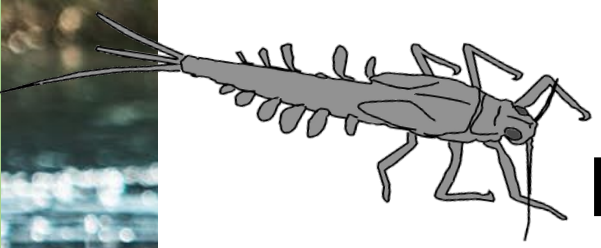

Multiscale assessment of methane derived carbon in freshwater: from catchment to microorganisms

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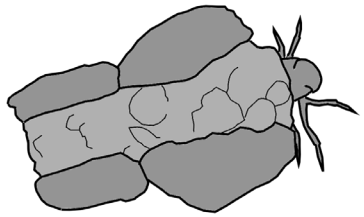
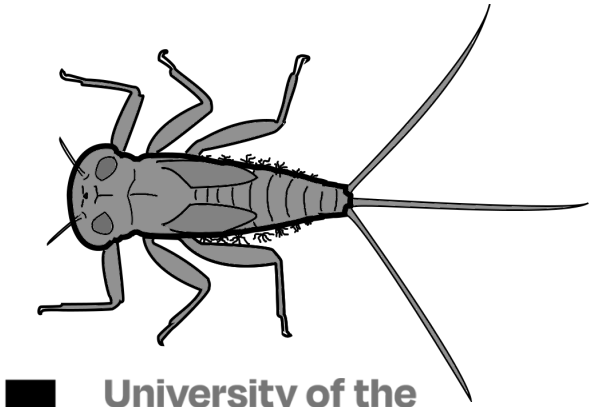


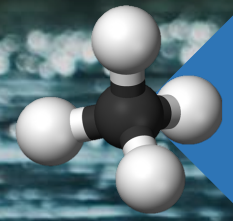


SUPER Scottish Universities Partnership for Environmental Research

Edinburgh Napier UNIVERSITY

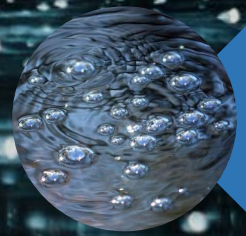
UHI University of the Highlands and Islands Oilthigh na Gàidhealtachd agus nan Eilean

Methane in Freshwater

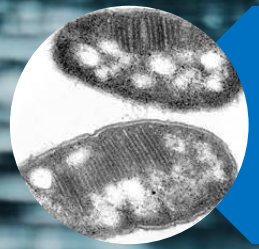


Methane (CH_4) >80x more potent as a GHG than CO_2 over a 20-year span.

Previously methane production was thought only to occur in oxygen depleted waters.

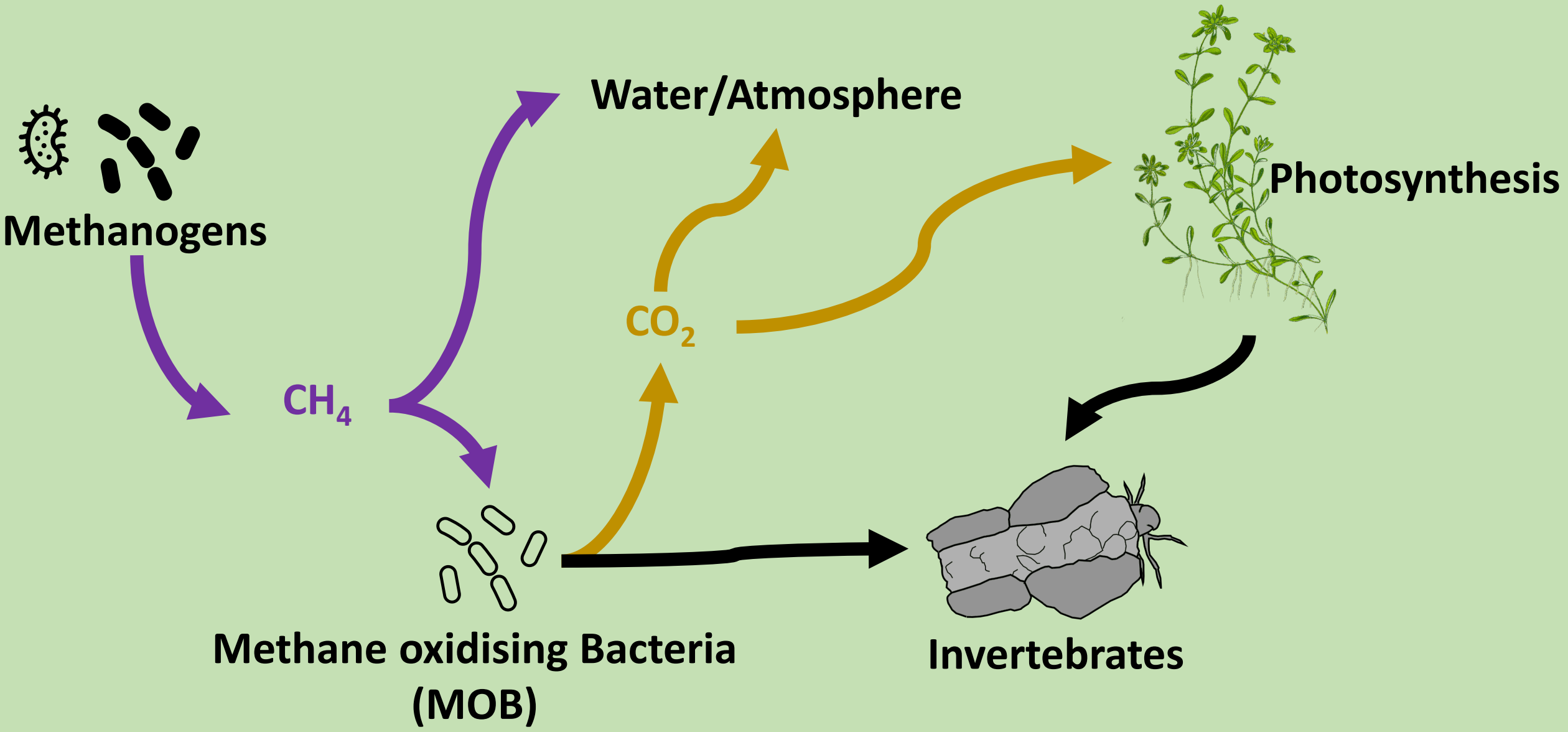


UK streams are frequently supersaturated in methane.

