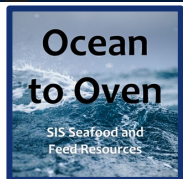


Trophodynamics of mesopelagic communities elucidates their roles in food security and sustainable nutrition provision



Zhu Y.¹, Kjellevold M.¹, Azad A.M.¹, Madsen L.¹, Wiech, M.¹
¹ *Institute of Marine Research, Norway*



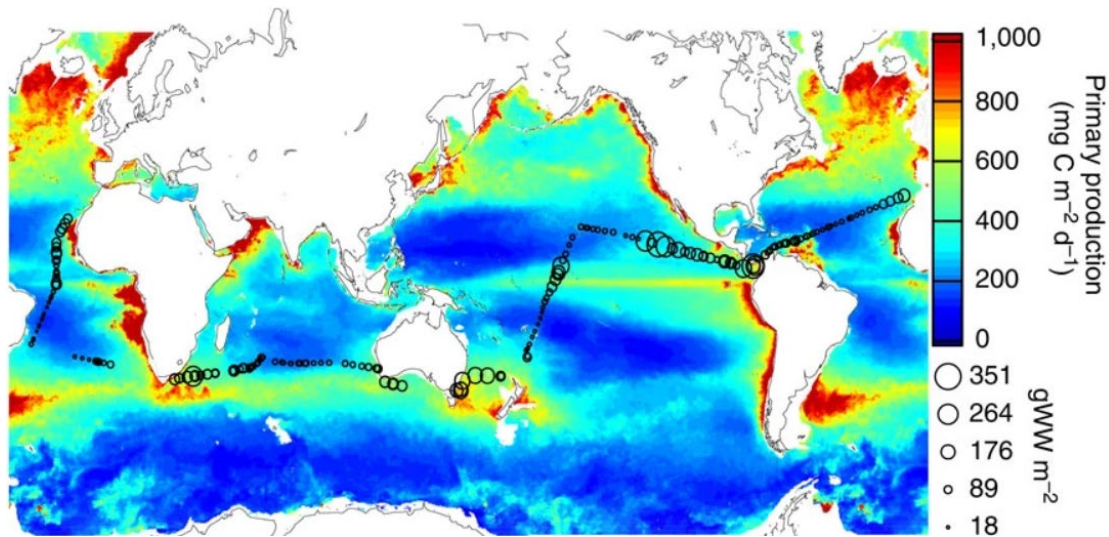
**Small Pelagic Fish:
New Frontiers in Science
and Sustainable
Management**
November 7 - 11, 2022
Lisbon, Portugal

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Why? Because...

✓ High biomass (Irigoien *et al.* 2014, Alvheim *et al.* 2020)



Irigoien *et al.* *Nature communications* (2014)



Why? Because...

- ✓ High biomass (Irigoien *et al.* 2014, Alvheim *et al.* 2020)
- ✓ Nutrient dense (Alvheim *et al.* 2020, Nordhagen *et al.* 2020)

Potential contribution to RI (%)	Iodine	Calcium	Iron	Zinc	Selenium	Vitamin A1	Vitamin D3
RI ^a	150 µg	800 mg	15 mg	7 mg	50 µg	700 RE	10 µg
<i>Benthosema glaciale</i>	14	31	4	6	61	117	<LOQ
<i>Maurolicus muelleri</i>	9	34	5	8	44	73	<LOQ
<i>M. norvegica</i>	40	41	7	7	101	5	<LOQ
<i>Pasiphaea sp.</i>	15	40	1	6	43	1	<LOQ
<i>Eusergestes arcticus</i>	39	33	1	13	52	3	<LOQ
<i>Periphylla periphylla</i>	1	3	0	8	4	0	<LOQ
Salmon filet (<i>Salmo salar</i>)	1	0	1	3	17	-	43
Cod filet (<i>Gadus morhua</i>)	63 *	-	0	3	25	1	-
Sprat (<i>Sprattus sprattus</i>)	2	-	6	15	36	-	-
Pork	0	0	3	13	6	0	0
Chicken ^b	0	1	2	11	12	1	0
Beef	1	0	8	29	6	0	0
No of daily doses of RI from mesopelagic species/ km ³ fjord ^c	169,000	353,000	31,800	87,300	591,000	348,000	-

Alvheim *et al.* Foods (2020)





But (there is always a but)...

- ✓ High biomass (*Irigoien et al. 2014, Alvheim et al. 2020*)
- ✓ Nutrient dense (*Alvheim et al. 2020, Nordhagen et al. 2020*)

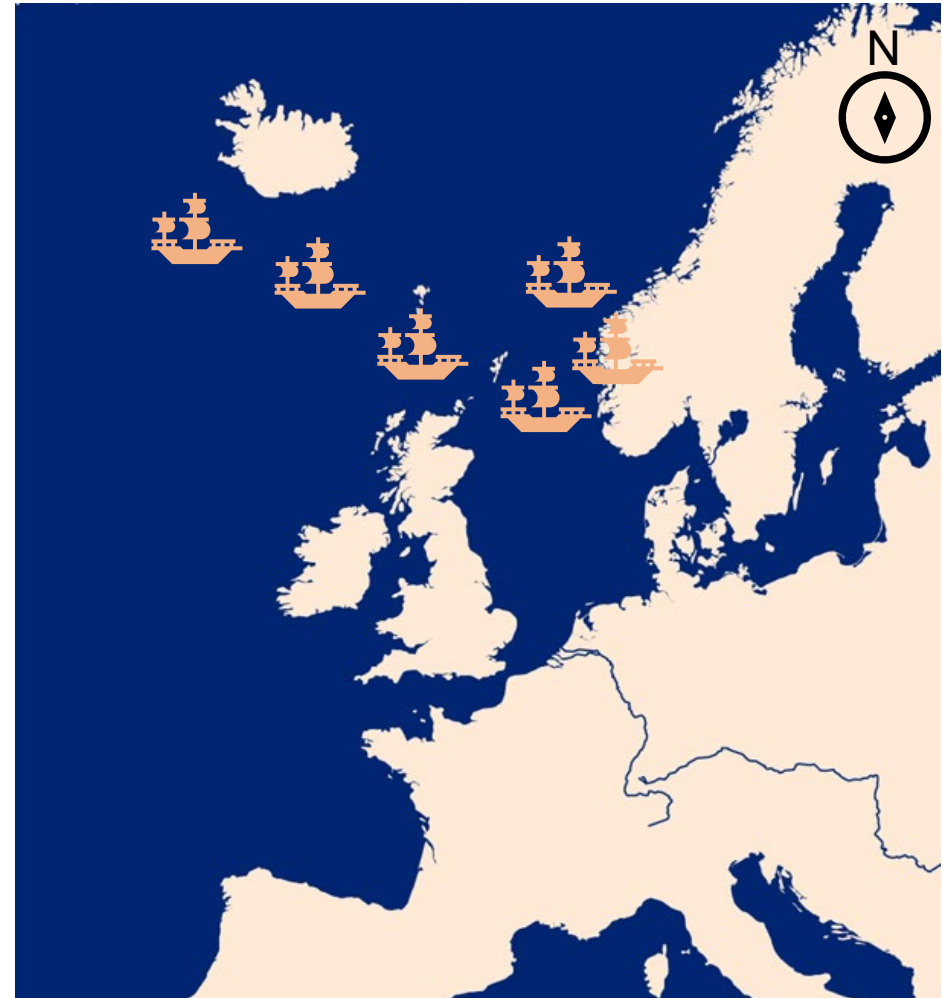
- Trophic ecology
 - Nutrient tracing
 - Predator-prey relationship
 - Stability
 - Trophic connectivity





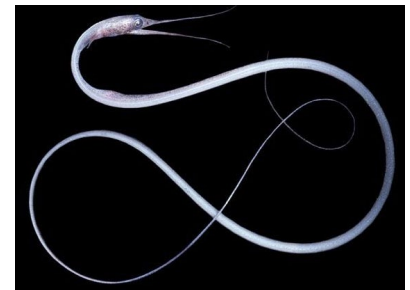
Where did we go?

- Regions
 - Irminger Basin
 - Iceland Basin
 - Faroe Ridge
 - Norwegian Sea
 - North Sea
 - Fjords





What did we get?



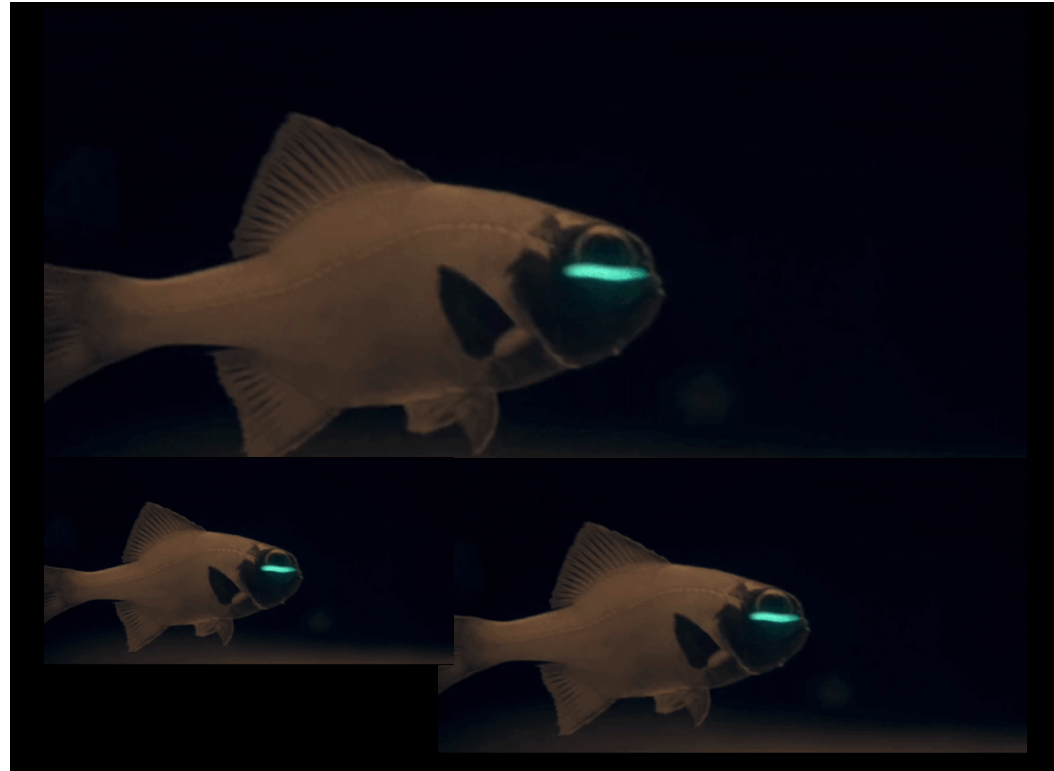
What have we analysed?

