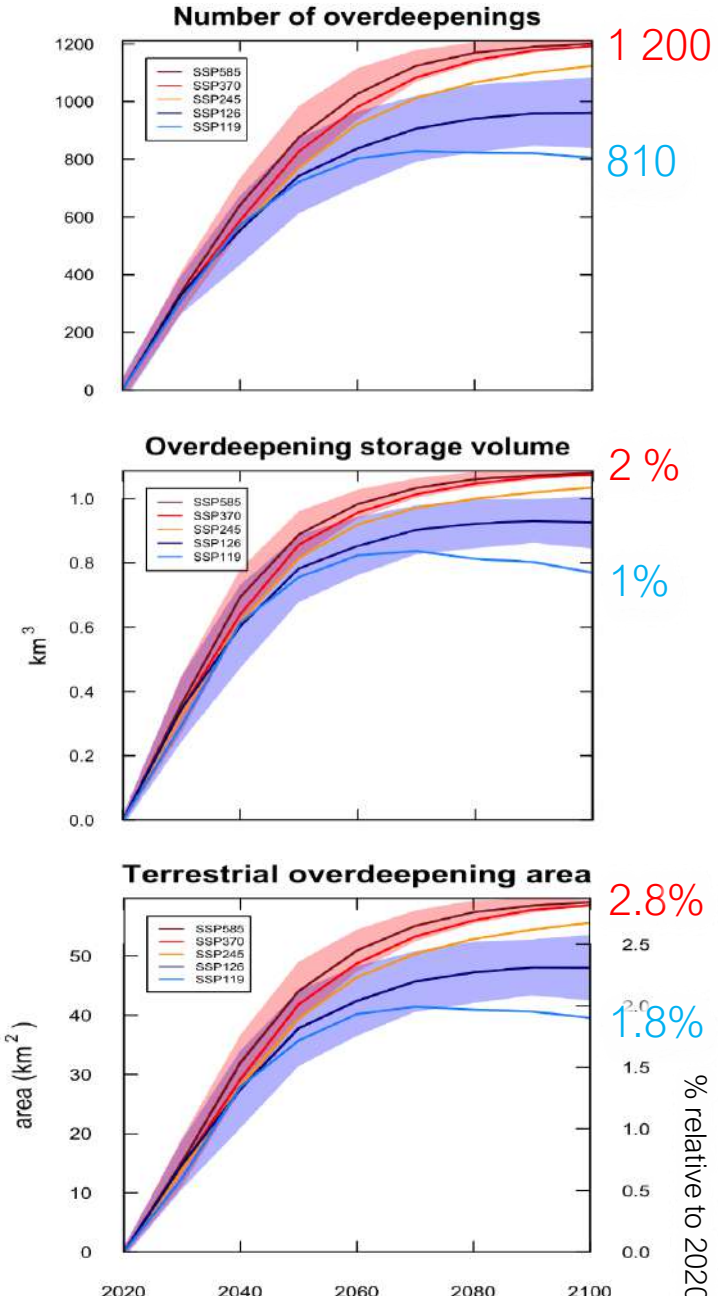
Emission scenario (& very likely range of warming in 2081-2100 compared to pre-industrial level)

Business as usual	+4°C	SSP-5-8.5 (3.3 - 5.7 °C)
		SSP-3-7.0 (2.8 - 4.6 °C)
		SSP-2-4.5 (2.1 - 3.5 °C)
Paris Agreement	+1.5°C	SSP-1-2.6 (1.3 - 2.4 °C)
		SSP-1-1.9 (1.0 - 1.8 °C)

Low Latitude glaciers



Emerging ecosystems



Emission scenario (& very likely range of warming in 2081-2100 compared to pre-industrial level)

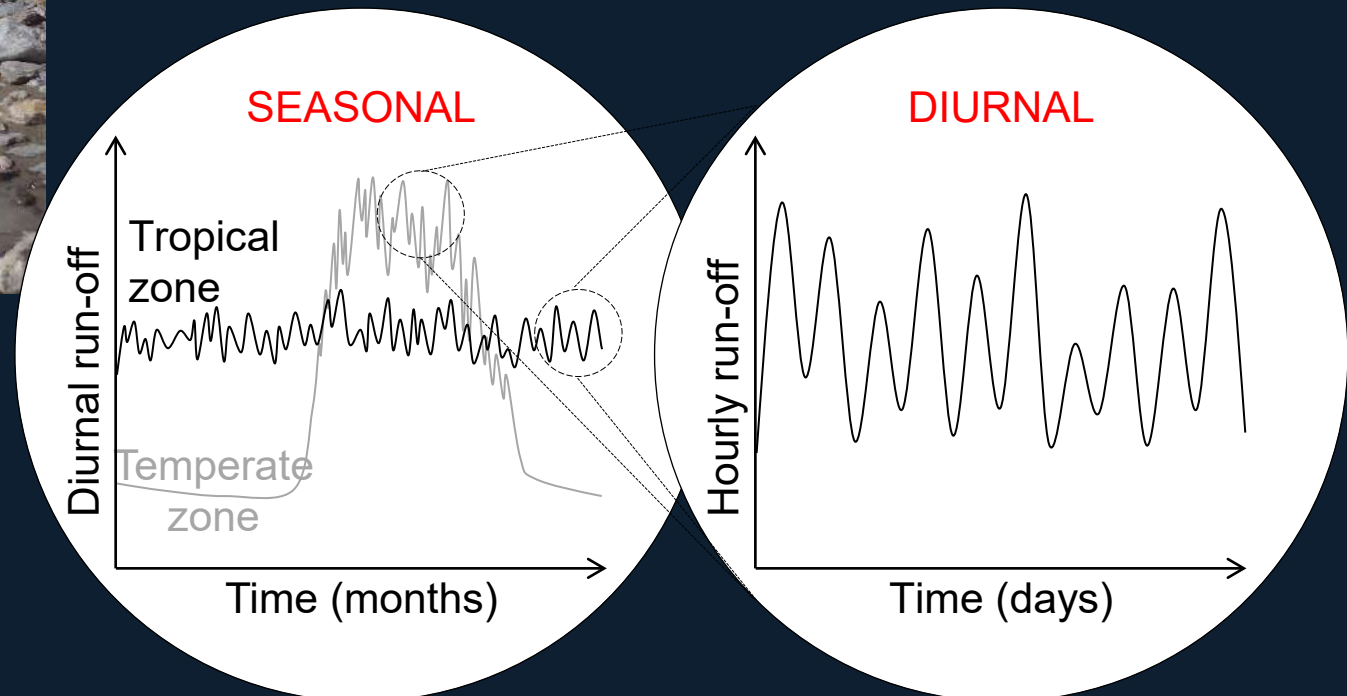
Business as usual	+4°C	SSP-5-8.5 (3.3 - 5.7 °C)
		SSP-3-7.0 (2.8 - 4.6 °C)
		SSP-2-4.5 (2.1 - 3.5 °C)
Paris Agreement	+1.5°C	SSP-1-2.6 (1.3 - 2.4 °C)
		SSP-1-1.9 (1.0 - 1.8 °C)