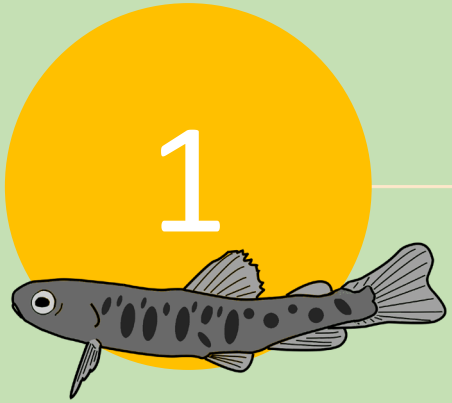


Stream C fixation through methane oxidation in rare cases can match photosynthesis

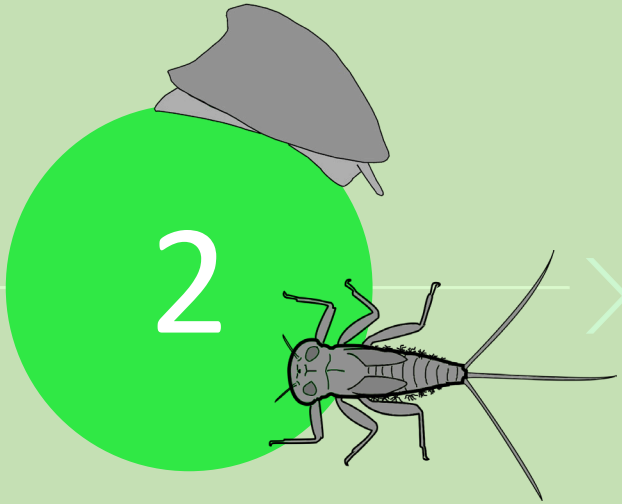
In-stream pathways of Methane Derived Carbon (MDC)



PhD by Chapters



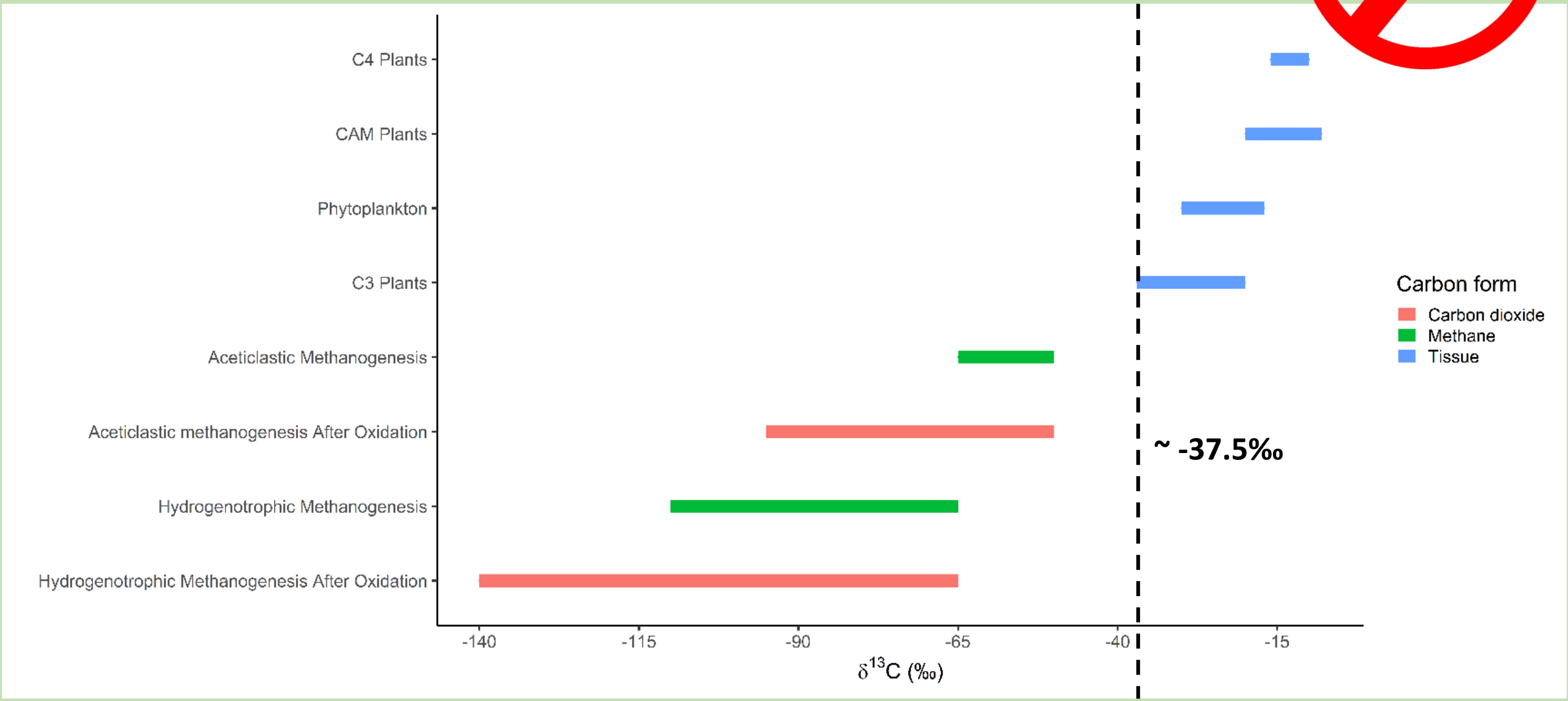
Identify the catchment characteristics that governs MDC occurrence.

