



ICMGP 2024
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Mercury biomagnification and large-scale
distribution using seabirds as innovative samplers



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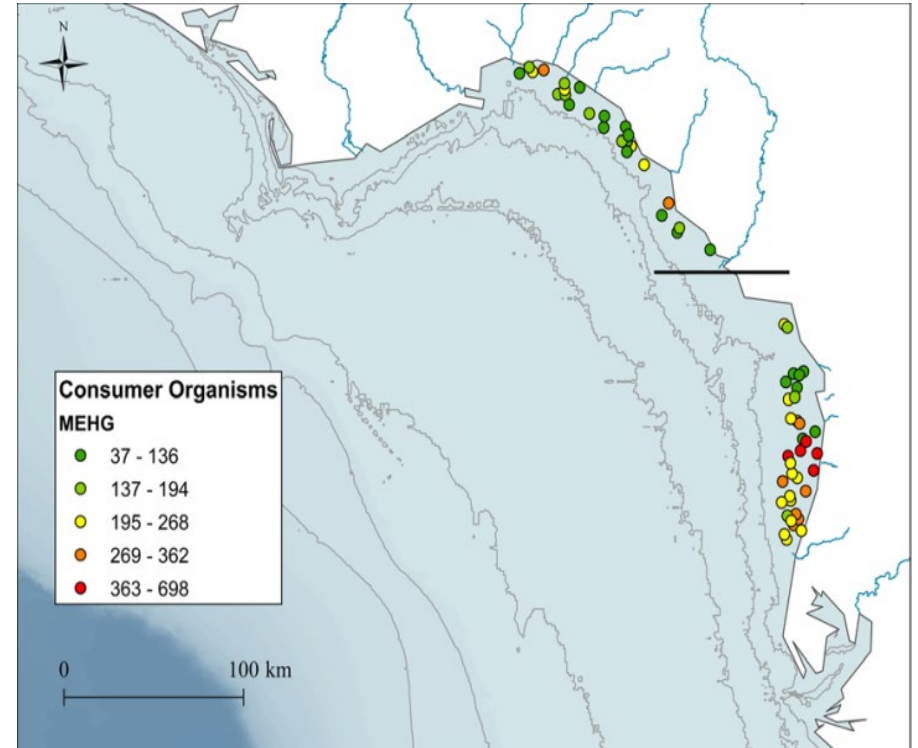
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MERCURY IN WILDLIFE

- Biomagnifies in food webs
- Foraging habitat can influence Hg burden in animals
- Even on local scales Hg concentrations can fluctuate spatially
- Variable for species foraging in different food webs