Glacier-fed stream

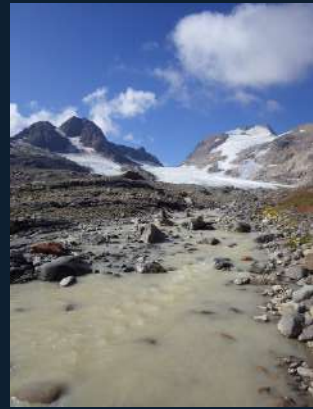
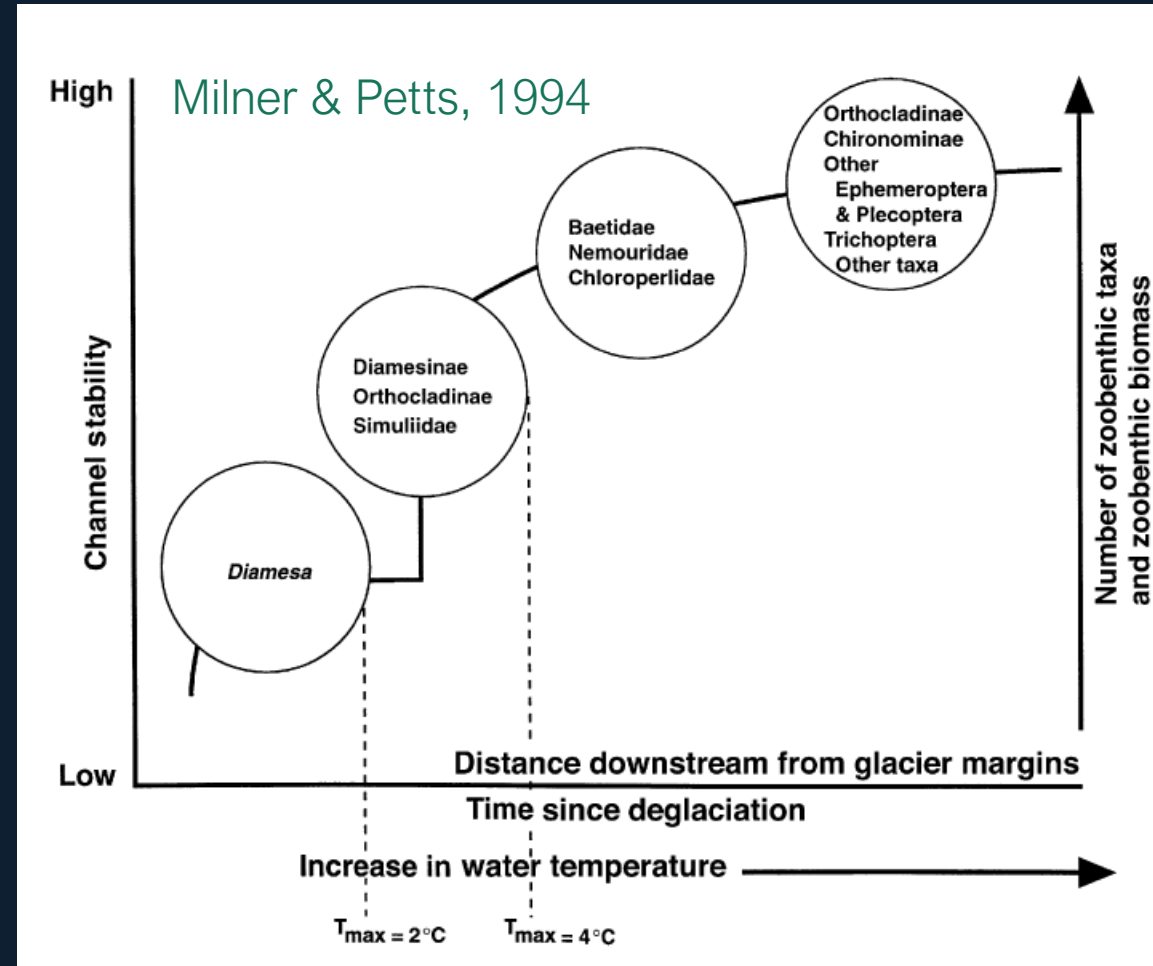
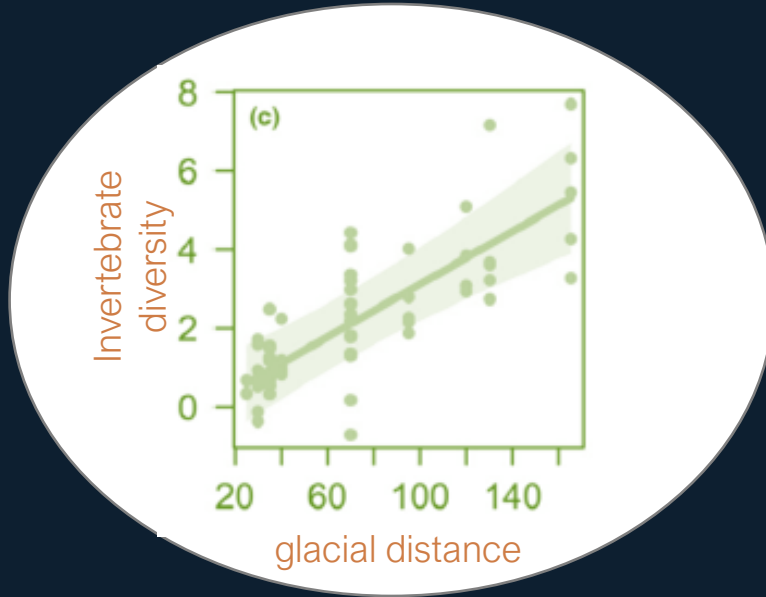


Harsh & variable abiotic conditions

- Low temperature ($< 4\text{ }^{\circ}\text{C}$)
- Low conductivity ($< 10\text{ }\mu\text{s.cm}^{-1}$)
- Low channel stability
- High turbidity ($> 30\text{ NTU}$)
- Seasonal & diurnal hydrological pattern