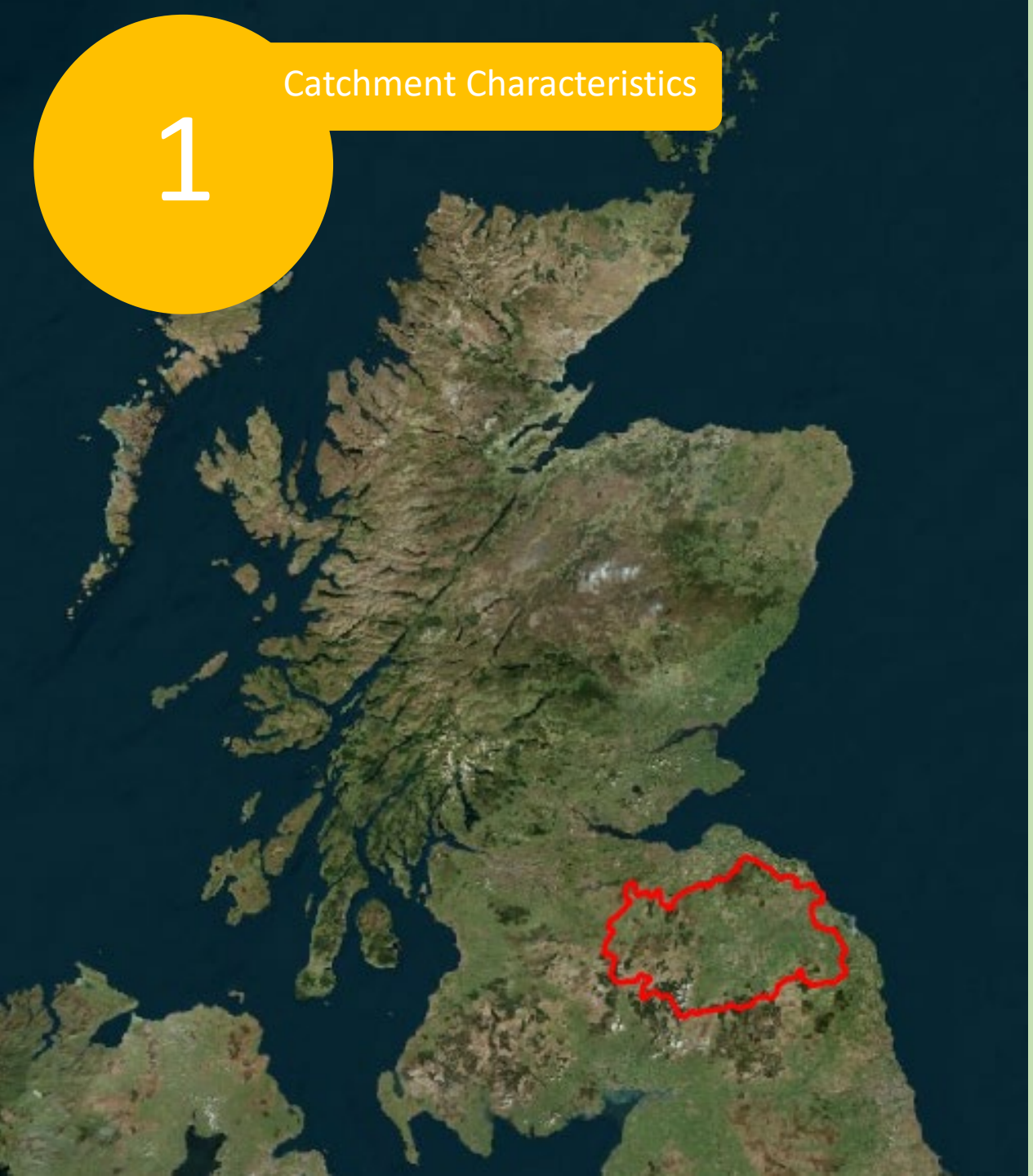


Identify organisms that benefit from MDC and source how MDC enters their diet.

Identify the in-stream niches that associated with MOB and Methanogens.

Carbon Stable Isotopes: searching for MDC





1

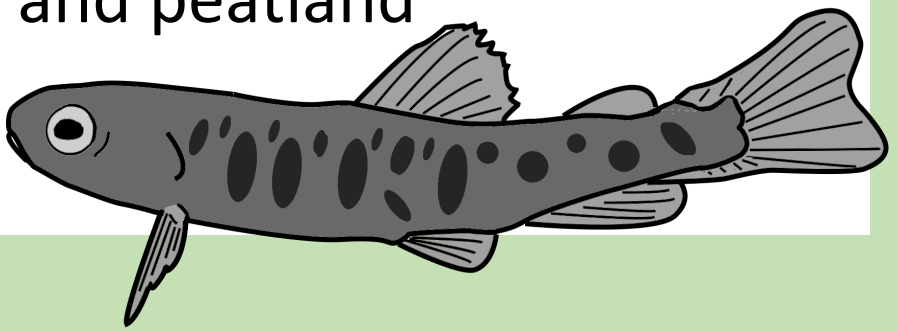
Catchment Characteristics

Trout of the Tweed

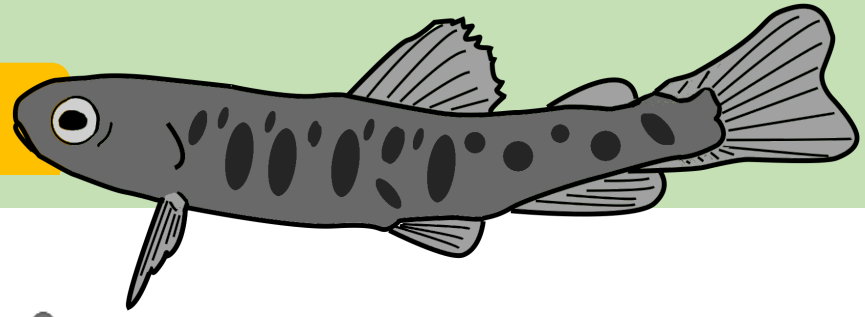
Large variance in isotopic ratios of brown trout fry (*Salmo trutta*).

Some trout populations show lower **$\delta^{13}C$ values**, indicative of Methane derived Carbon (**MDC**).

The Tweed catchment is mostly rural dominated by moors & heathland, agriculture and peatland



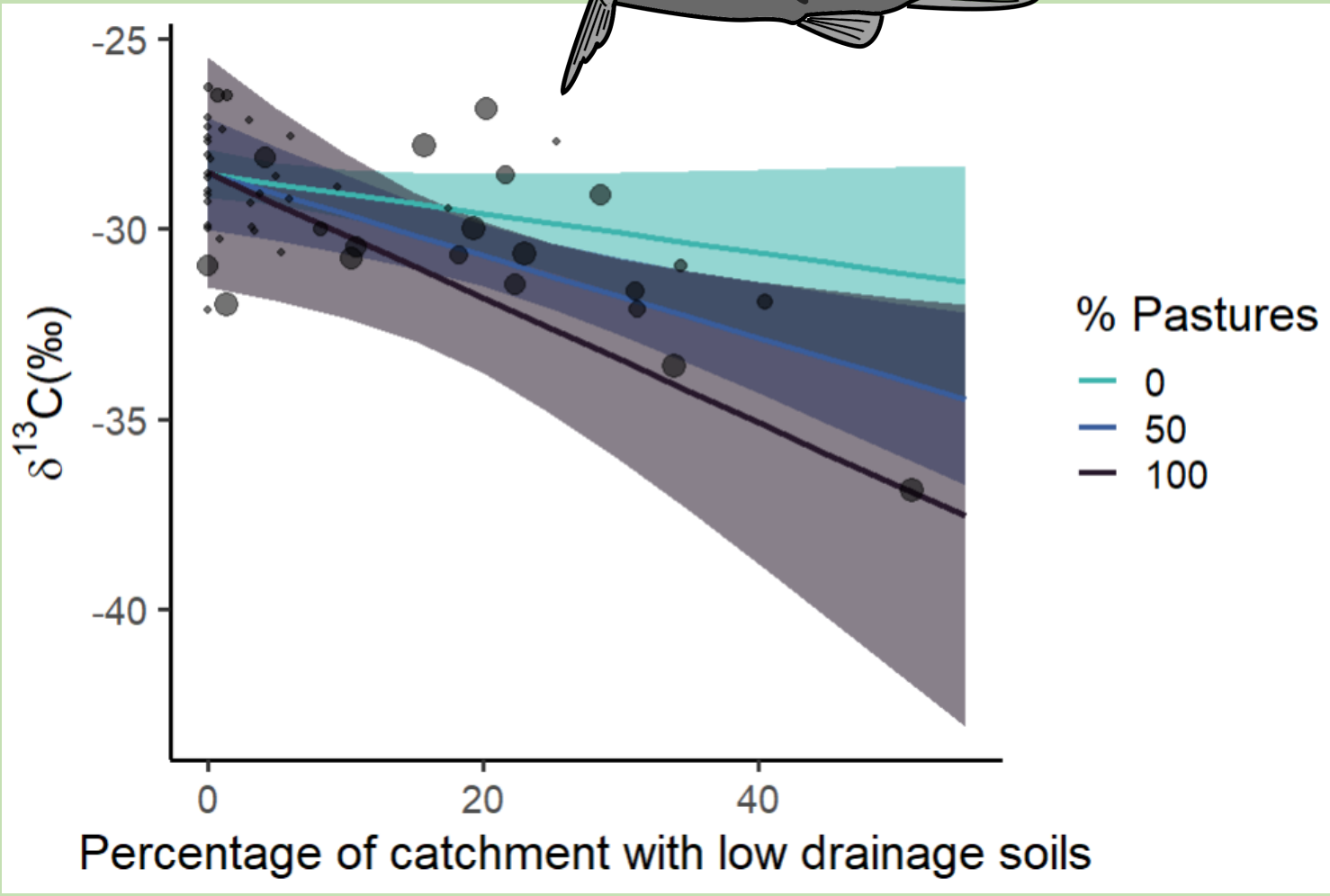
1 Catchment Characteristics



Trout fry sampled from 60 upland sites.