- Stable isotopes
 - $\delta^{13}\text{C}$ (nutrient source)
 - $\delta^{15}\text{N}$ (trophic position)
 - Iso-space, SIBER, trophic structure
- Nutrients and contaminants
 - Micro- and macro-nutrients
 - Hazardous metal and POPs
 - Correlation





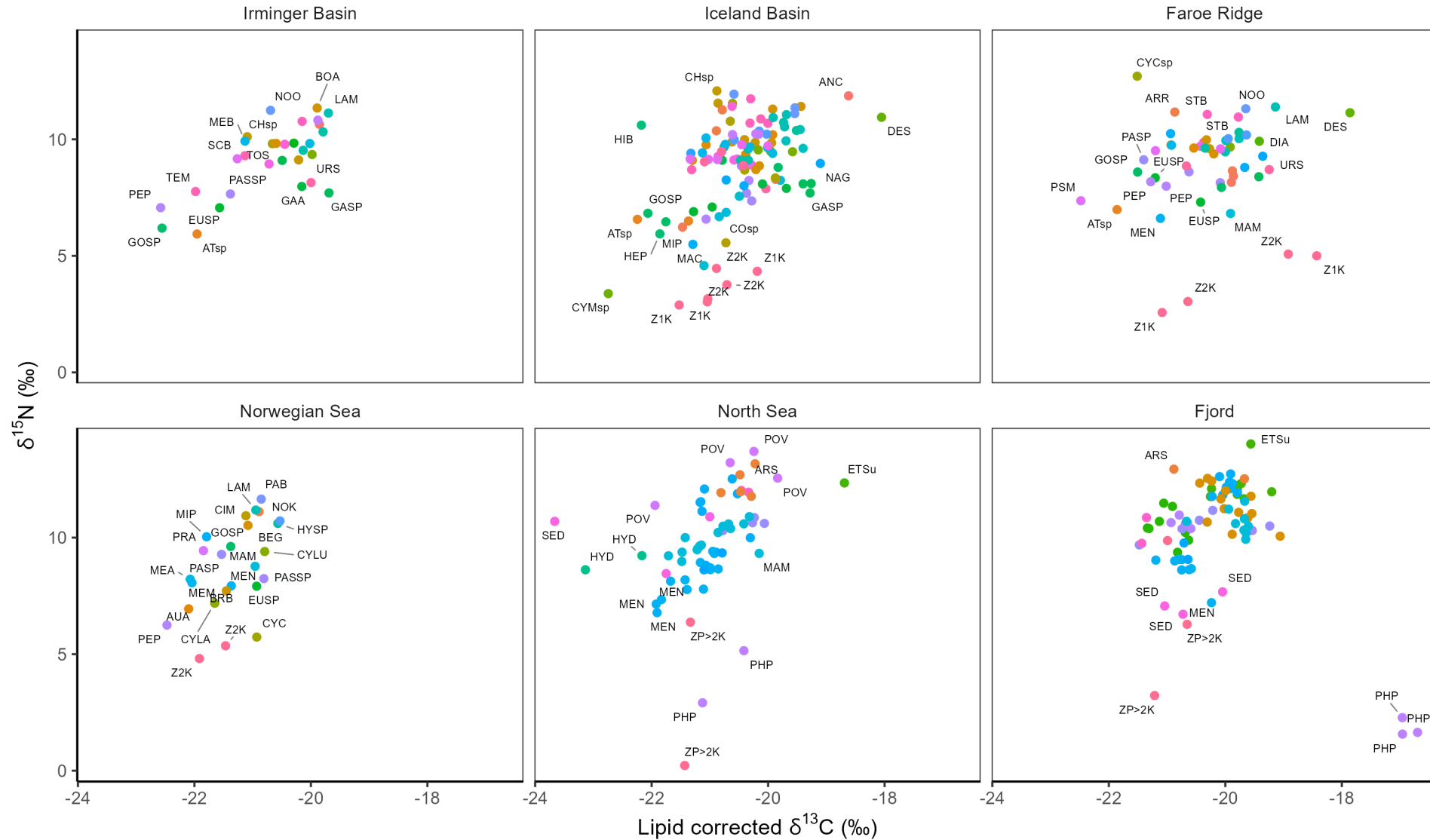
Take a 'deep' breath...



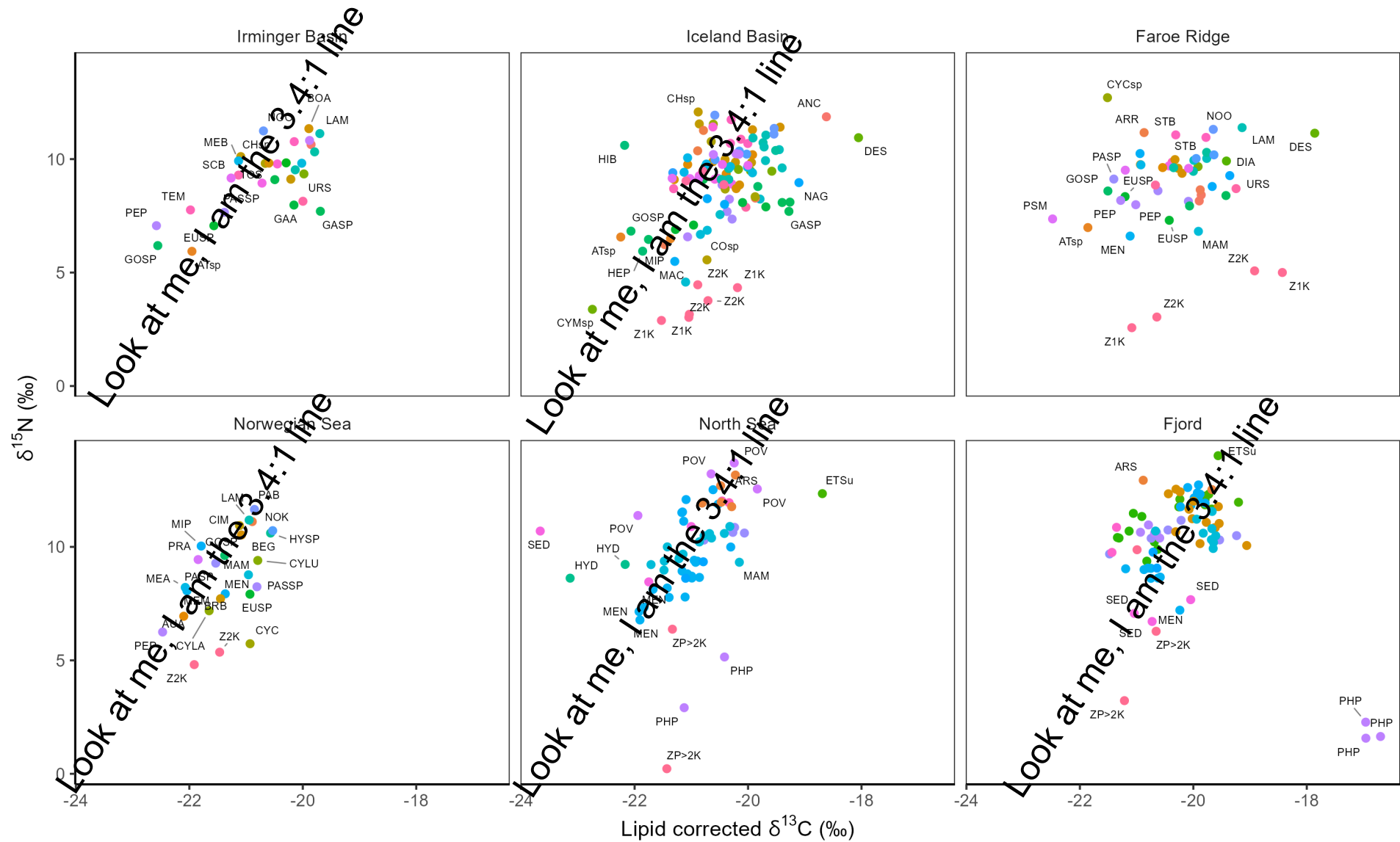
Let's go!



Iso-space (step 1)

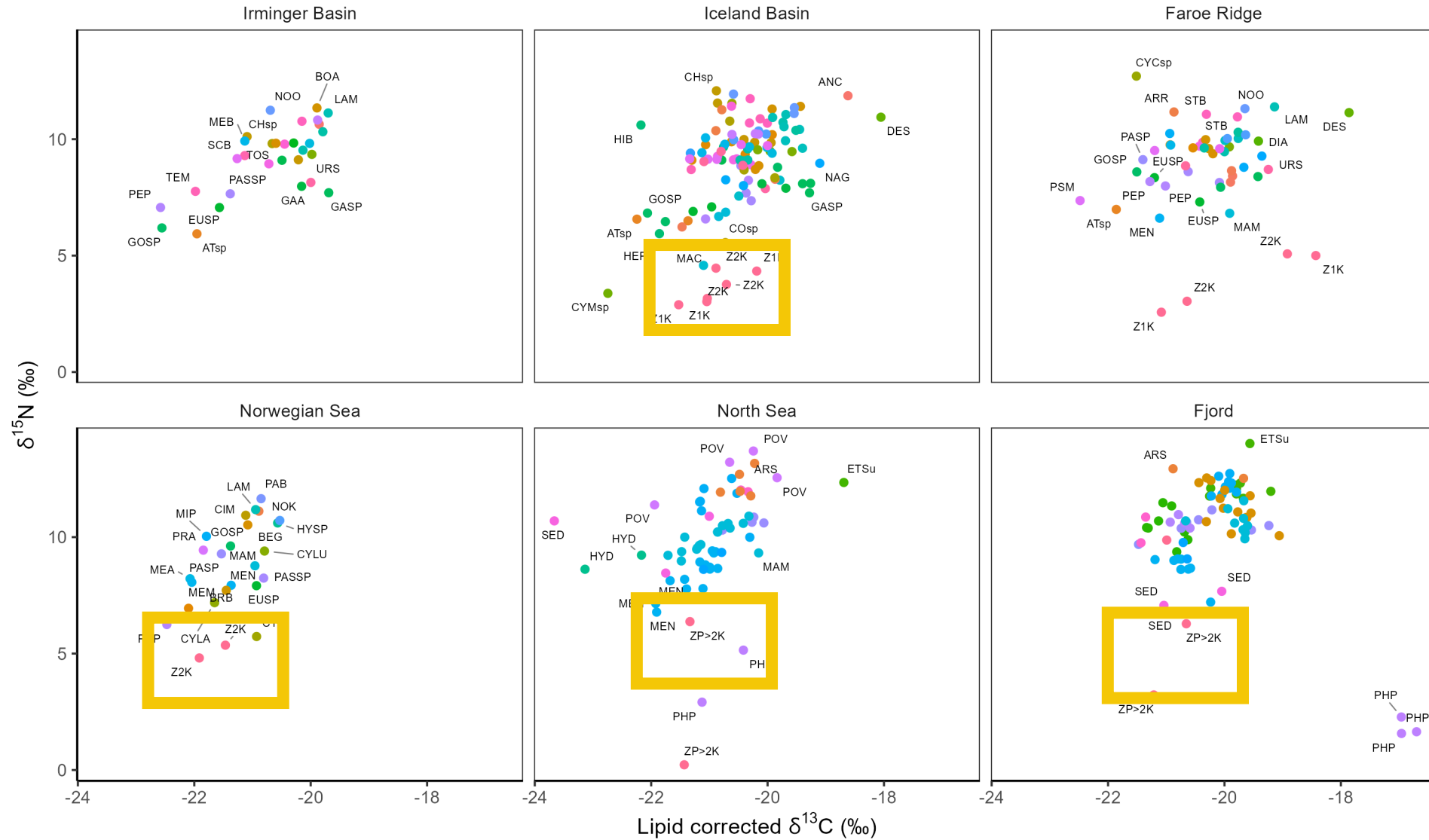


Iso-space (step 1)



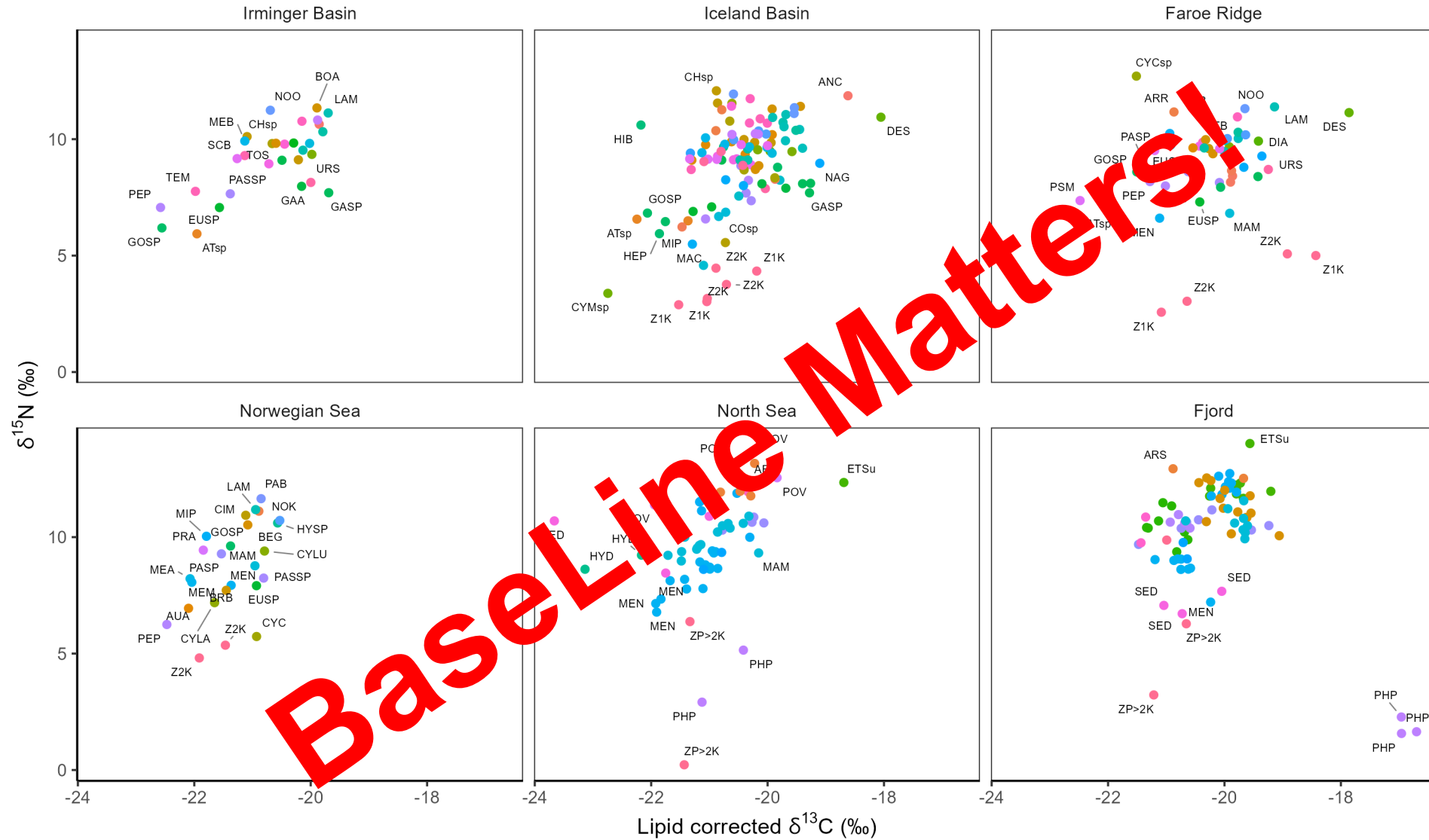


Iso-space (step 1)