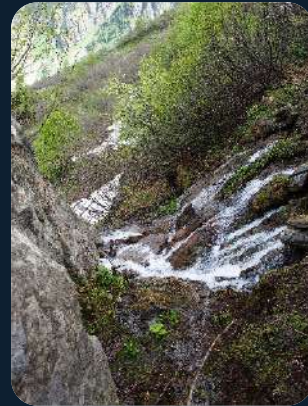
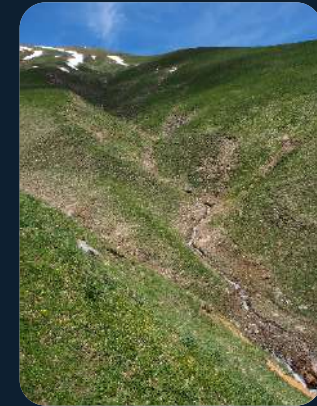
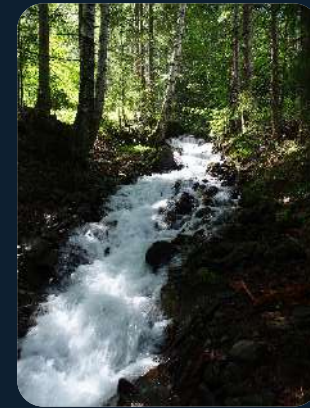
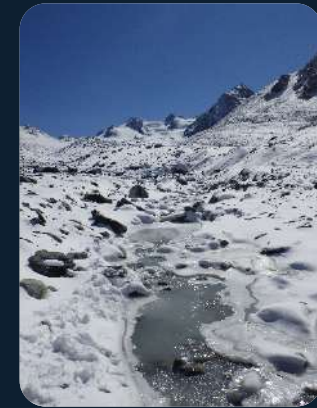
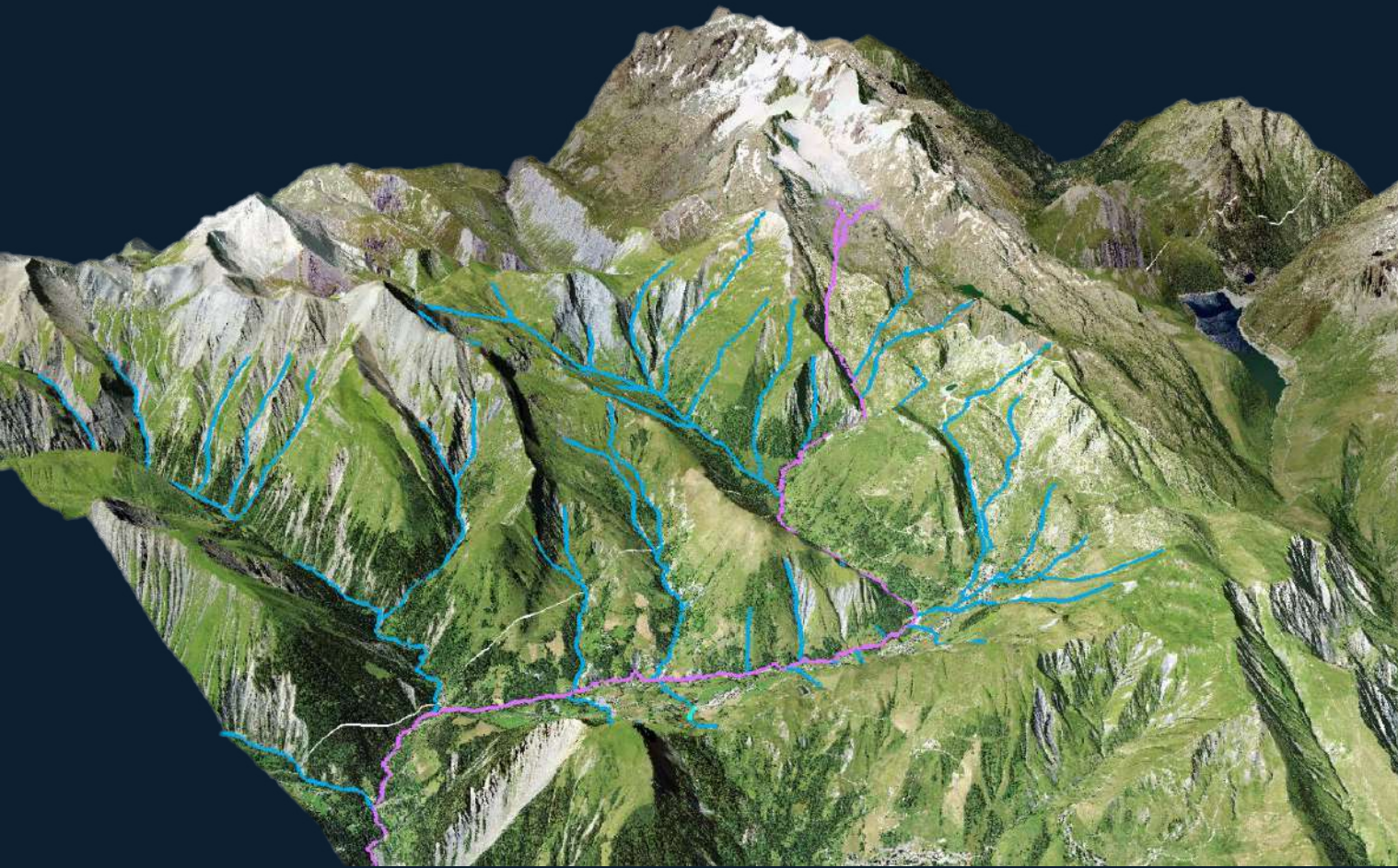


Longitudinal ecological trend along glacier-fed stream

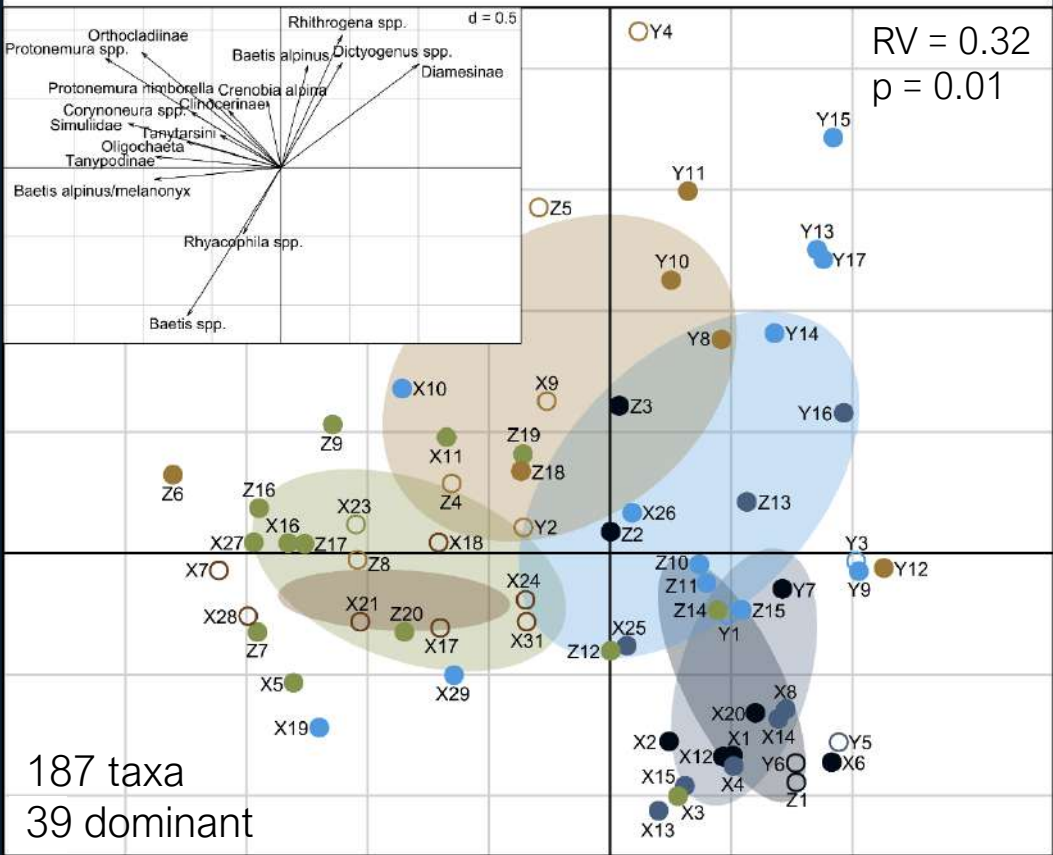
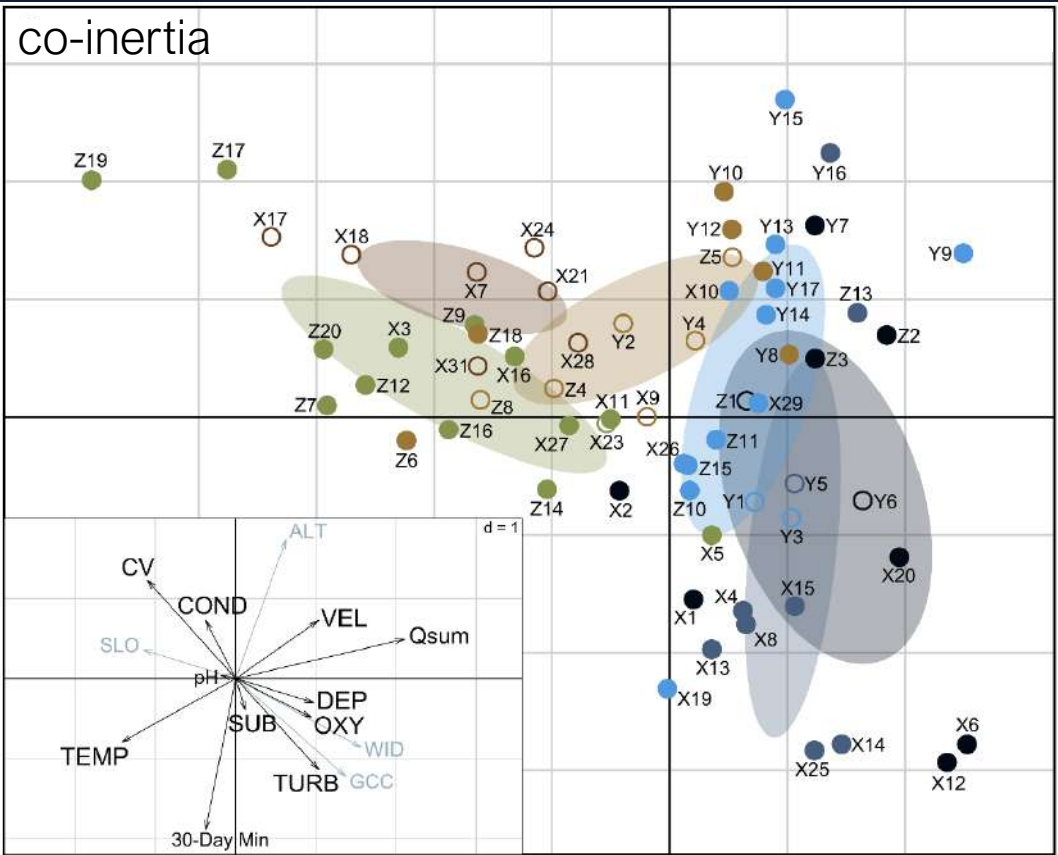