Carbon stable isotope values ($\delta^{13}C$) of trout fry compared with stream catchment characteristics:

- Land use
- Soil drainage
- Topography



Increases in the area with **low drainage** or used for **pastures** in a catchment increase likelihood of MDC in trout fry tissue

2 Identifying Invertebrates that benefit from MDC

10 sites across the Upper Tweed and Gala
Sampled for carbon and nitrogen stable isotopes.

Sampled for:

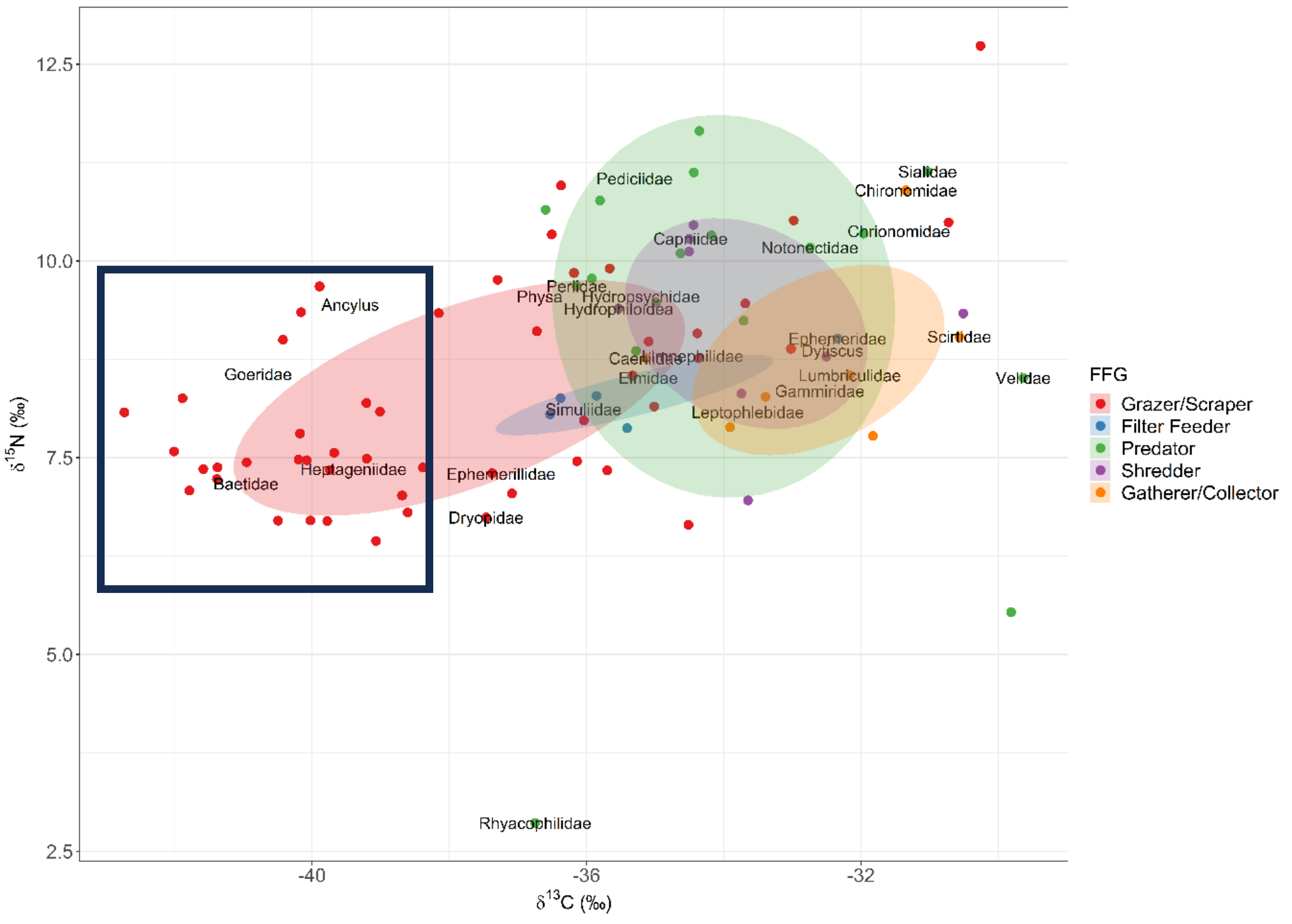
- Bryophytes
- Epilithon
- POM
- Macrophytes
- Invertebrates

2

Carbon and Nitrogen Stable isotopes sampled for all invertebrates at a single site.

Split into Functional feeding groups (FFG). Grazer/Scrapers with lowest -37.5 ‰

Taxa with average $\delta^{13}C$ below -37.5 ‰ selected for analysis at the other 9 sites