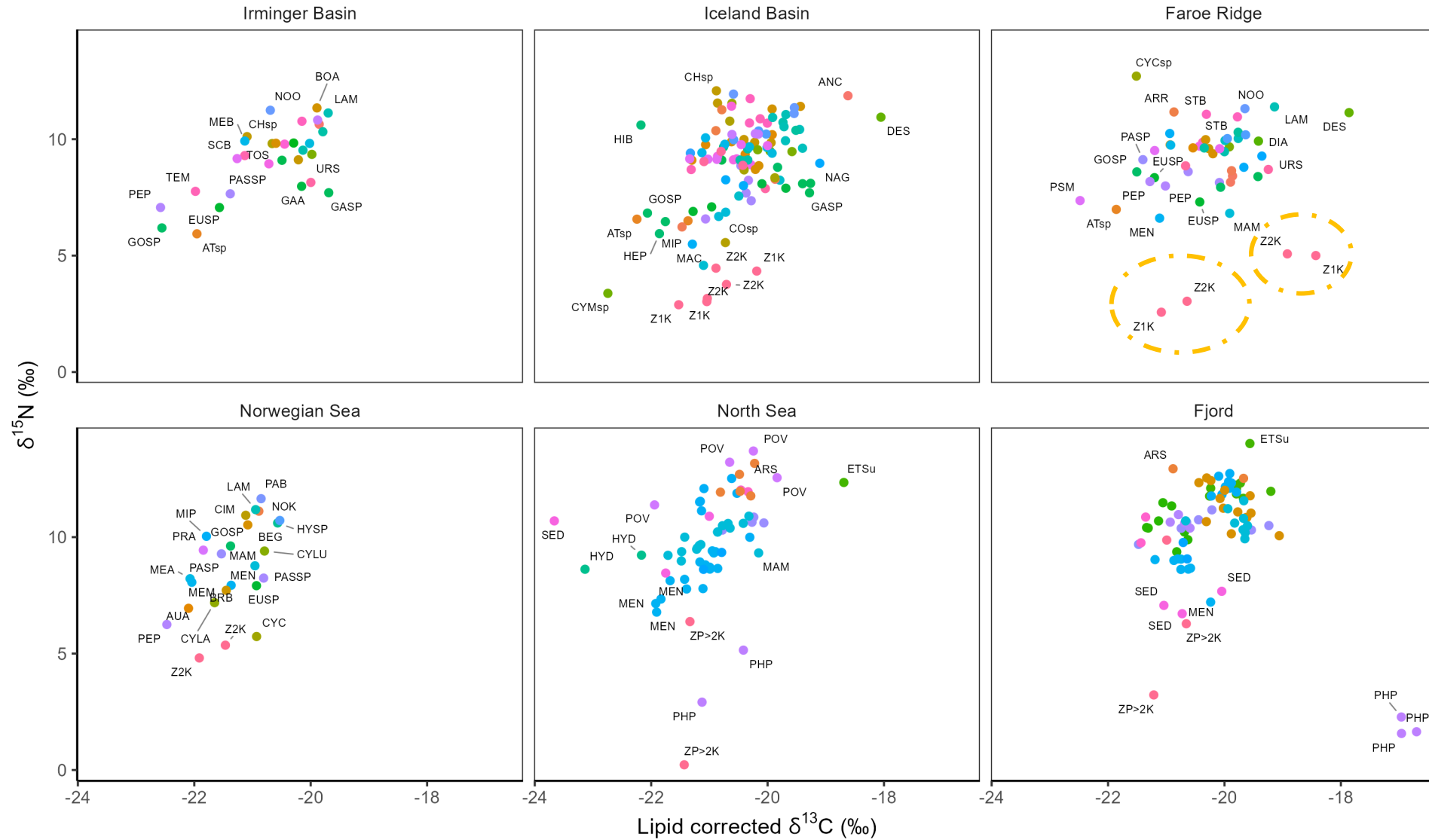


Iso-space (step 1)





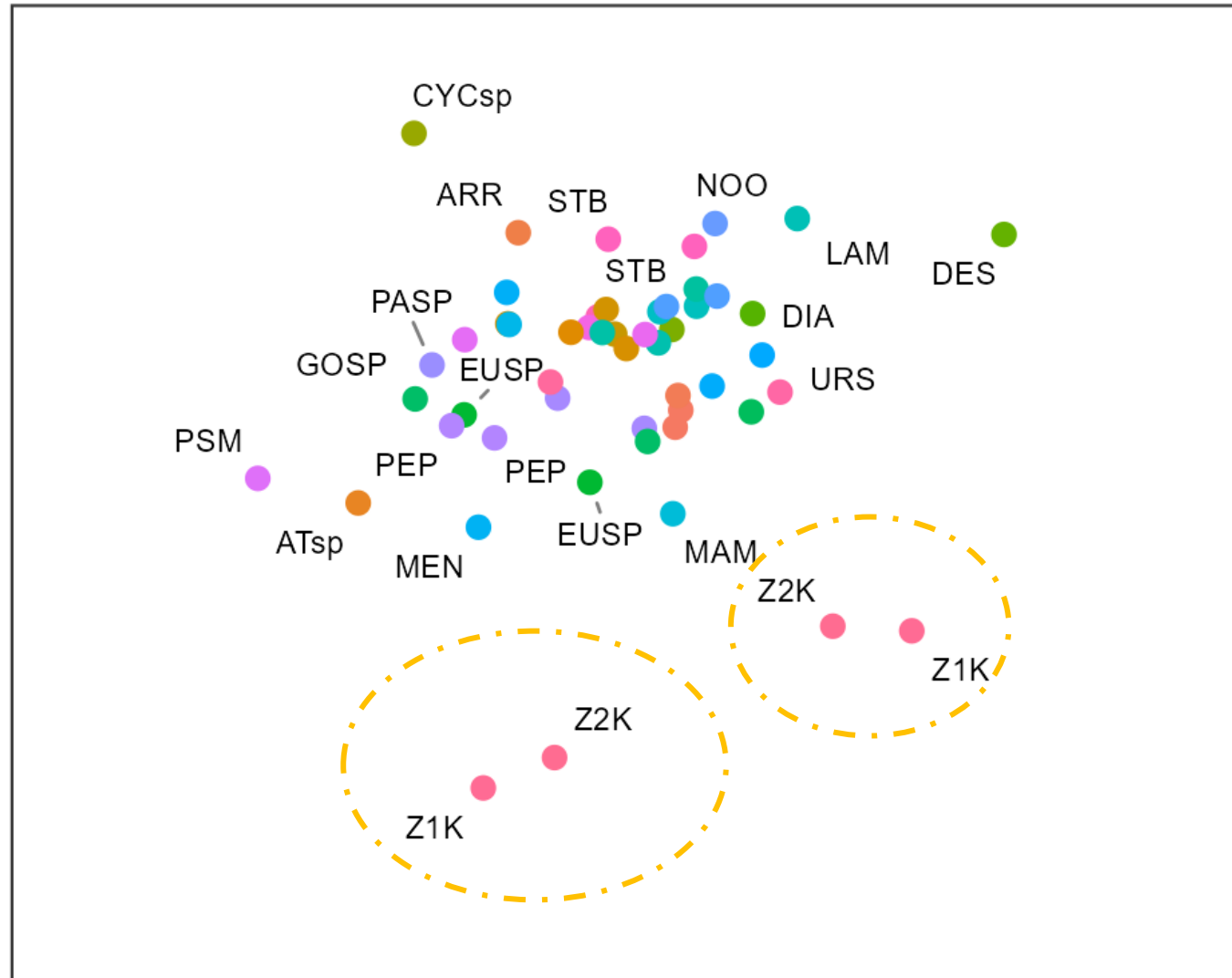
Iso-space (step 1)



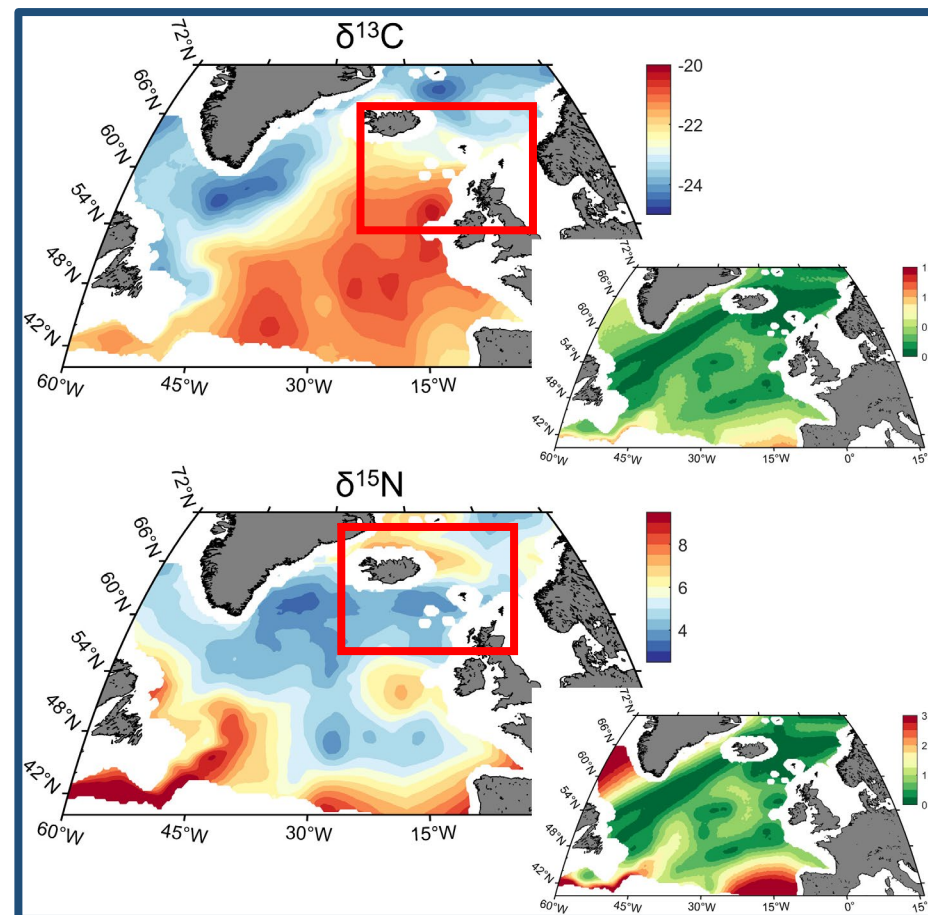


Iso-space (step 1)