Switzerland (Lods-Crozet et al 2001) - Italy (Maiolini & Lencioni 2001) - Ecuador (Jacobsen et al 2010) - New Zealand (Milner et al 2001) - Austria (Füreder et al 2001) - Norway (Brittain et al 2001) - Iceland (Gíslason et al 2001)

Glacier-fed stream network



Glacier-fed stream network



Becquet et al. 2022 Freshwater Biol., Launay et al. 2021 BESF
Cauvy-Fraunié et al. 2015 Plos One, Wilkes et al. 2023 NEE

Glacier-fed stream network



Baetis alpinus



Rhithrogena loyolaea



Drusus discolor



Diamesinae



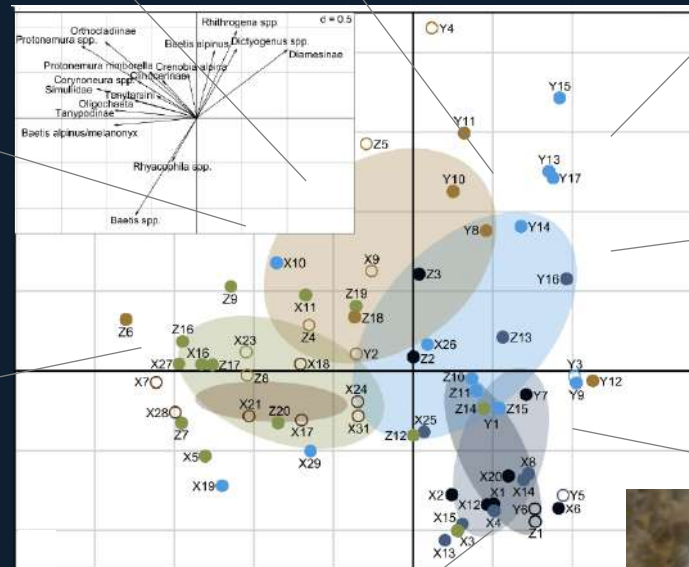
Rhithrogena nivata



Dictyogenus alpinus



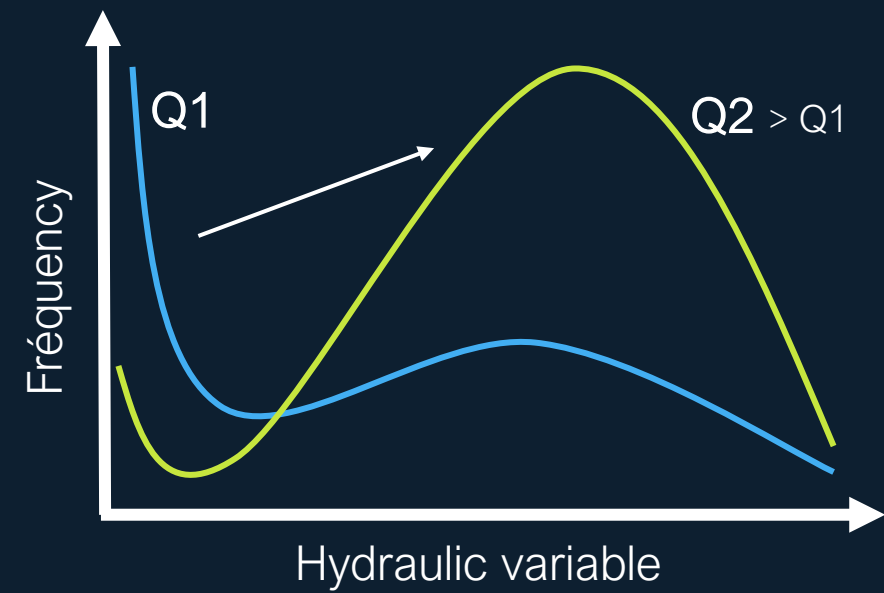
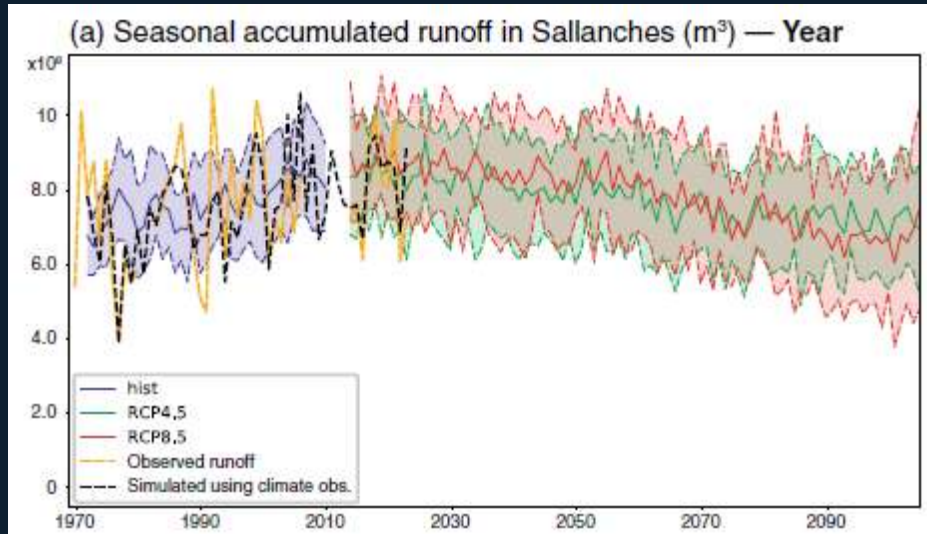
Rhithrogena delphinensis