2

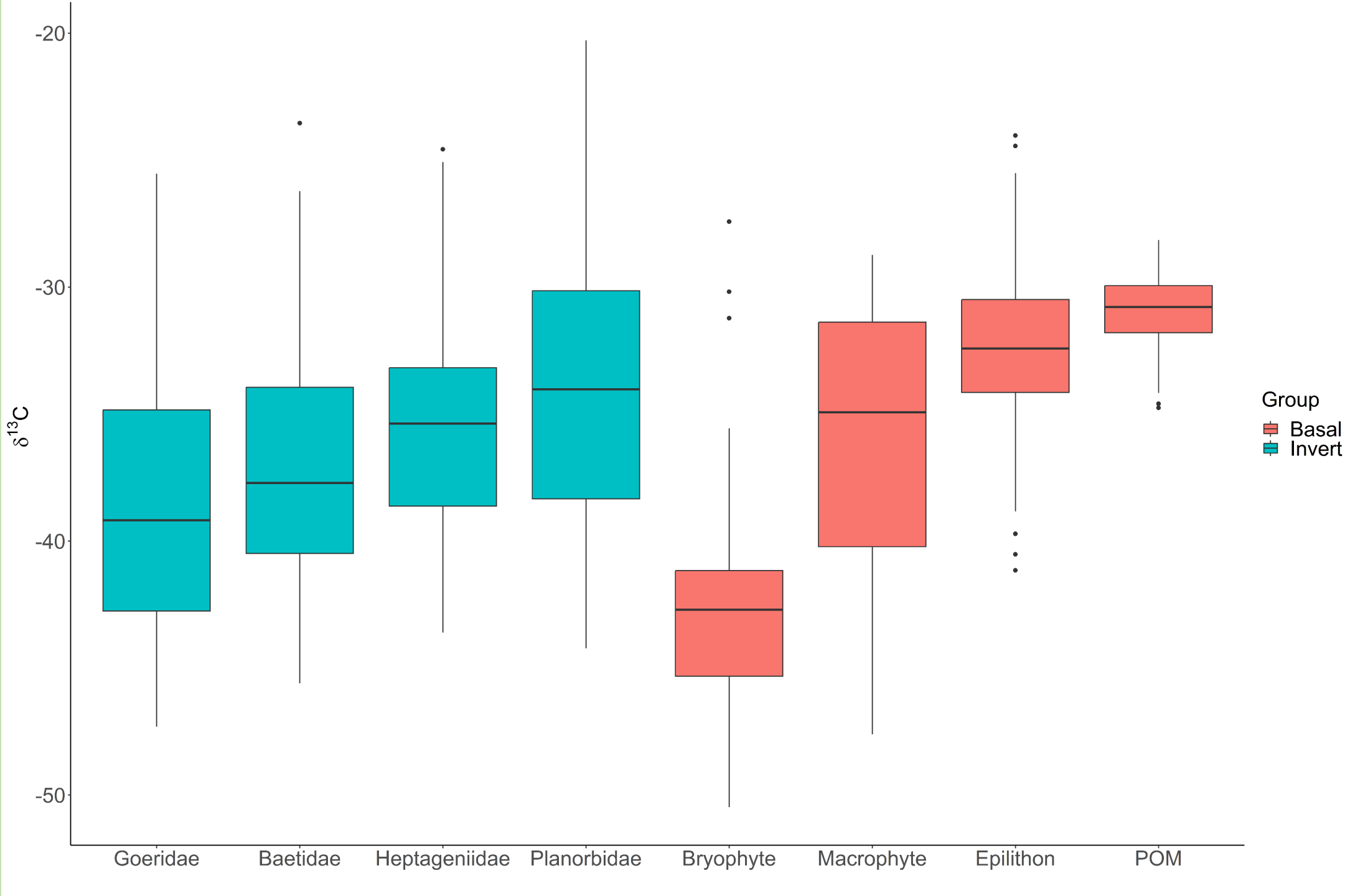
Heptageniidae

Goeridae

Planorbidae – Ancylus fluviatilis

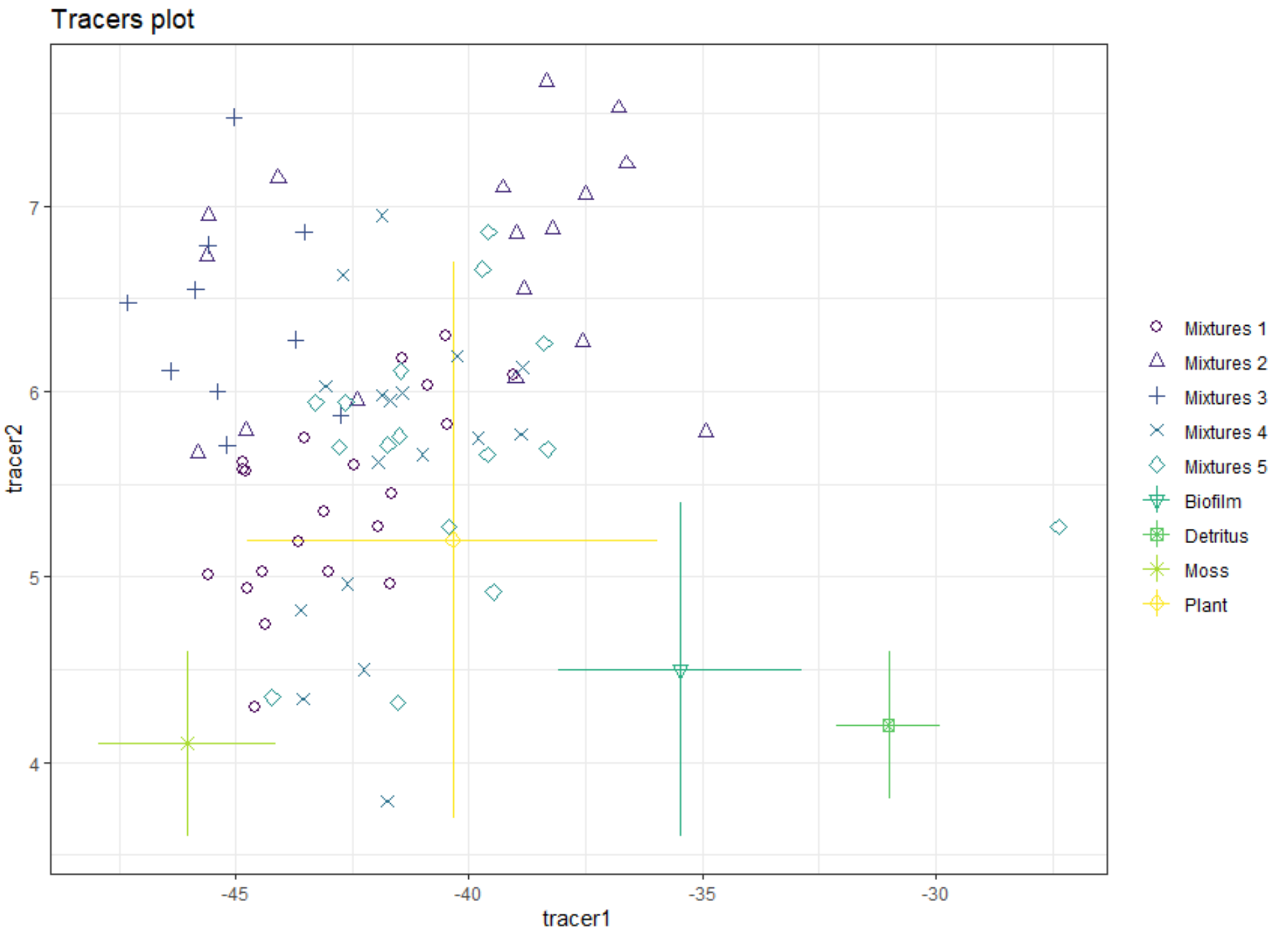
Baetidae - Baetis

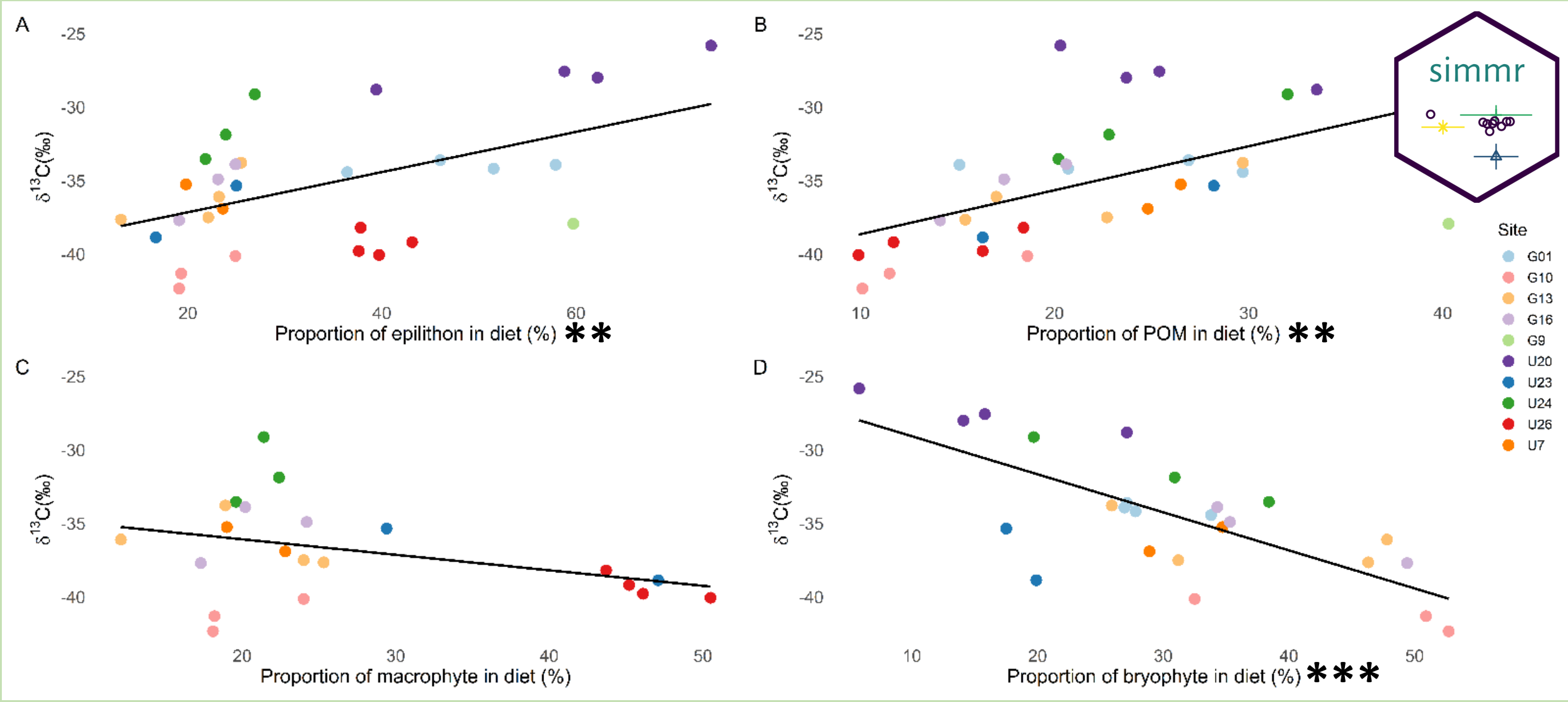
2


-20
-30
-40
-50
δ13C
Goeridae
Baetidae
Heptageniidae
Planorbidae
Bryophyte
Macrophyte
Epilithon
POM
Group
Basal
Invert

2

simmr


Tracers plot