Faroe Ridge



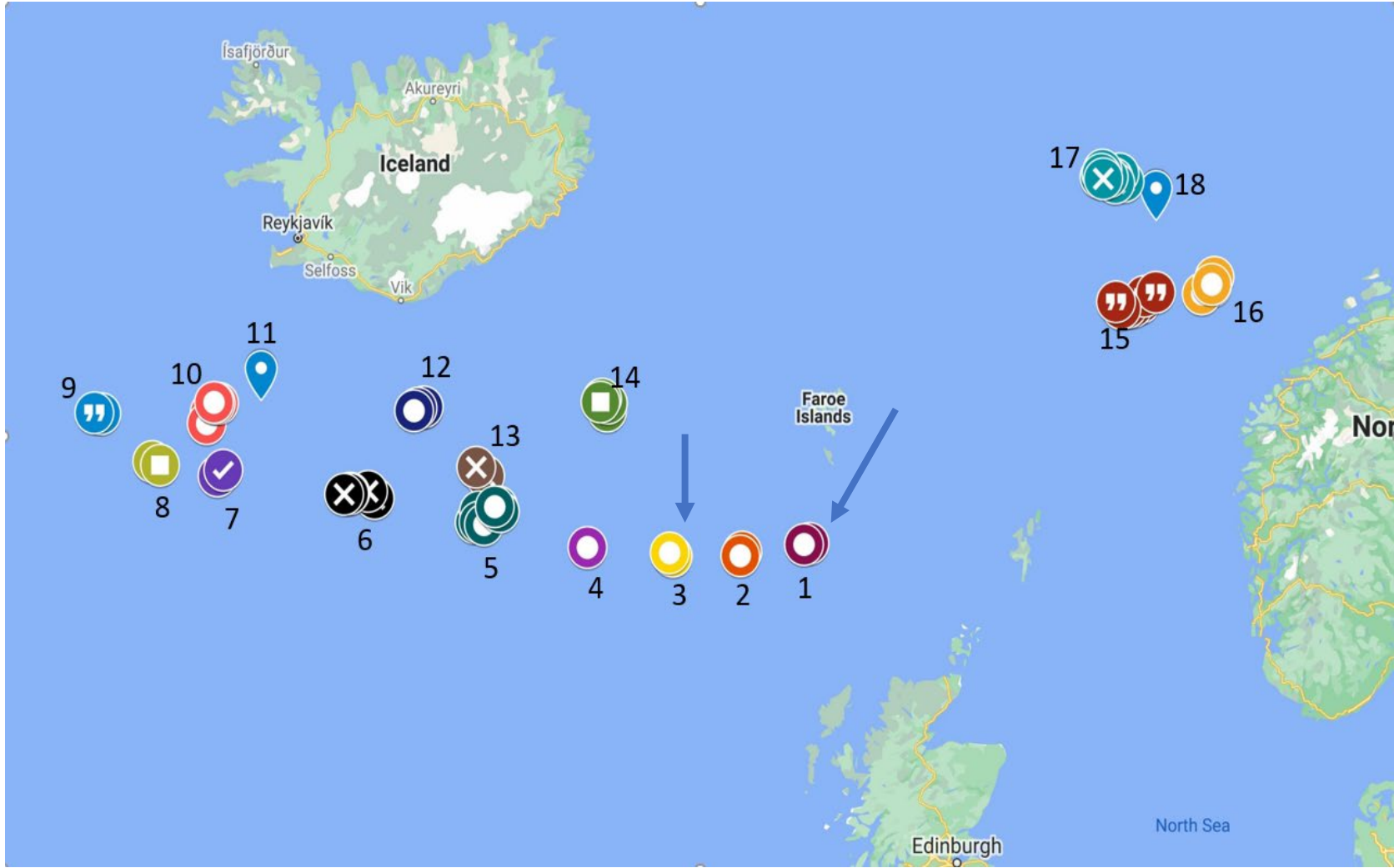
Isoscape in North Atlantic



Average yearly isoscape predicted for 1998-2020 (left) and the associated variance (right) using *Calanus finmarchicus* and *C. helgolandicus*.

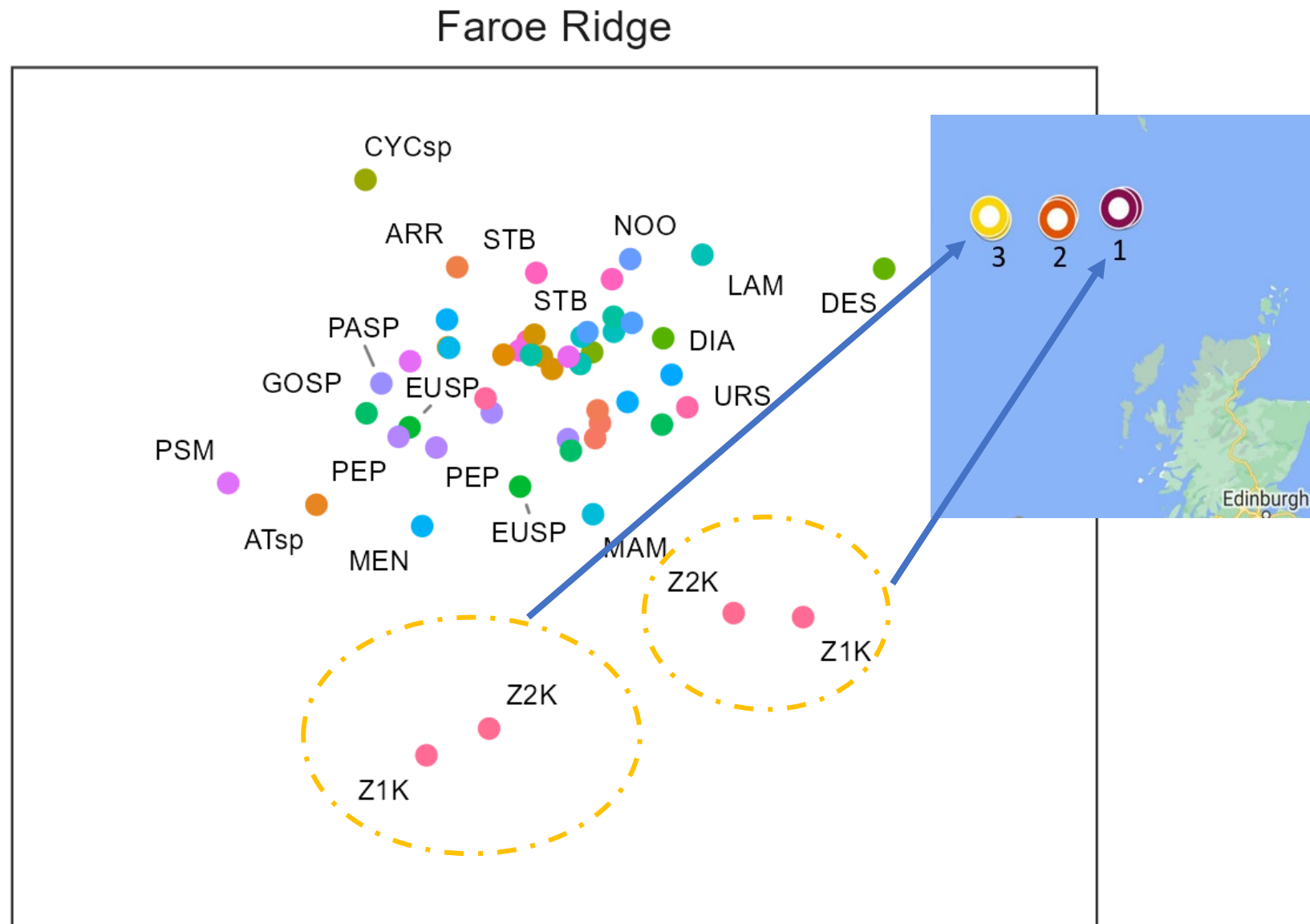
Espinasse *et al.*, 2022





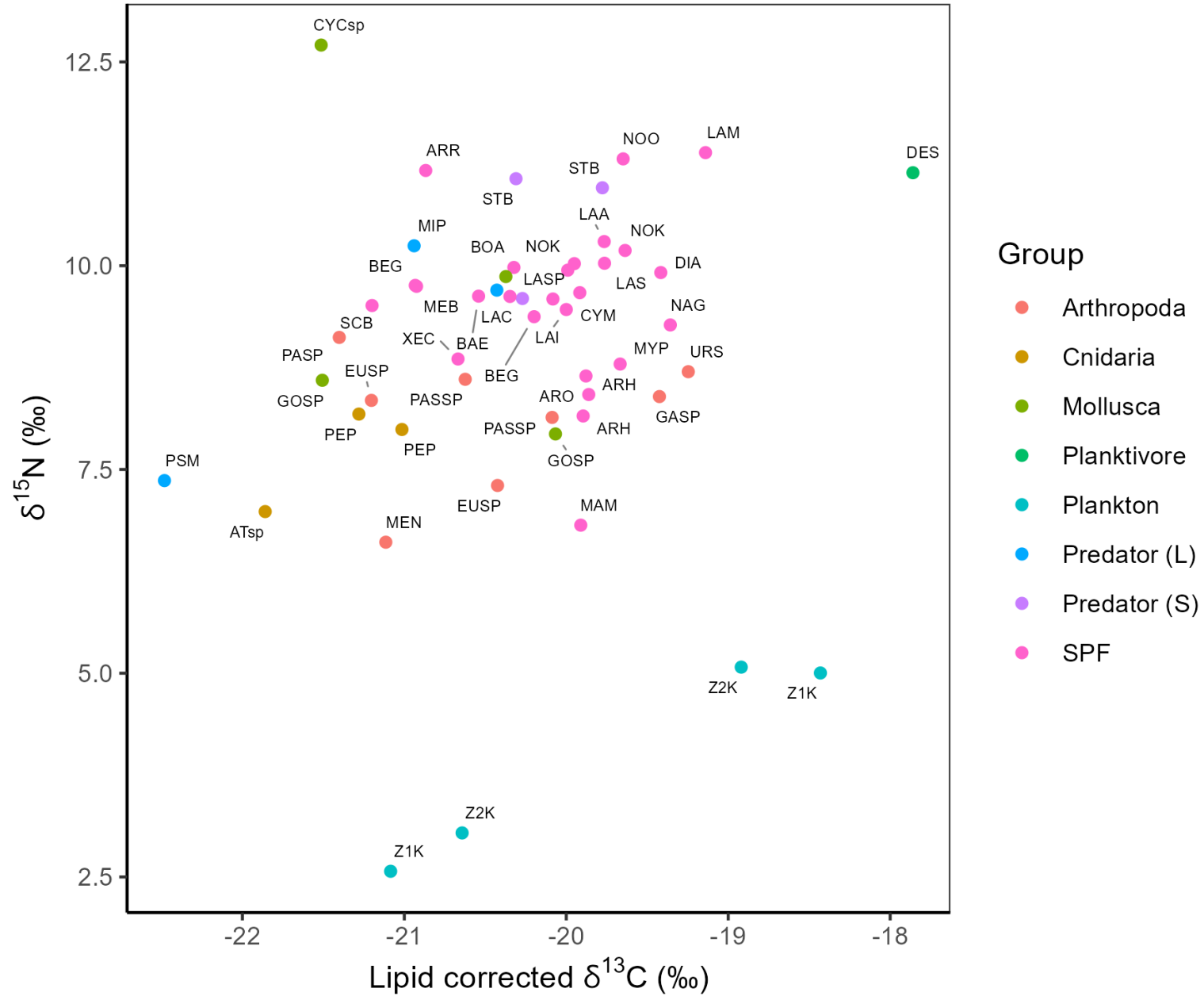


Iso-space (step 1)



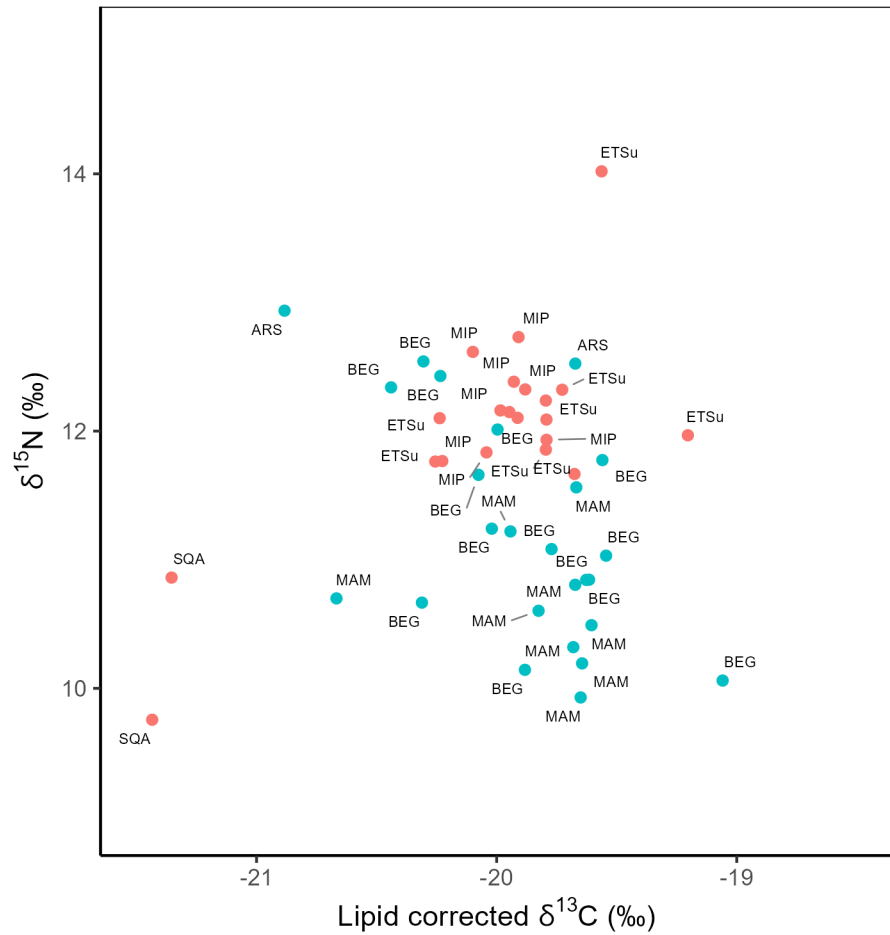


Iso-space (step 2)