Rhabdiopteryx alpina



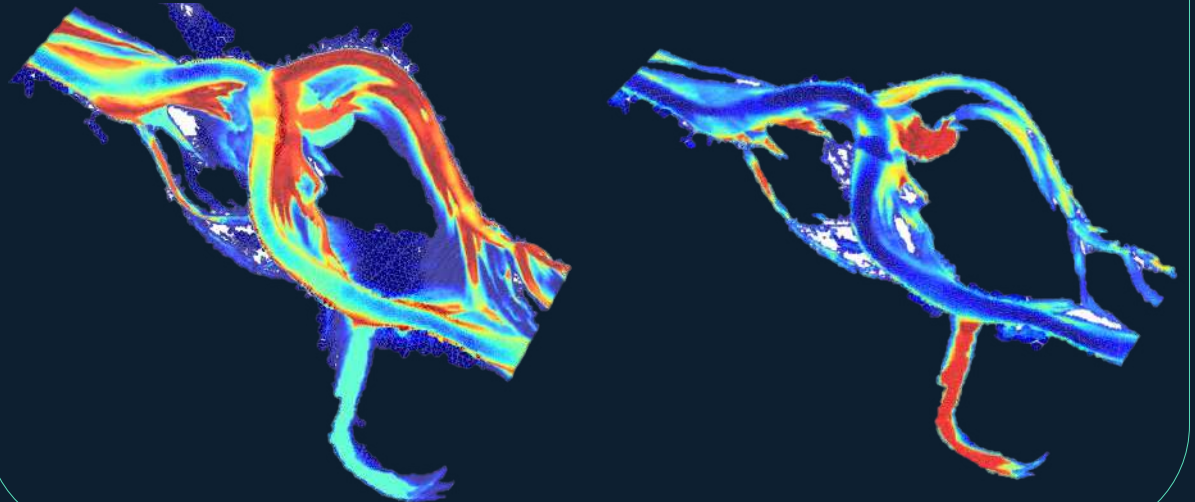
Glacier melting – water supply



MELTWATER ALTERATION



HYDRAULIC HABITAT

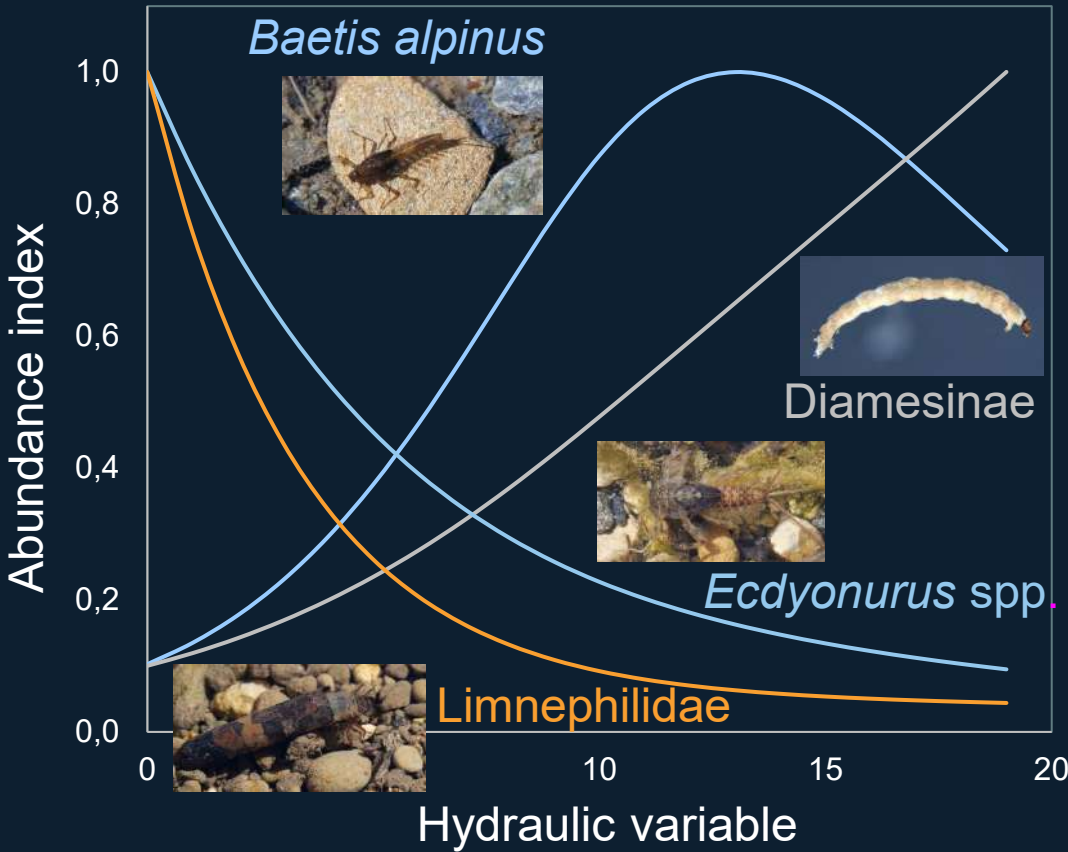
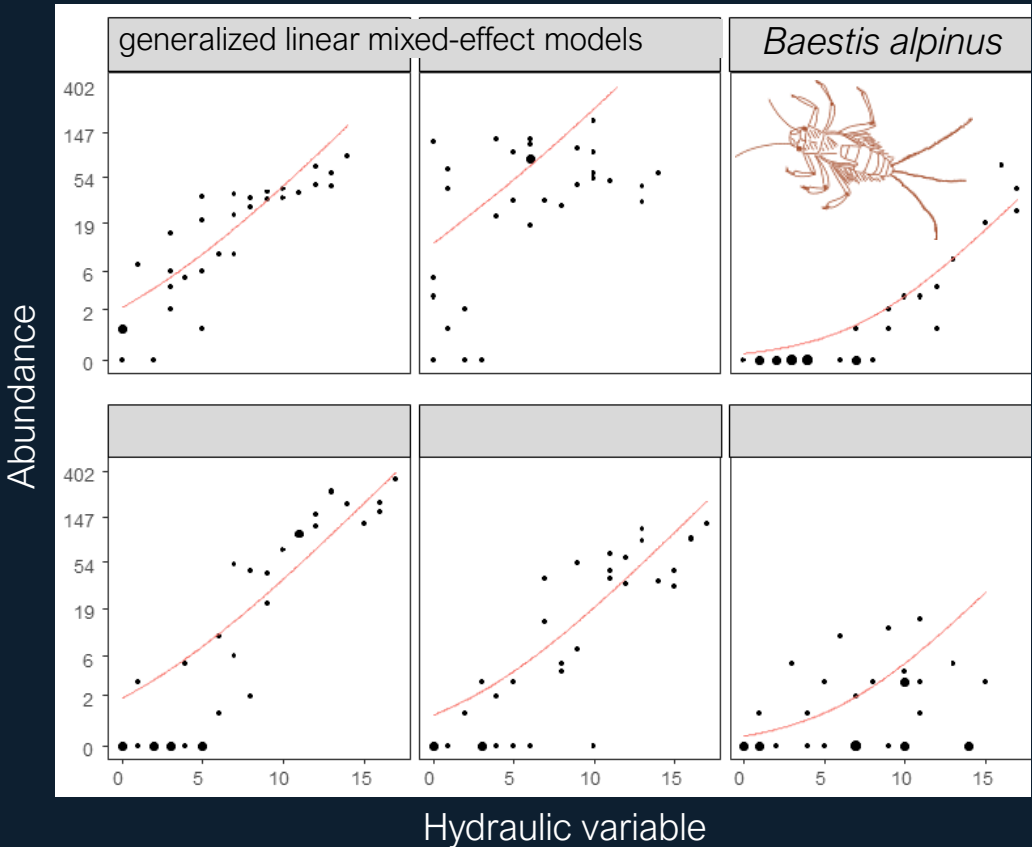