tracer2
tracer1
7
6
5
4
-45
-40
-35
-30
Mixtures 1
Mixtures 2
Mixtures 3
Mixtures 4
Mixtures 5
Biofilm
Detritus
Moss
Plant



** p < 0.01, *** p < 0.0001. Macrophytes show no significance

3 Methane Microbial community


G10


G16


U24

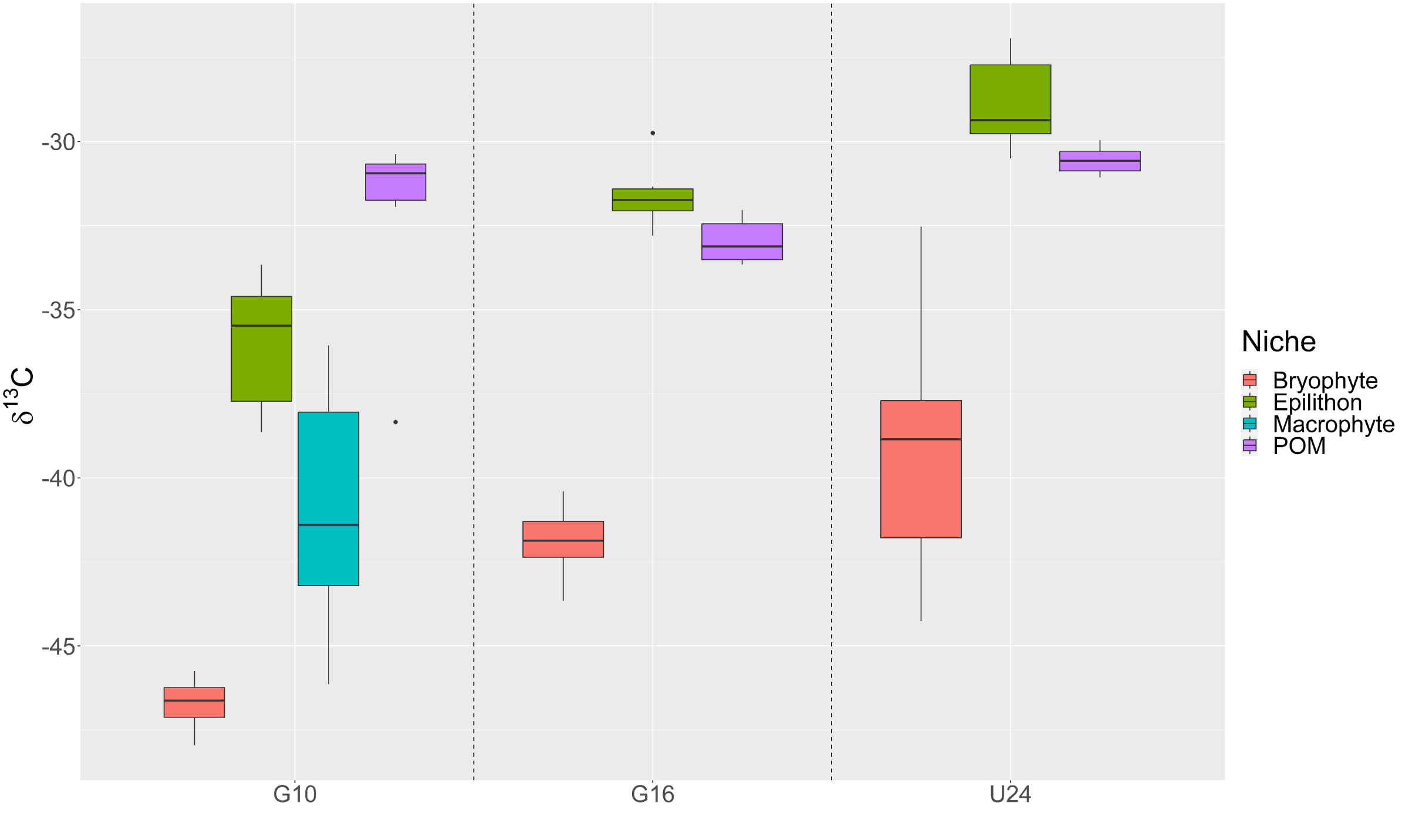
Sampled the fast and slow sections of three different streams.