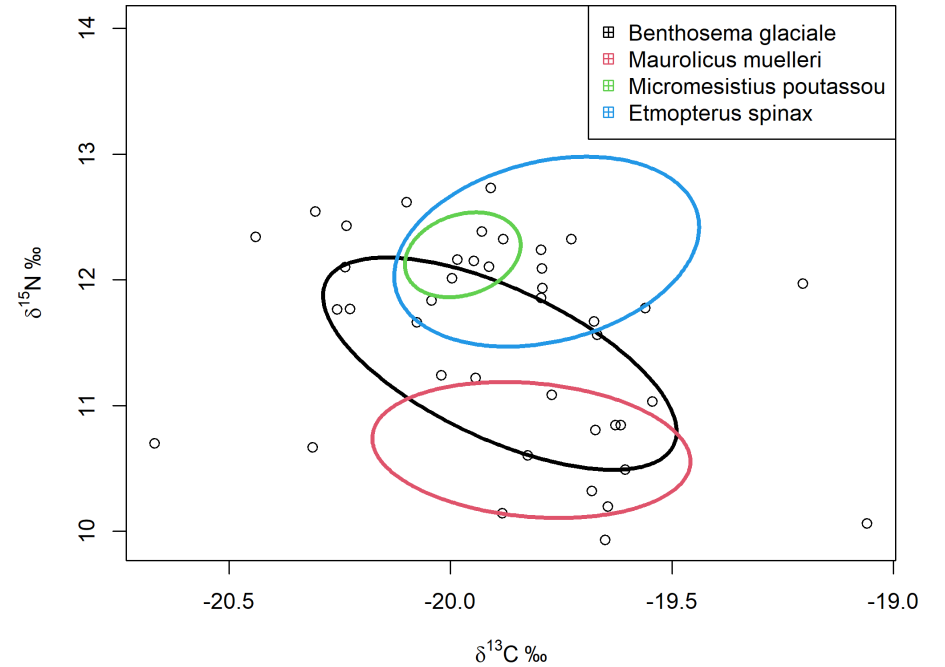


Iso-space (step 3): + Trophic Ecology



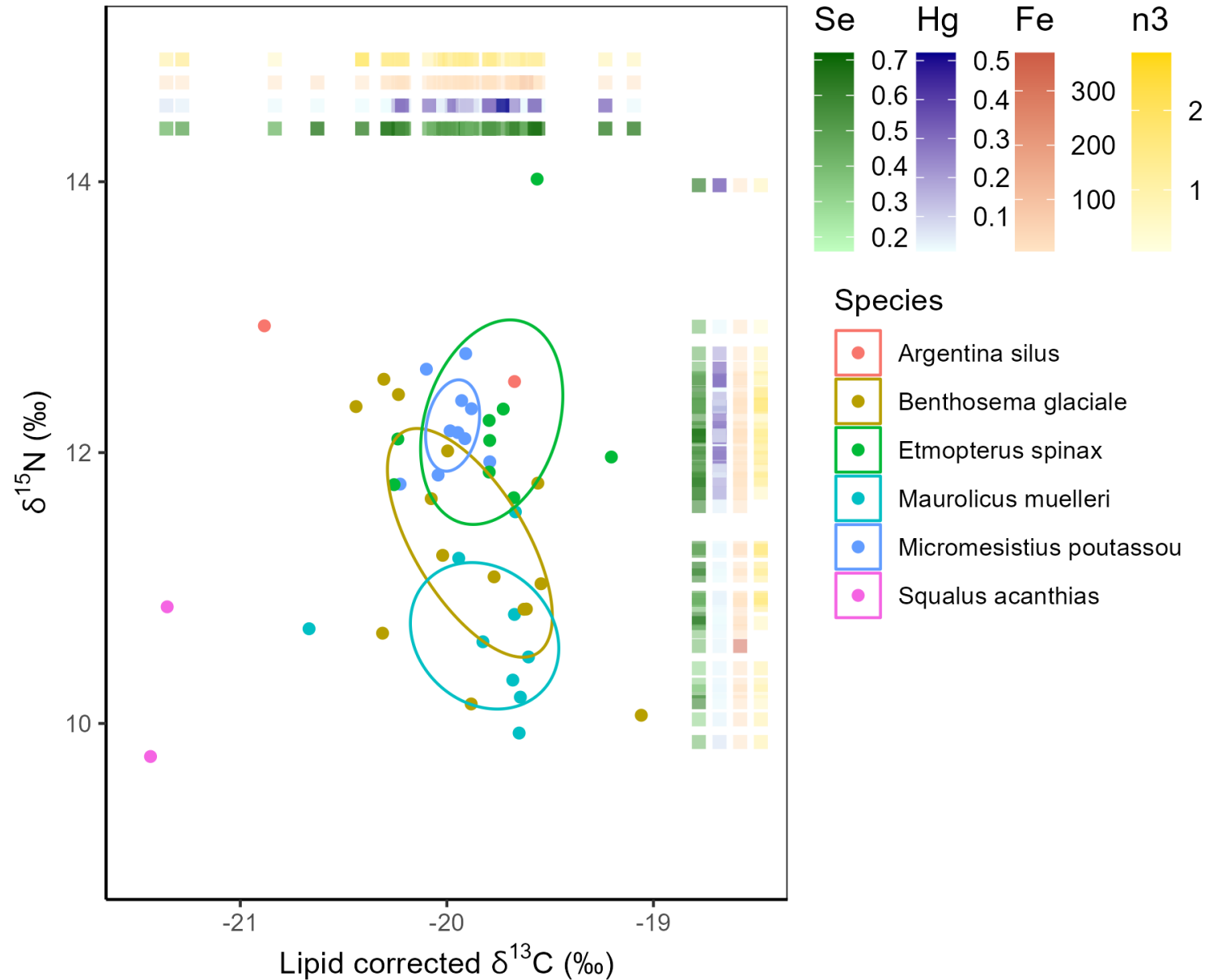
Group
● Predator (L)
● SPF

Stable Isotope Bayesian Ellipses in R "SIBER"