Glacier melting – water supply



HYDRAULIC HABITAT

substrate, velocity
depth, shear stress



Becquet et al. 2022 Freshwater Biol.
Forcellini et al. 2014 J. Ecohydraulics

Towards Andean e-flows

Bolivia 6 sitios

Altiplano

Altura: 4200- 4800 msnm

Precipitación: 174 - 305 mm

Ecuador 10 sitios x 2

Paramo

Altura: 2800-3200 msnm

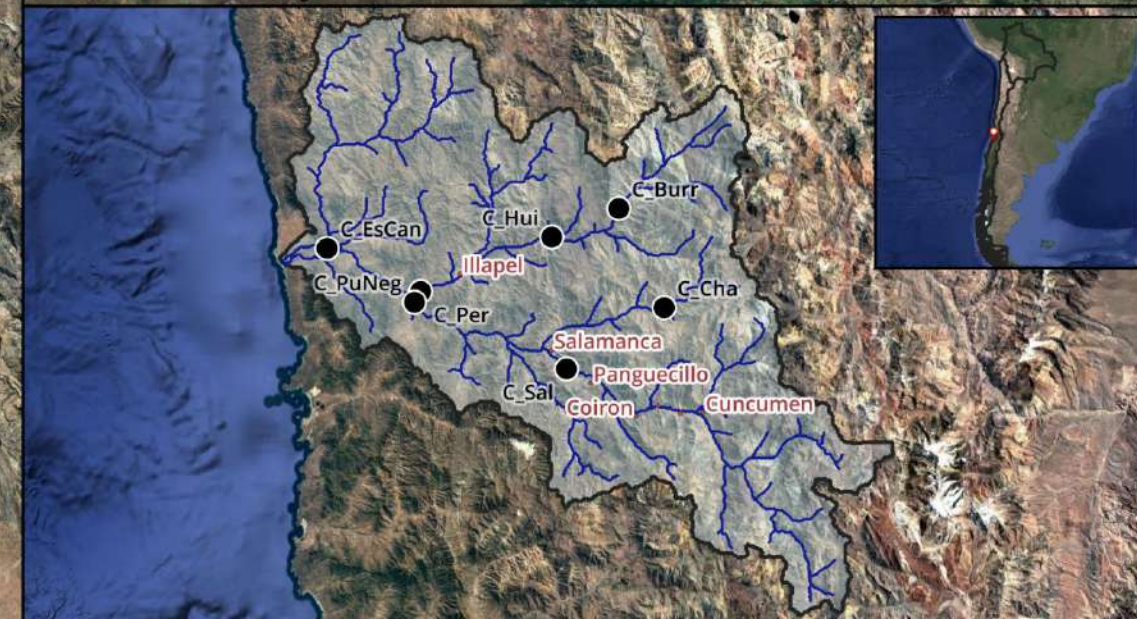
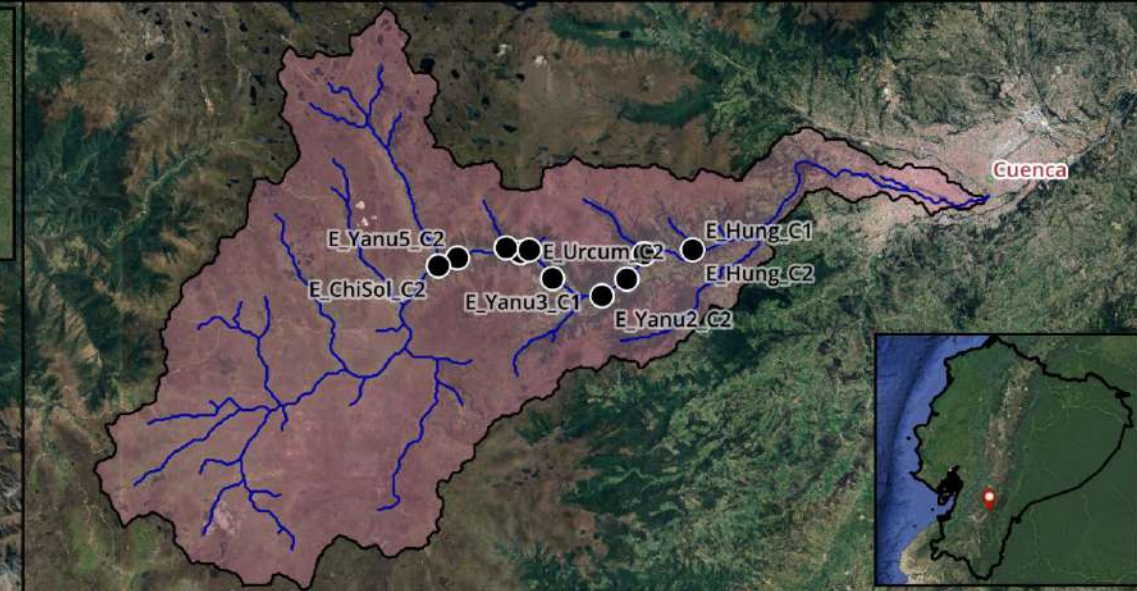
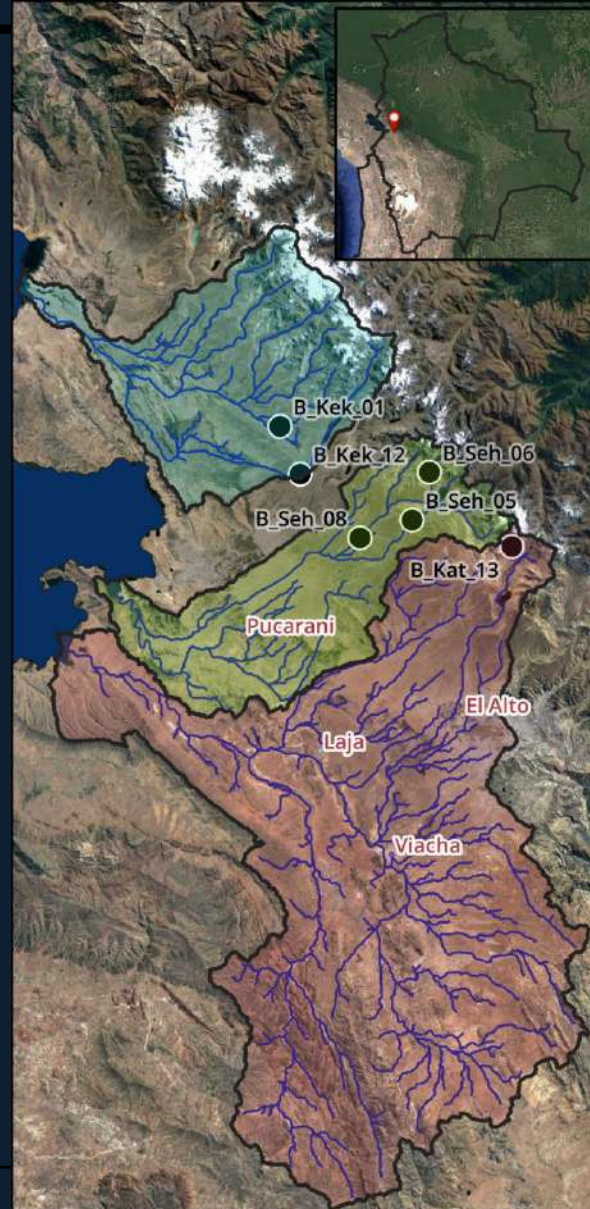
Precipitación: 800 -1200 mm