Stable isotopes on: Invertebrates, Basal resources

qPCR and Sequencing on: Basal resources

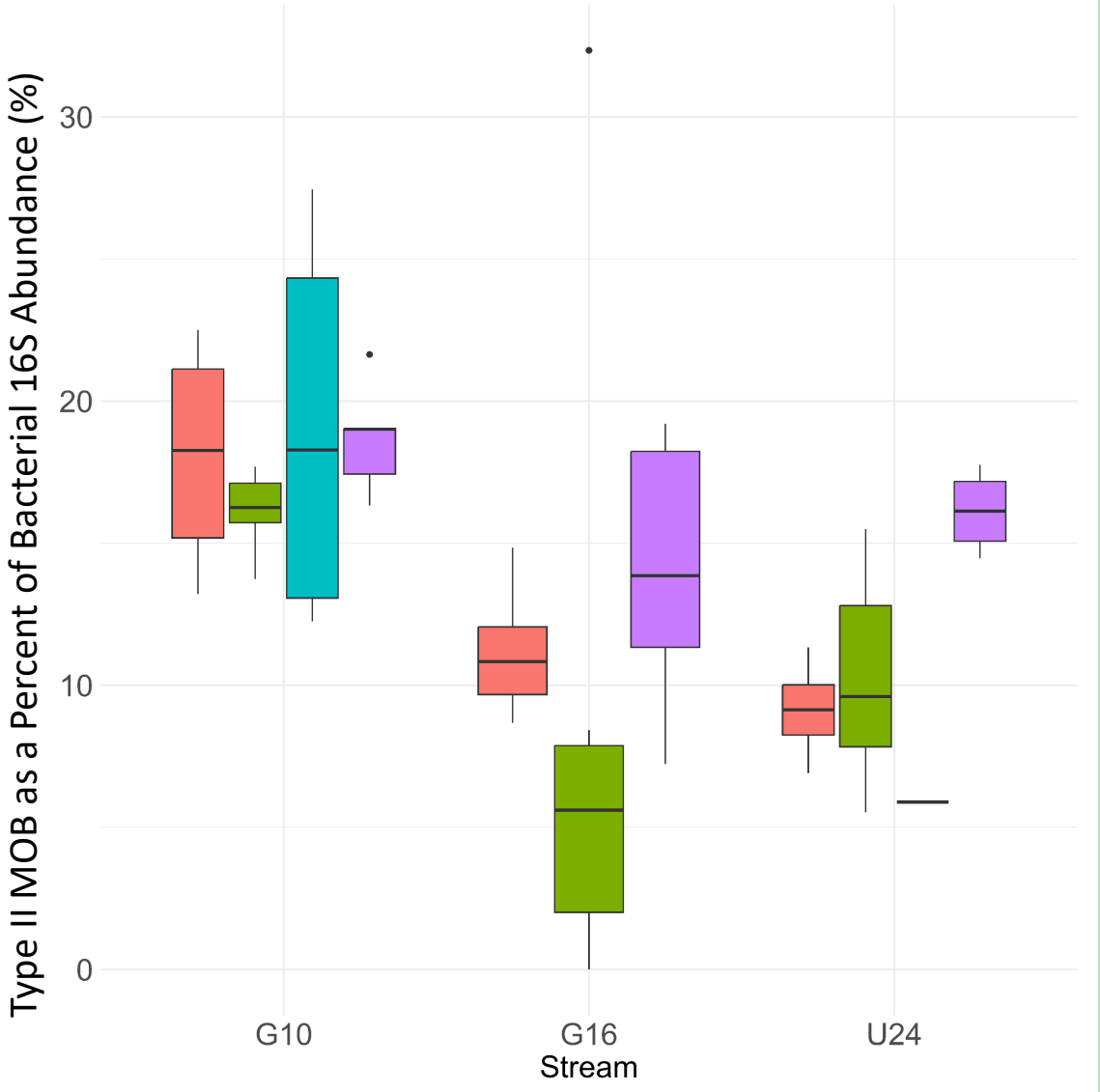
Does the community of MOB and methanogens change between resources (Abundance & Species composition)?

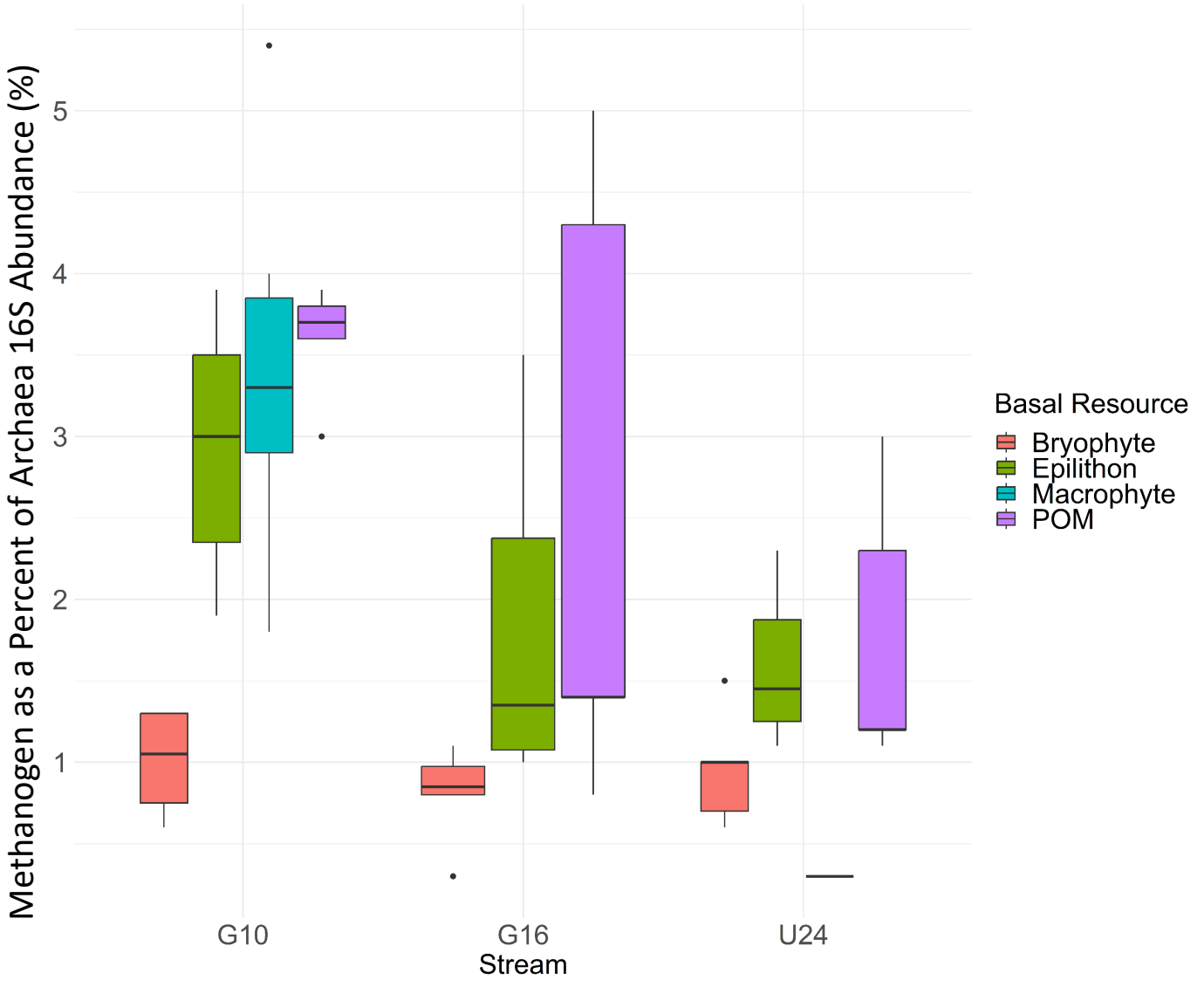
Are the changes in MOB/methanogen abundance reflected in invertebrate carbon isotopes?