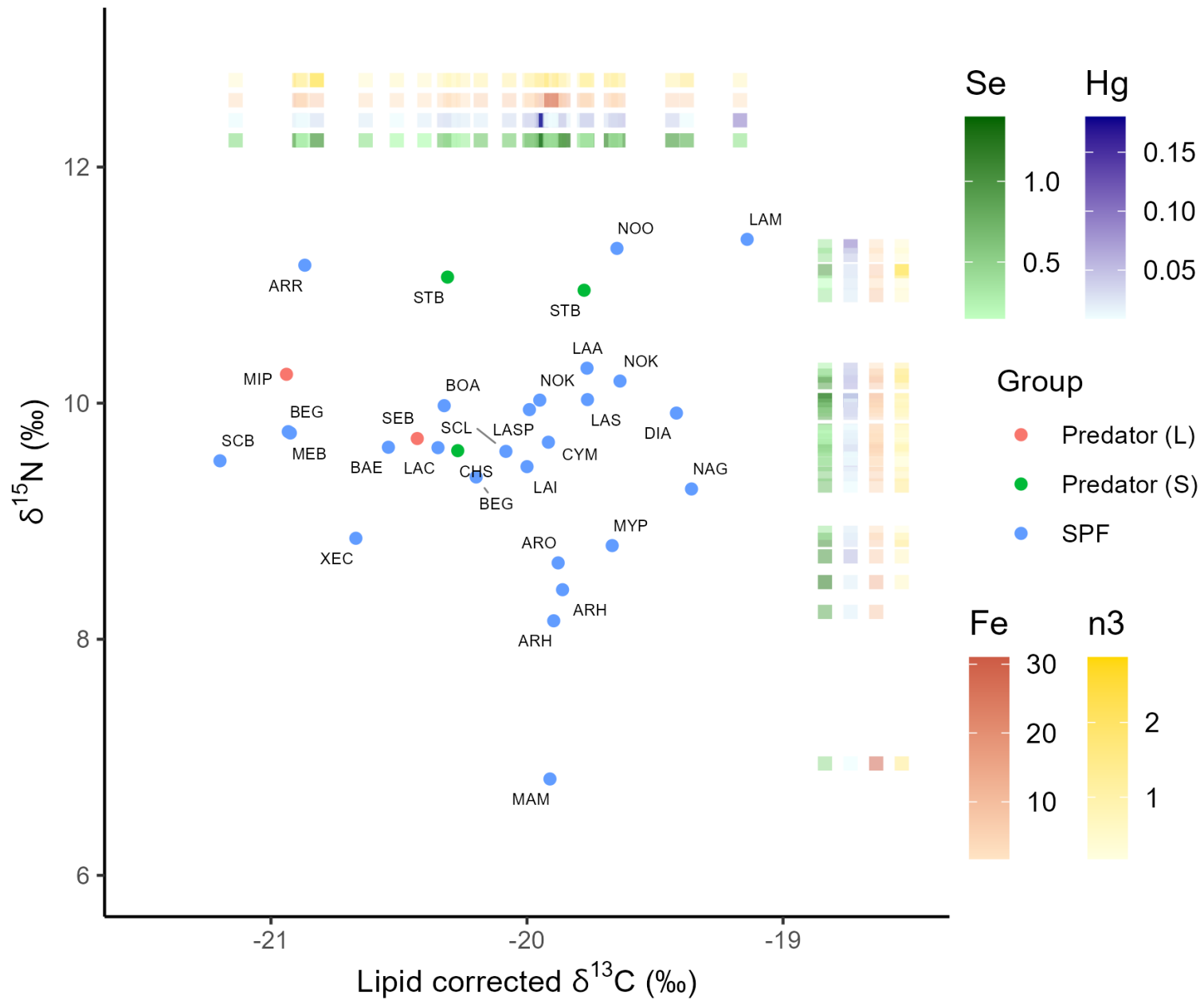




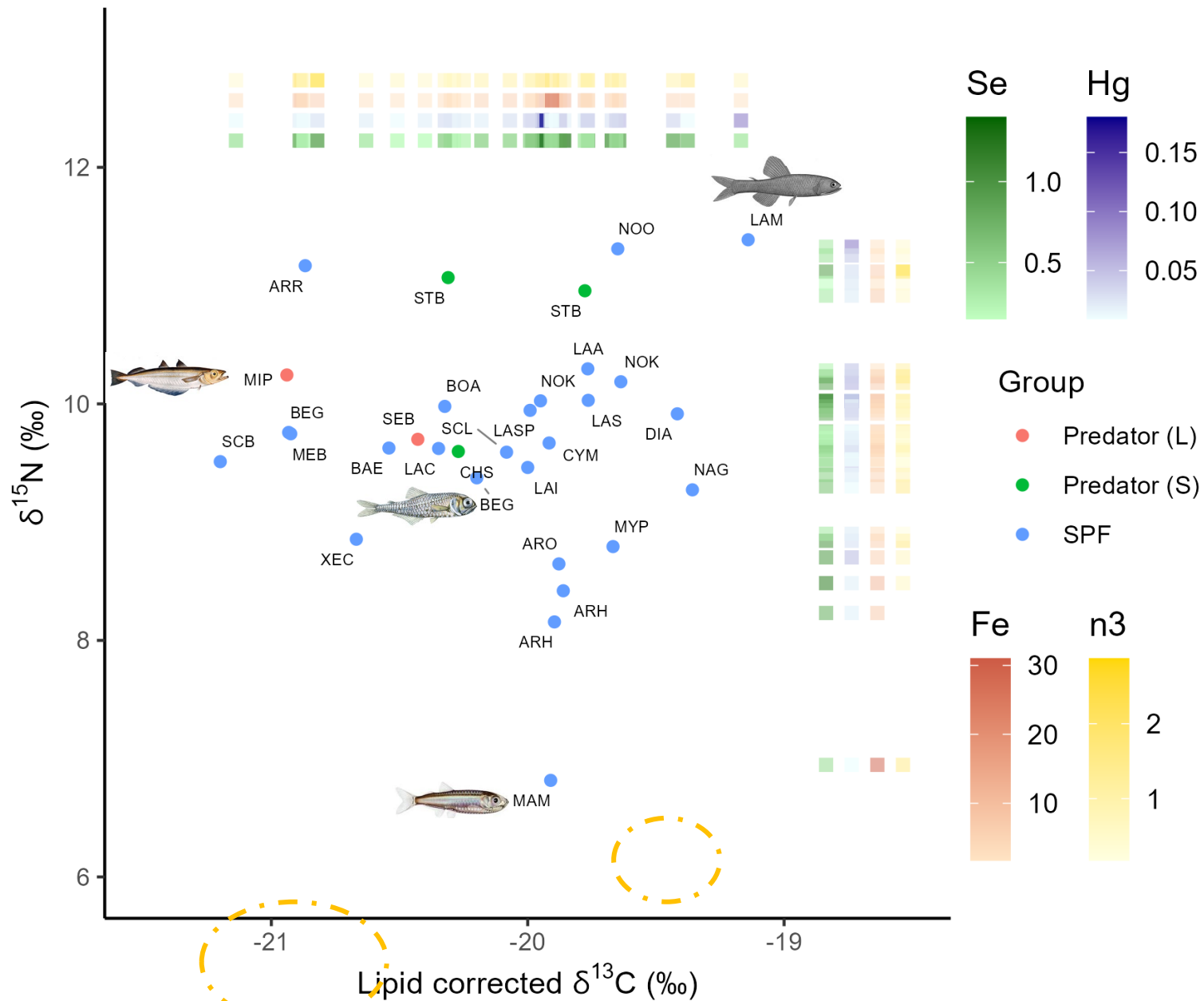
Iso-space (step 4): + Substance Levels



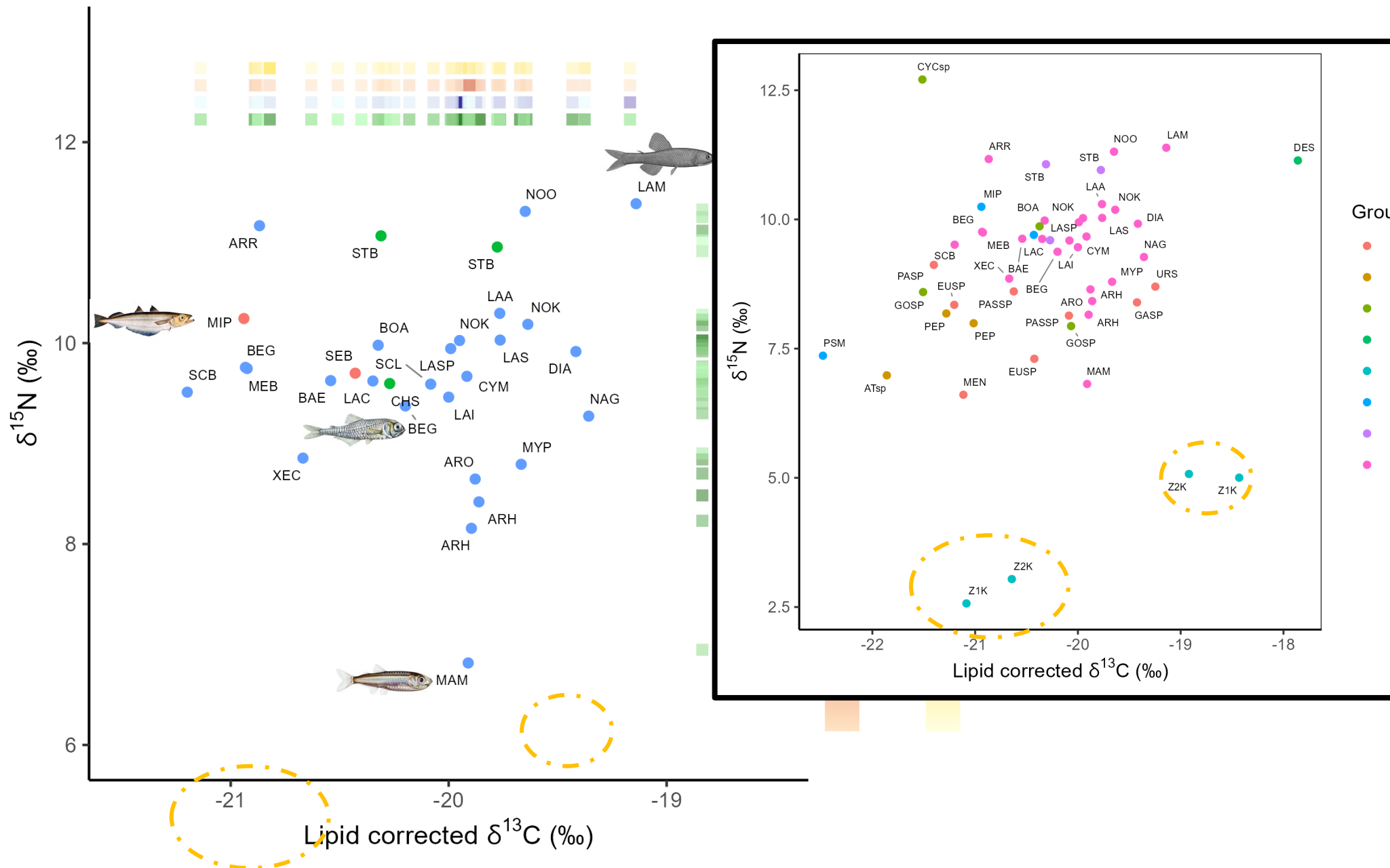
Faroe Ridge



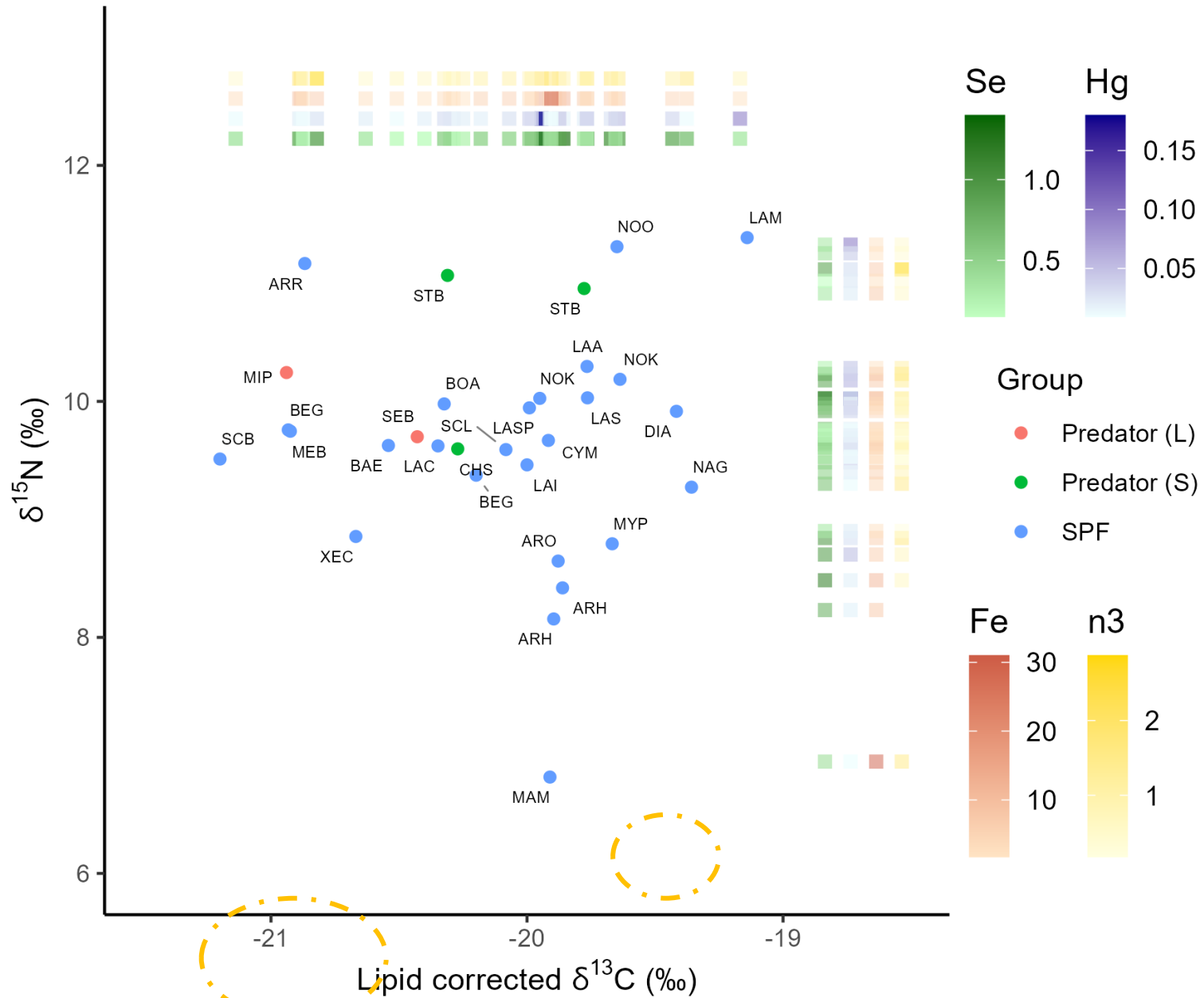
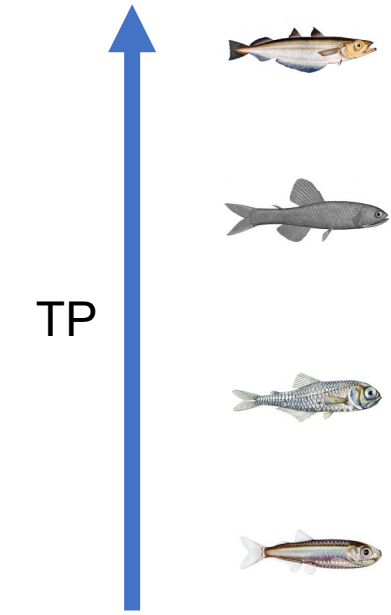
Faroe Ridge