Chile 7 sitios

Árido

Altura: 53-1400 msnm

Precipitación: 200 to 450 mm



Towards Andean e-flows

Bolivia 6 sitios

Altiplano

Altura: 4200- 4800 msnm

Precipitación: 174 - 305 mm

Ecuador 10 sitios x 2

Paramo

Altura: 2800-3200 msnm

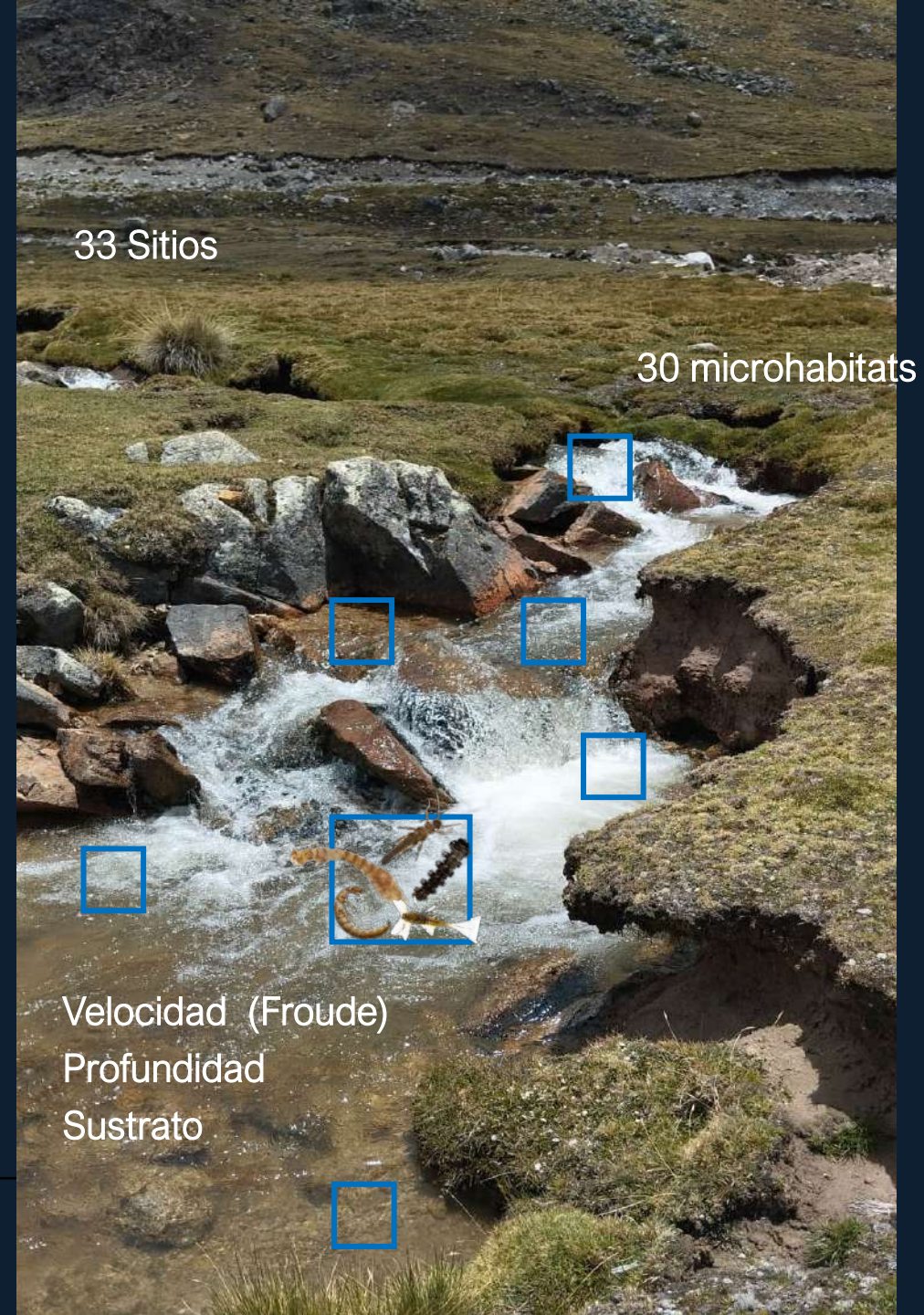
Precipitación: 800 -1200 mm

Chile 7 sitios

Árido

Altura: 53-1400 msnm

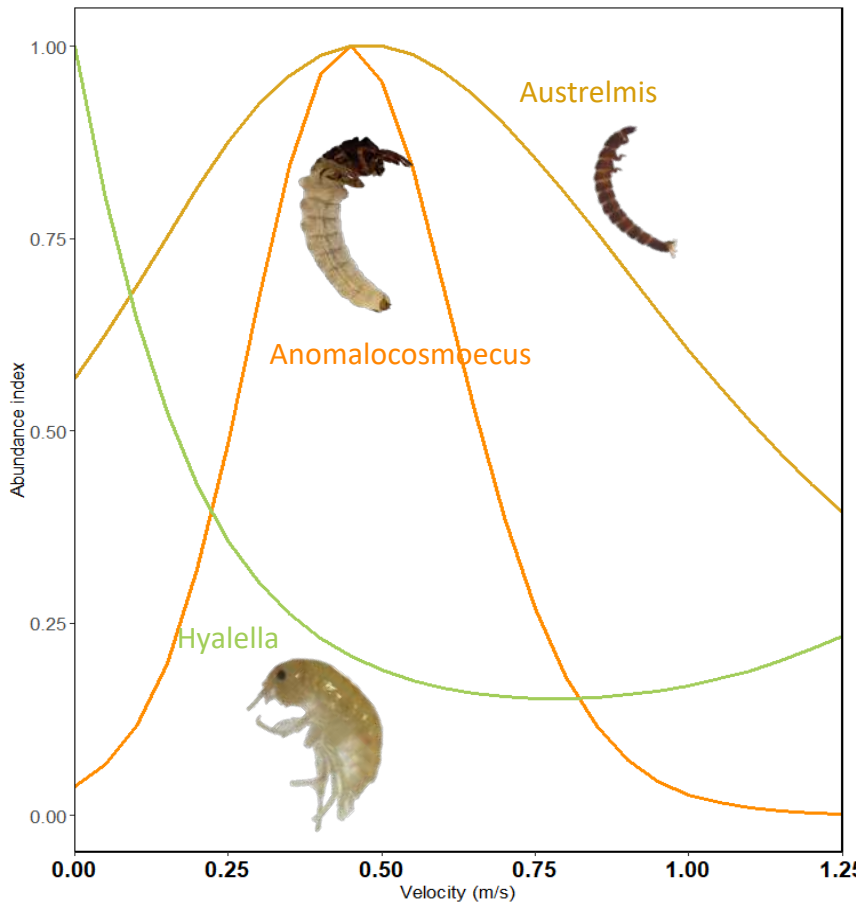
Precipitación: 200 to 450 mm



Towards Andean e-flows

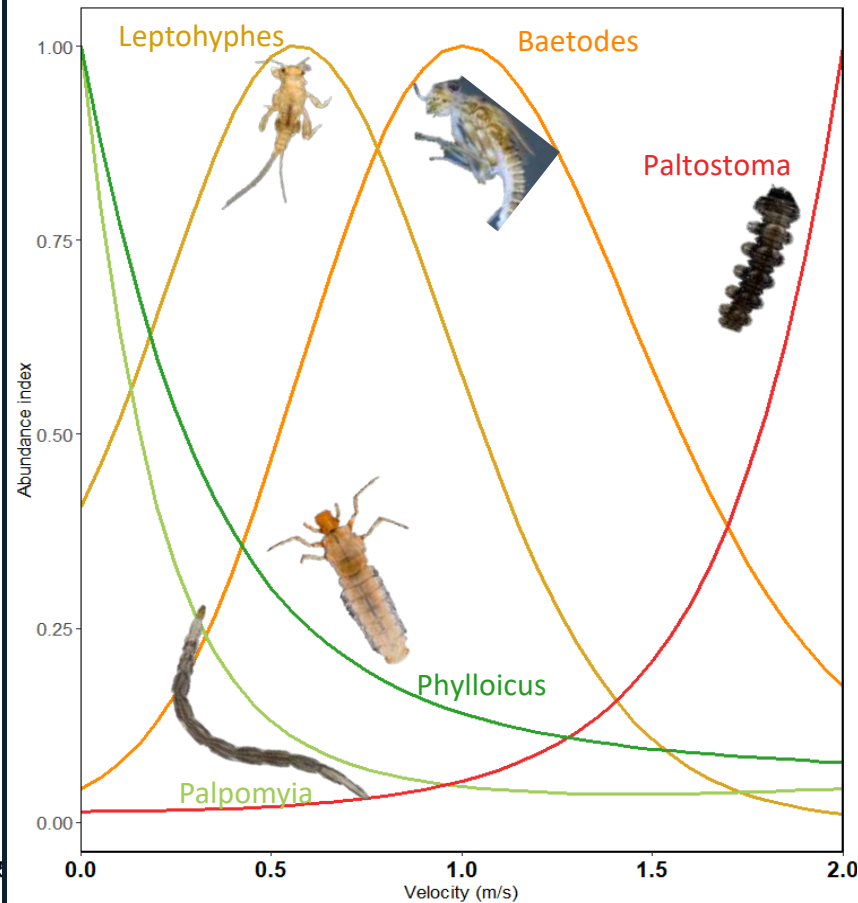
Variación en la respuesta de preferencia a la velocidades