-30
-35
-40
-45
δ13C
G10
G16
U24
Niche
Bryophyte
Epilithon
Macrophyte
POM

MOB (Type II)

Methanogens

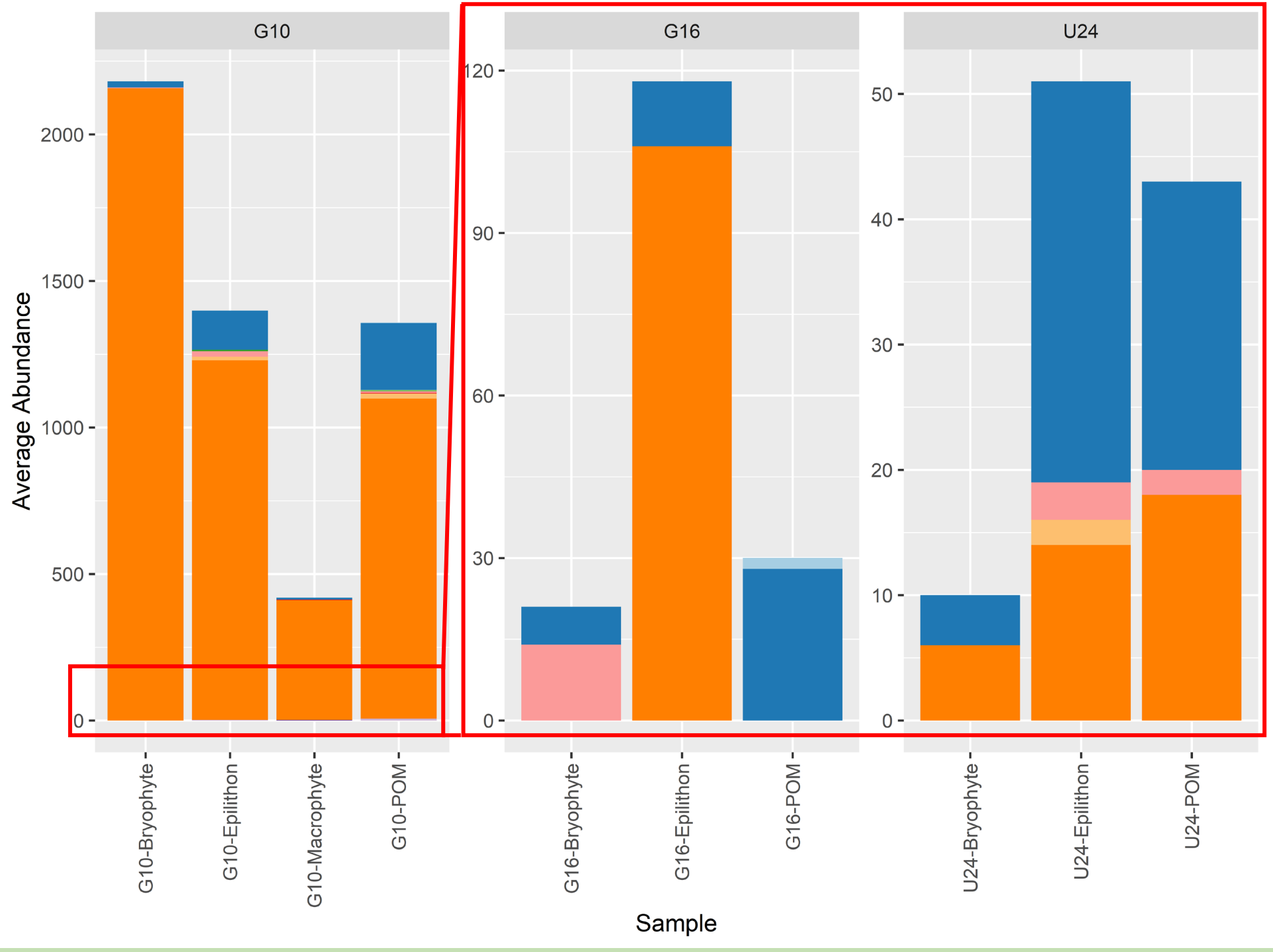




Stable Isotopes and microbial abundances

1. Invertebrate $\delta^{13}C$ negatively correlates with MOB (Type II) abundance
2. Invertebrate $\delta^{13}C$ correlation seen strongly in bryophyte MOB (Type II) abundance

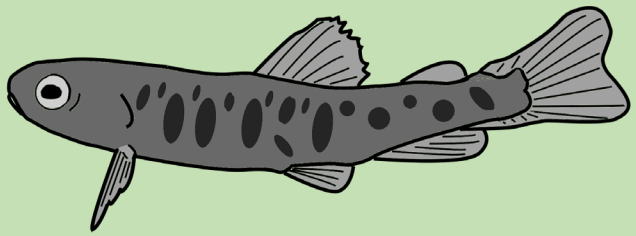
3. Epilithon $\delta^{13}C$ correlates with methanogen abundance
4. Invertebrate $\delta^{13}C$ correlates with methanogen abundance in epilithon



MOB

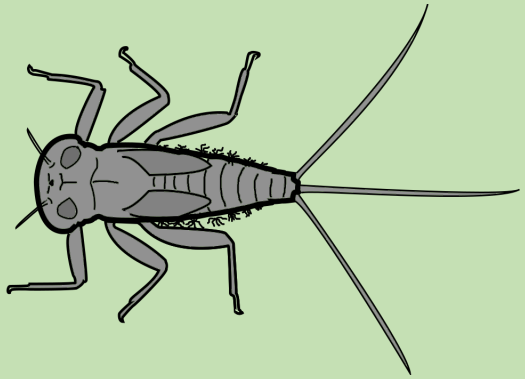
Type I MOB have higher C efficiency and have higher oxidation rates

Summary

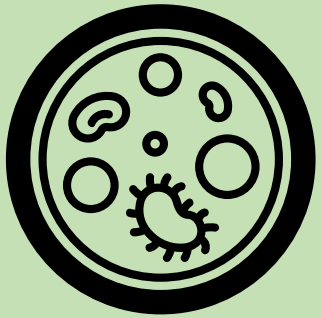


Catchment characteristics:

- Low drainage and Pastures correlate with low $\delta^{13}C$ values



- Grazers/Scrapers are the main group associated with MDC.
- MDC contributions correlates with the proportion of bryophyte and their bryophytic biofilms in their diet.



- MOB abundance main driver of MDC incorporation
  - Type I MOB associated with streams with higher MDC contributions

Thanks for listening!

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