Faroe Ridge

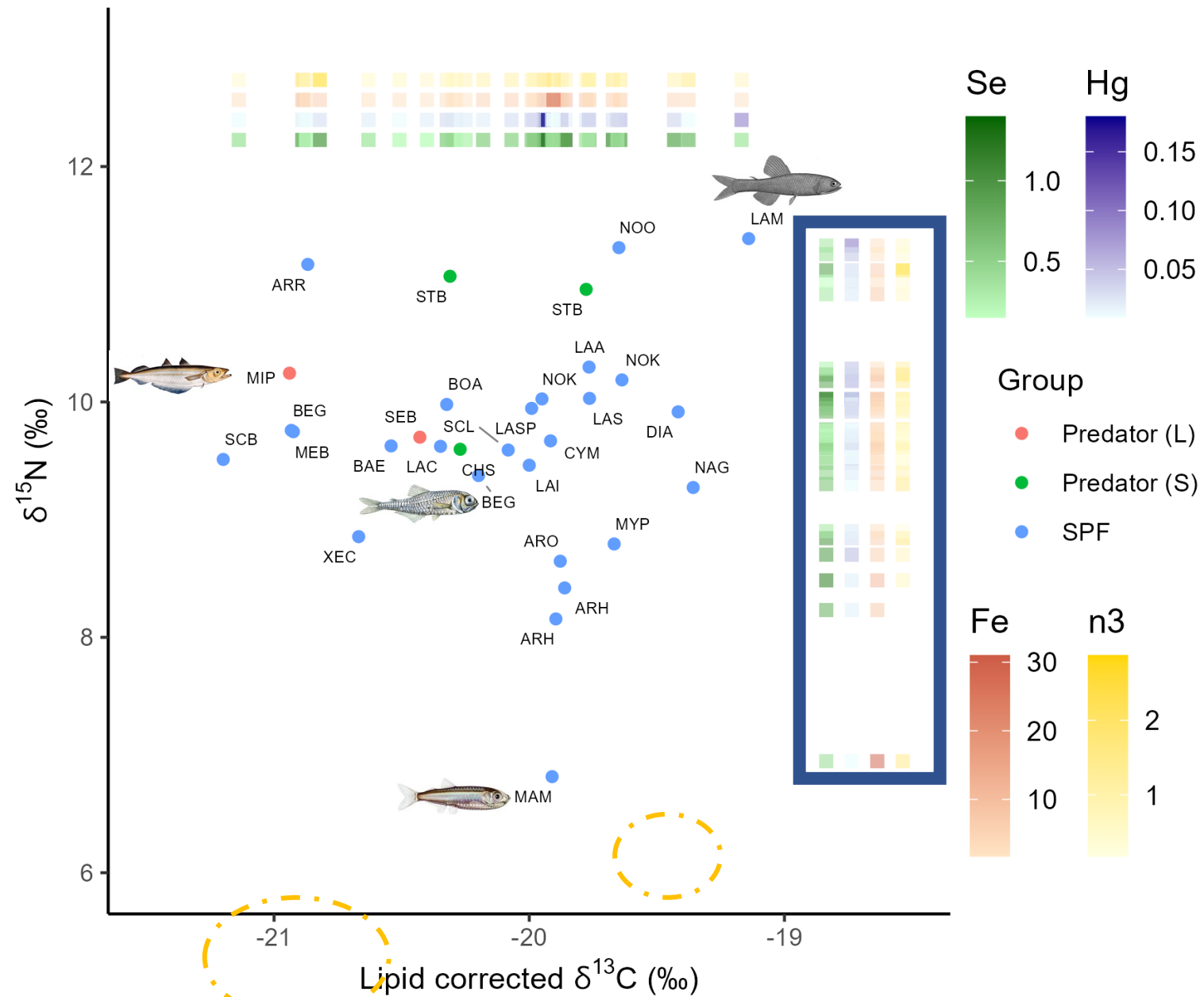


Faroe Ridge



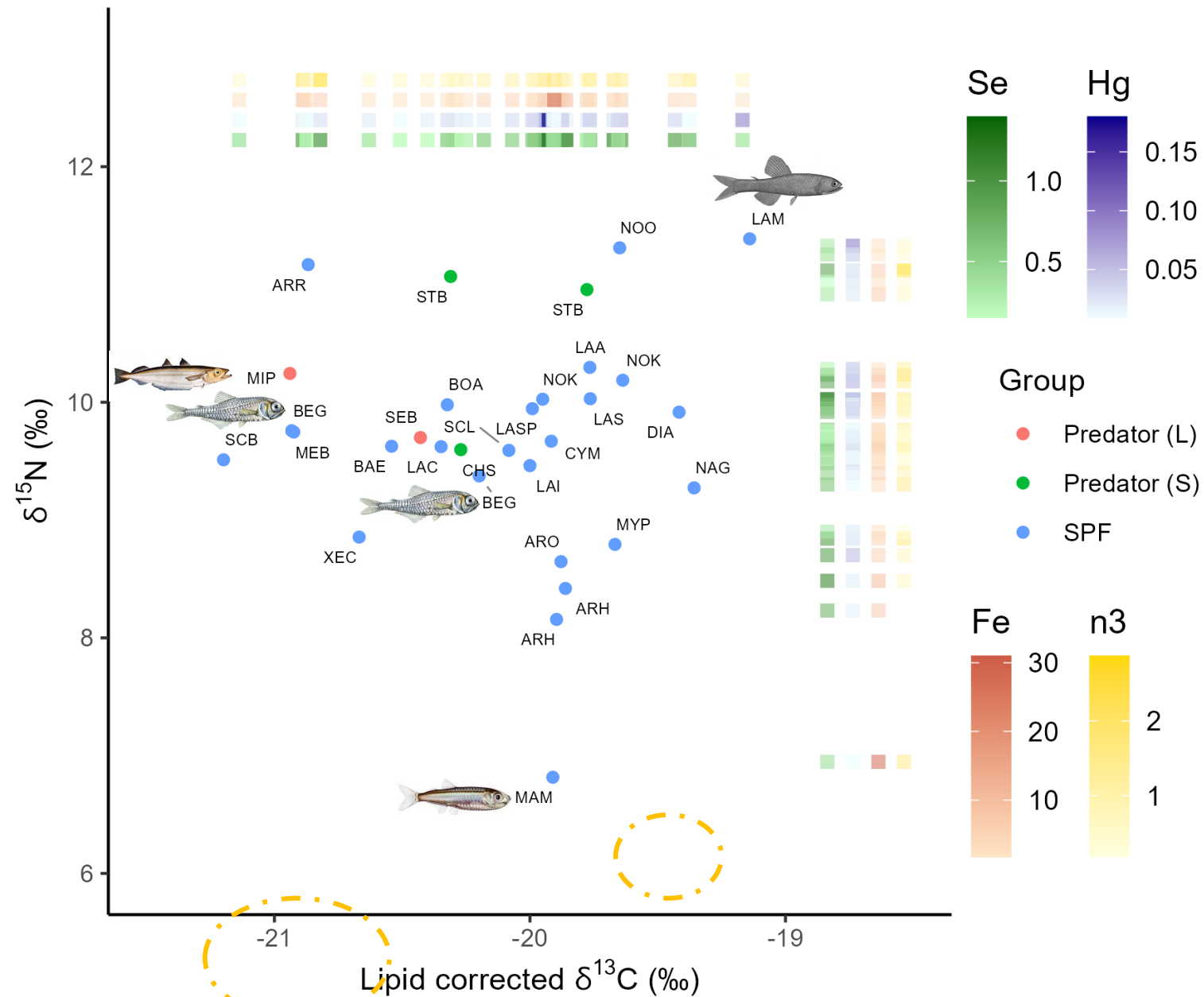


Faroe Ridge: TP vs. Nutrients

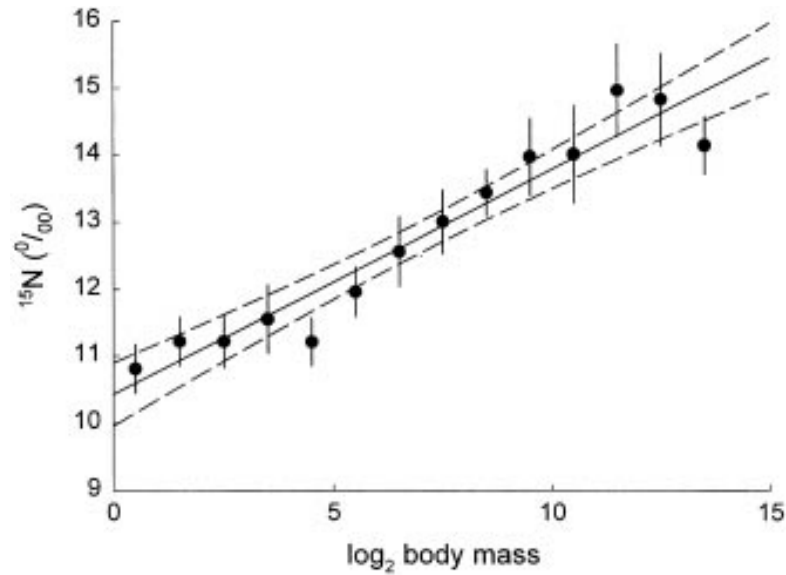




Faroe Ridge: Source vs. Nutrients

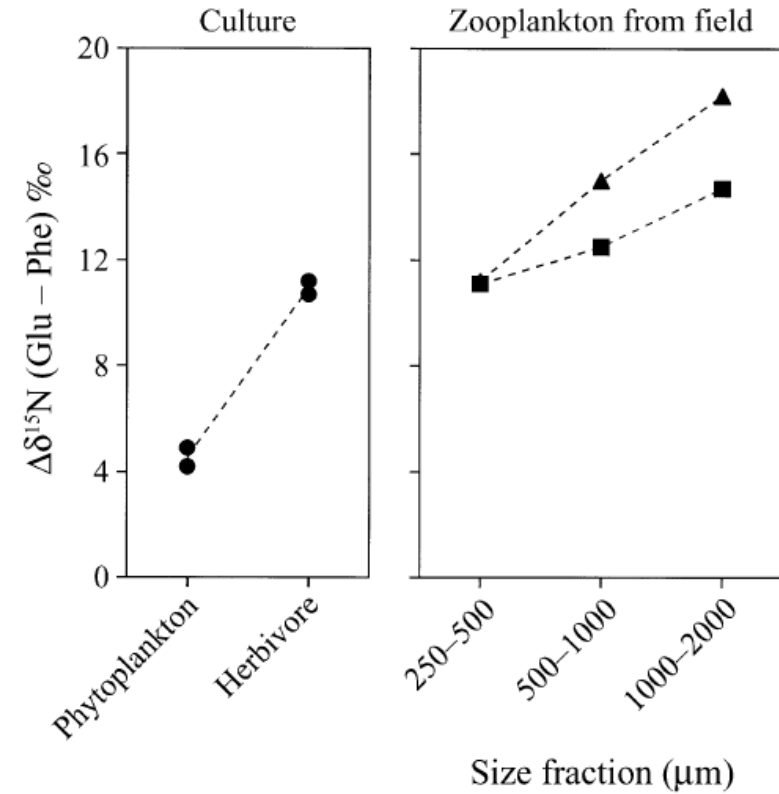


Does size matter?



Fishes in the northern North Sea

Jennings *et al.*, 2001

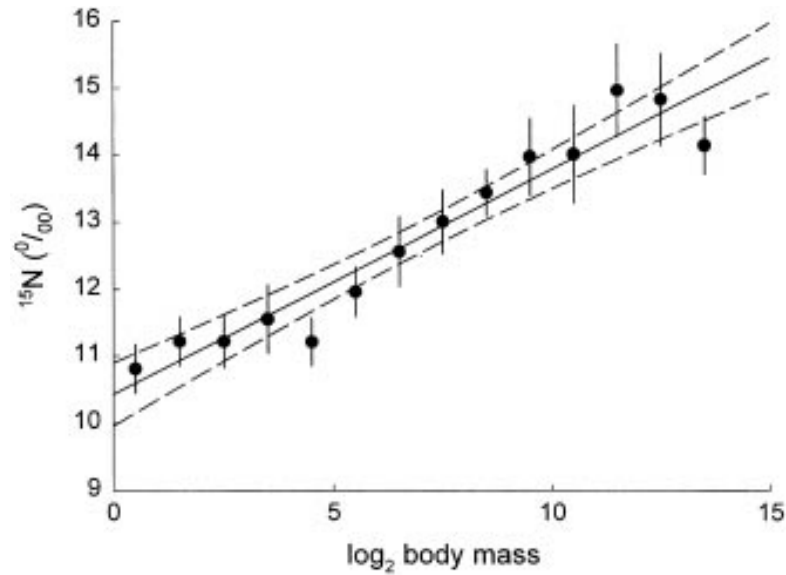


Zooplankton (size groups) from tropical and subtropical Atlantic

McClelland & Montoya, 2002

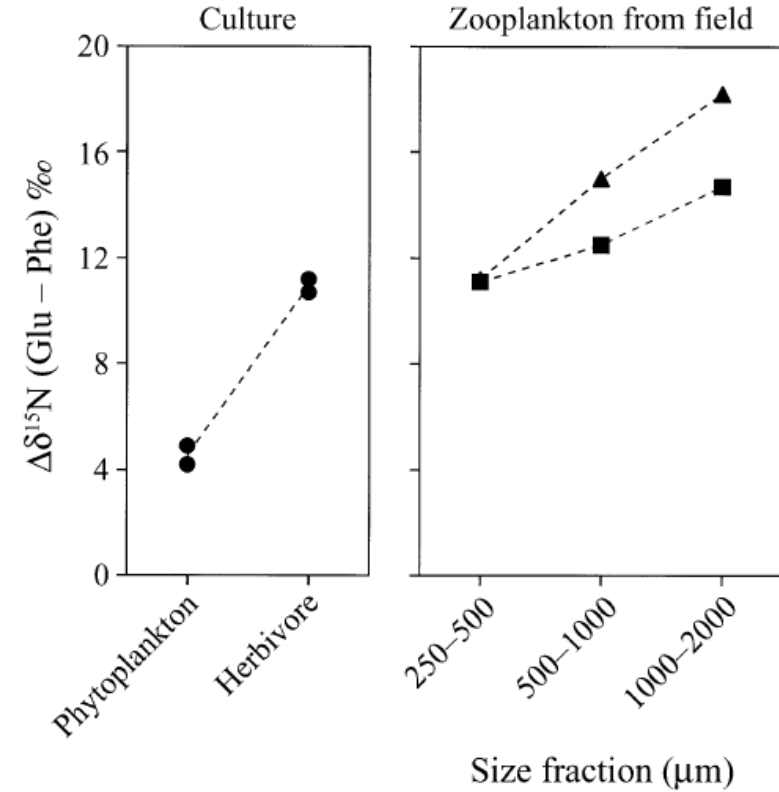
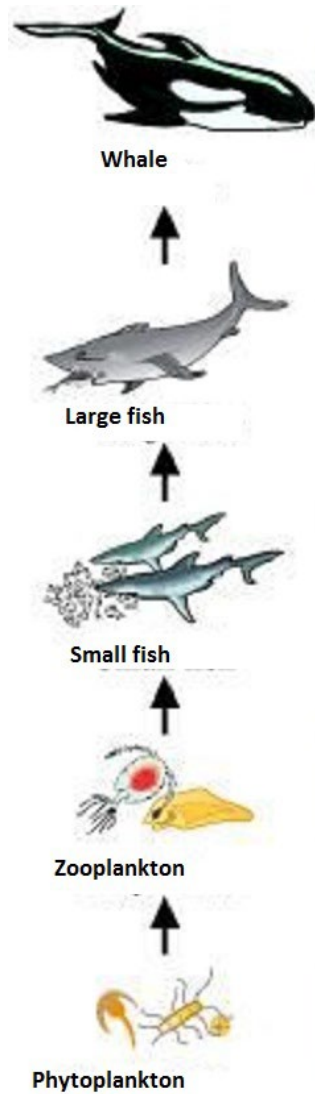