ALTIPLANO



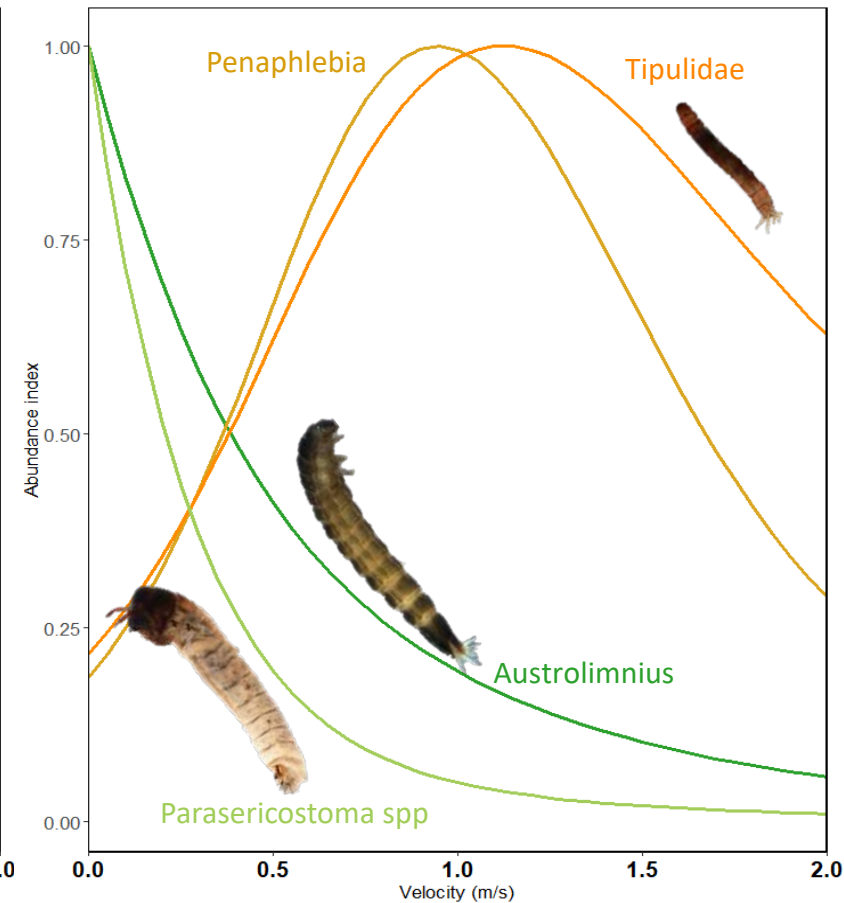
6 Taxones limnófilos
4 Taxones reófilos

PARAMO



8 Taxones limnófilos
7 Taxones reófilos

ARIDO



3 Taxones limnófilos
6 Taxones reófilos

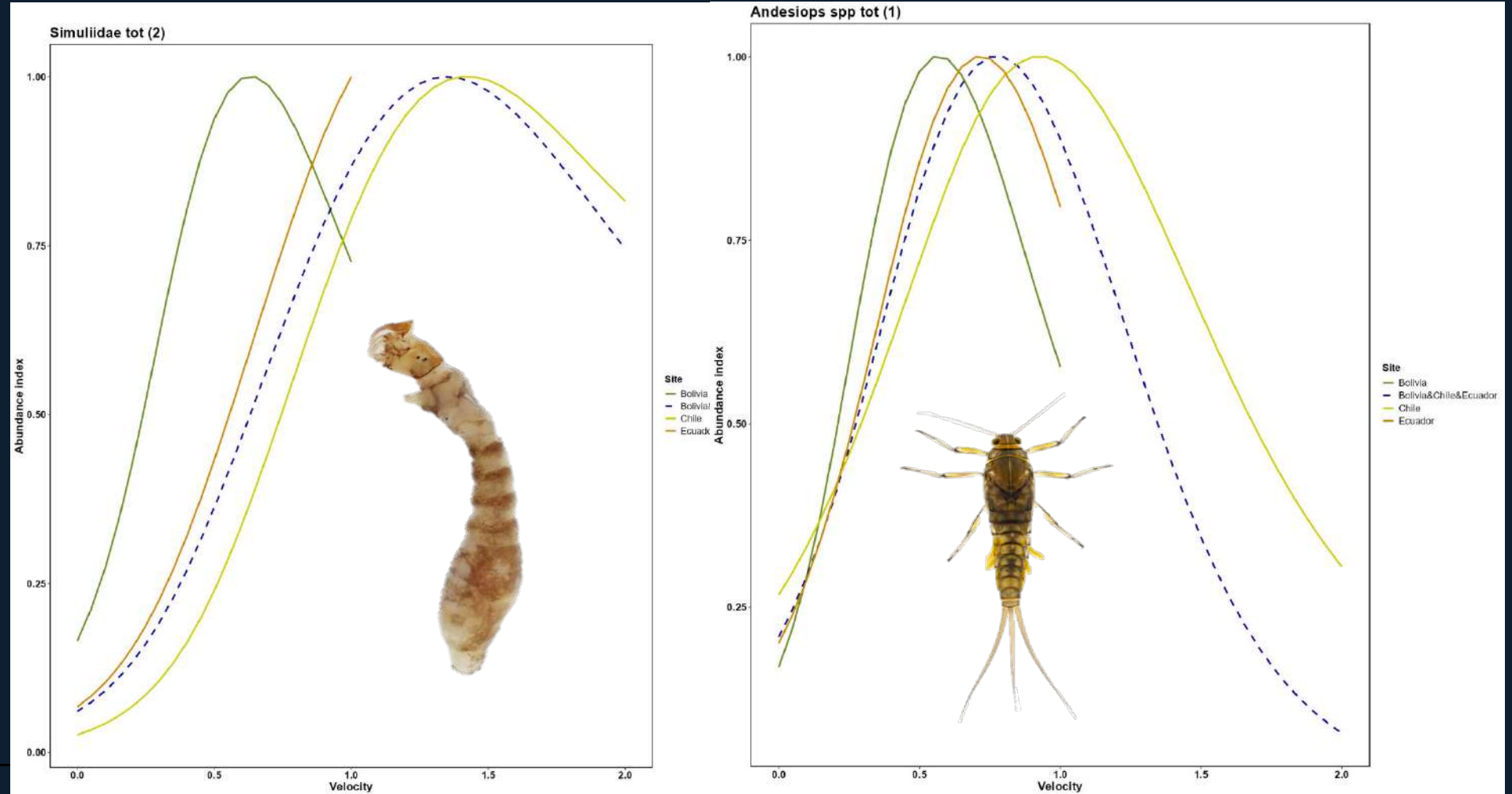
Towards Andean e-flows

Respuesta de preferencia de taxones comunes entre regiones

78/95 M3

55/78 M2

30/55 rheophilic



GRACIAS

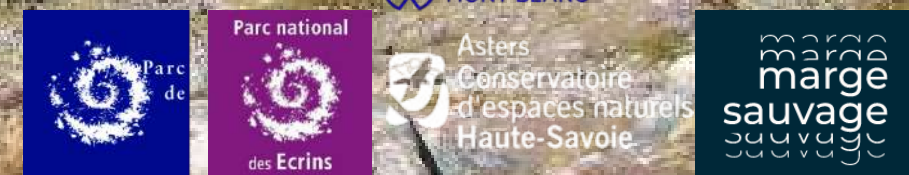


Ice&Life



Scientific partners

INRAE



Funders