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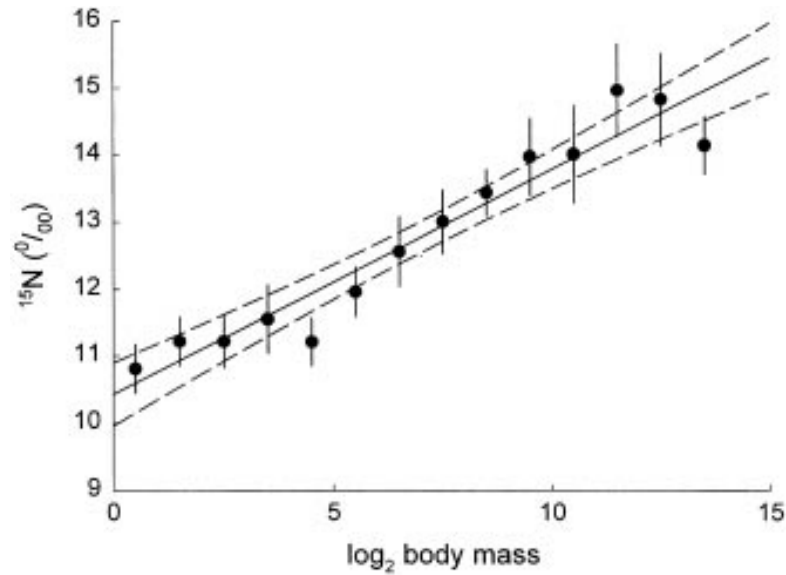


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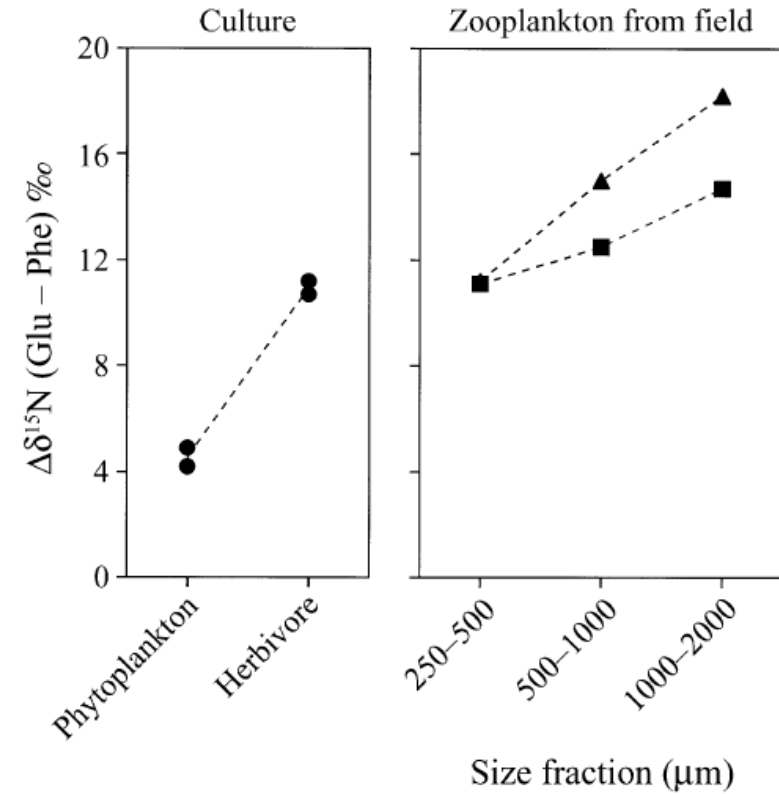


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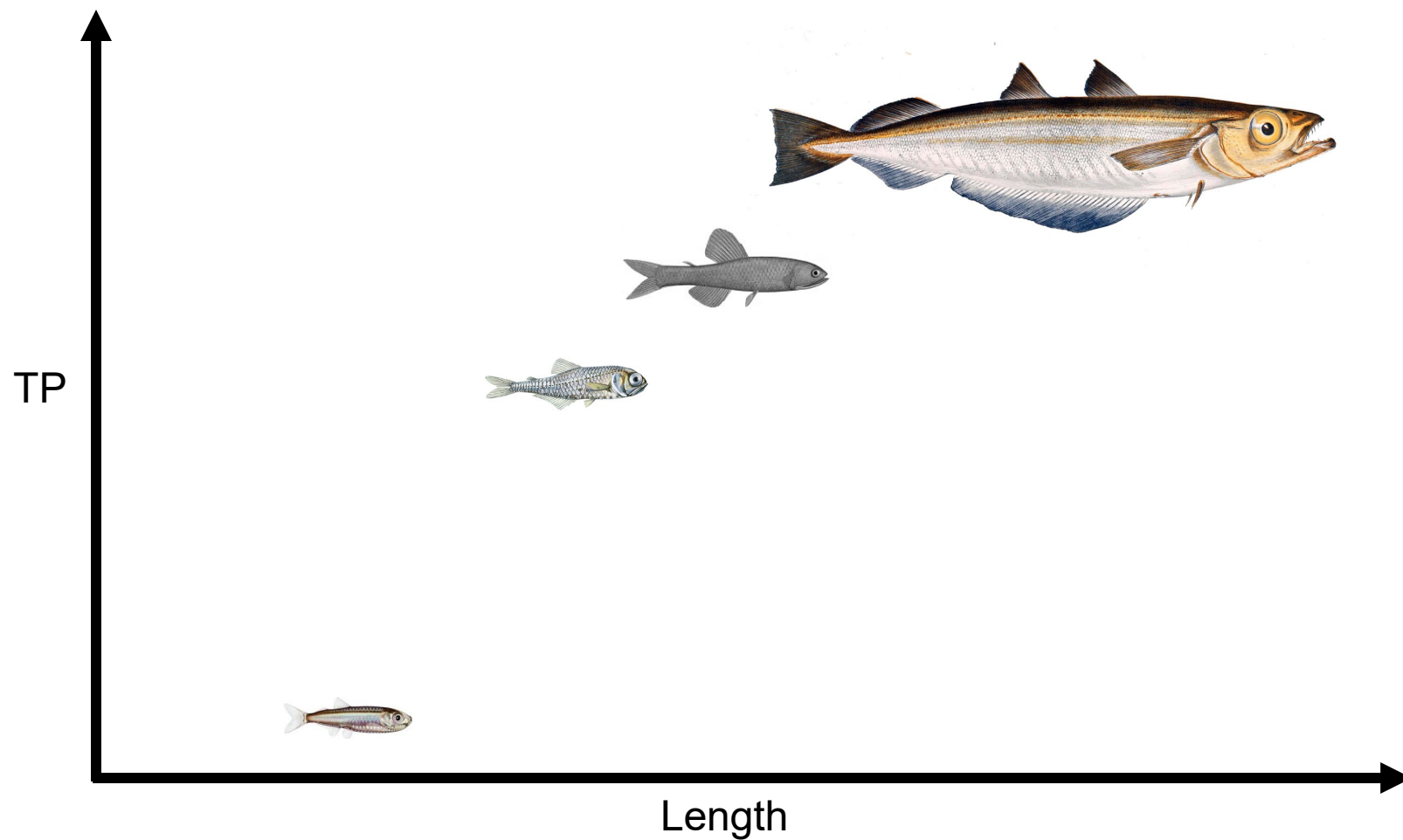


Zooplankton (size groups) from tropical and subtropical Atlantic

McClelland & Montoya, 2002



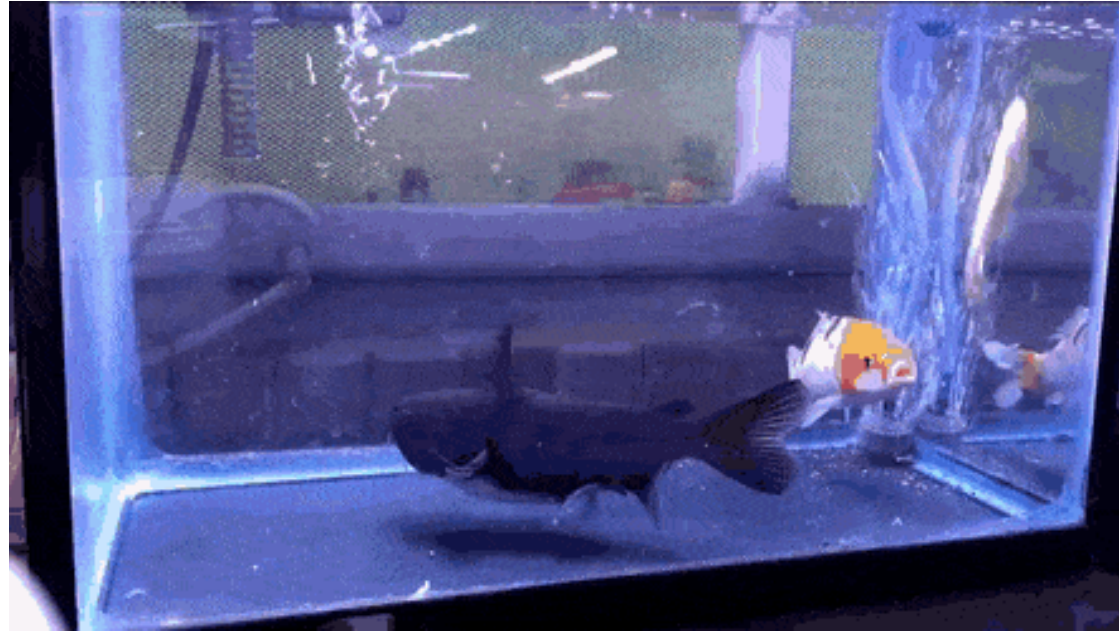
Faroe Ridge: Size vs. TP



Size-based feeding



Size-based feeding





Size-based feeding: mesopelagic

- Specialised feeding strategy
 - Alternative energy pathways
- Linear positive relationship?



To conclude...



- Diverse
 - Species
 - Feeding strategies
 - Trophodynamic
- Trophic ecology & substance
 - TP & Hg, n3 ✓
 - TP & Se, Fe ✗
 - Dual source Fe, Se, Hg, n3



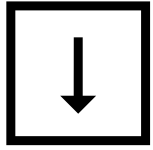
Next steps...



- Better estimation of TP
 - Dual-sourced system: tRophicPosition (Quezada-Romegialli et al., 2018)
 - Size-based trophic structure
- Nutrient source estimation
 - MixSIAR with SI and/or FA data
- Trophic ecology
 - Identifying basal sources
 - Predator-prey interactions



Next steps...



- Cross-system comparison
 - Better nutrition yield?
 - Higher contaminants?
- Sustainable exploitation
 - Inclusion of biomass
 - Seasonality and productivity
 - Habitat/trophic connectivity





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Thank you!