Harper et al. 2018 *Estuaries and Coasts*

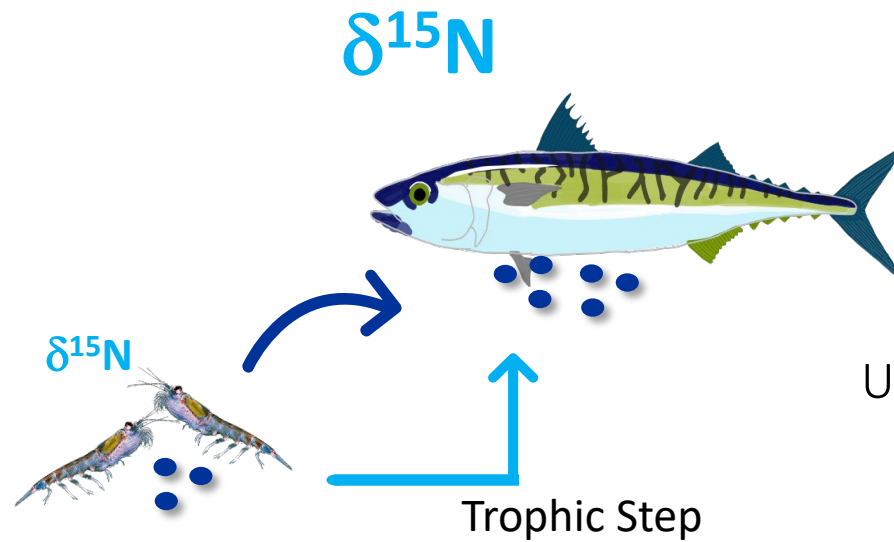


BULK STABLE $\delta^{15}\text{N}$

$\delta^{15}\text{N}$ informs on trophic position

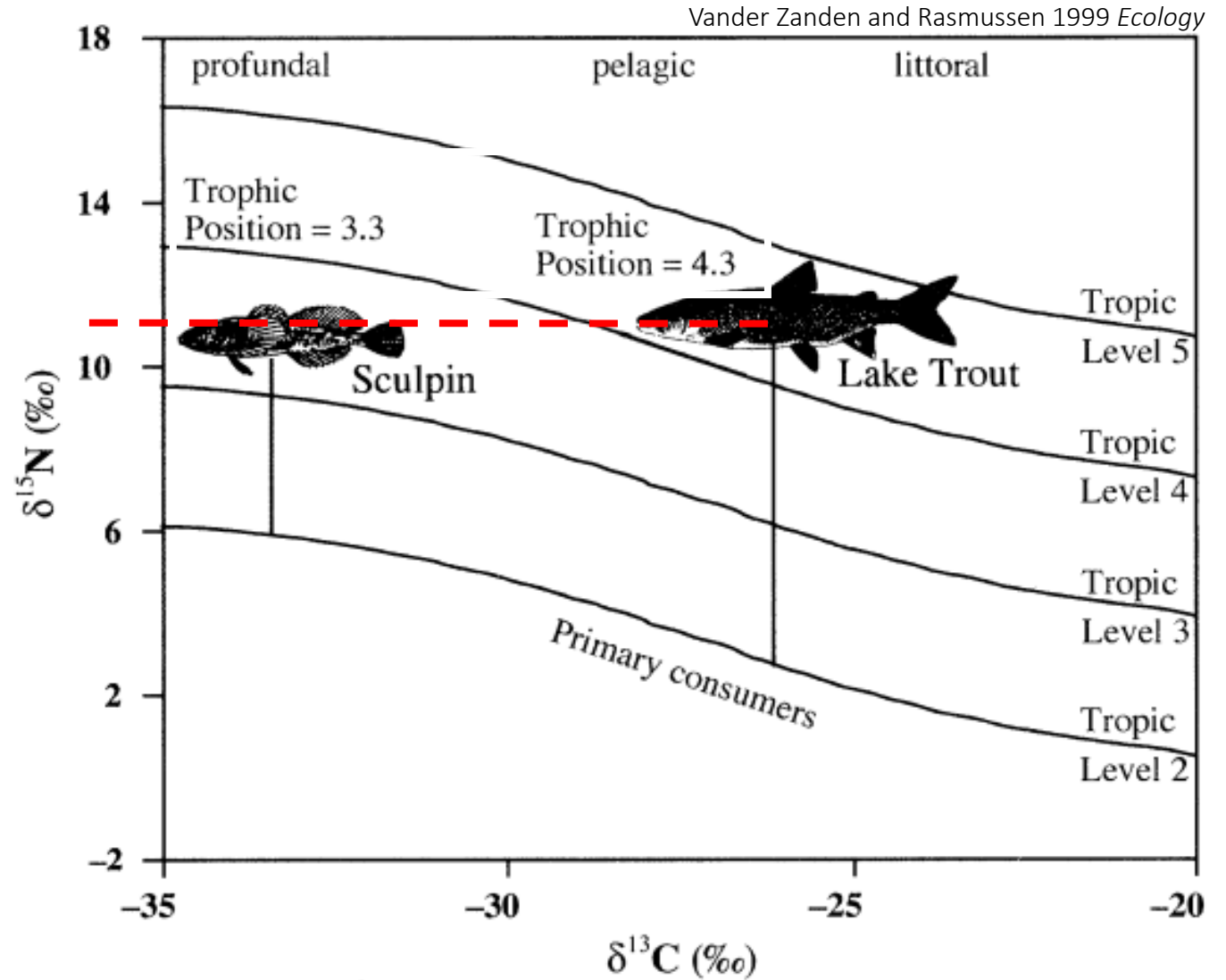
$\delta^{15}\text{N}$ increases predictably with each trophic step

Whole (bulk) tissue is analyzed for stable isotopes



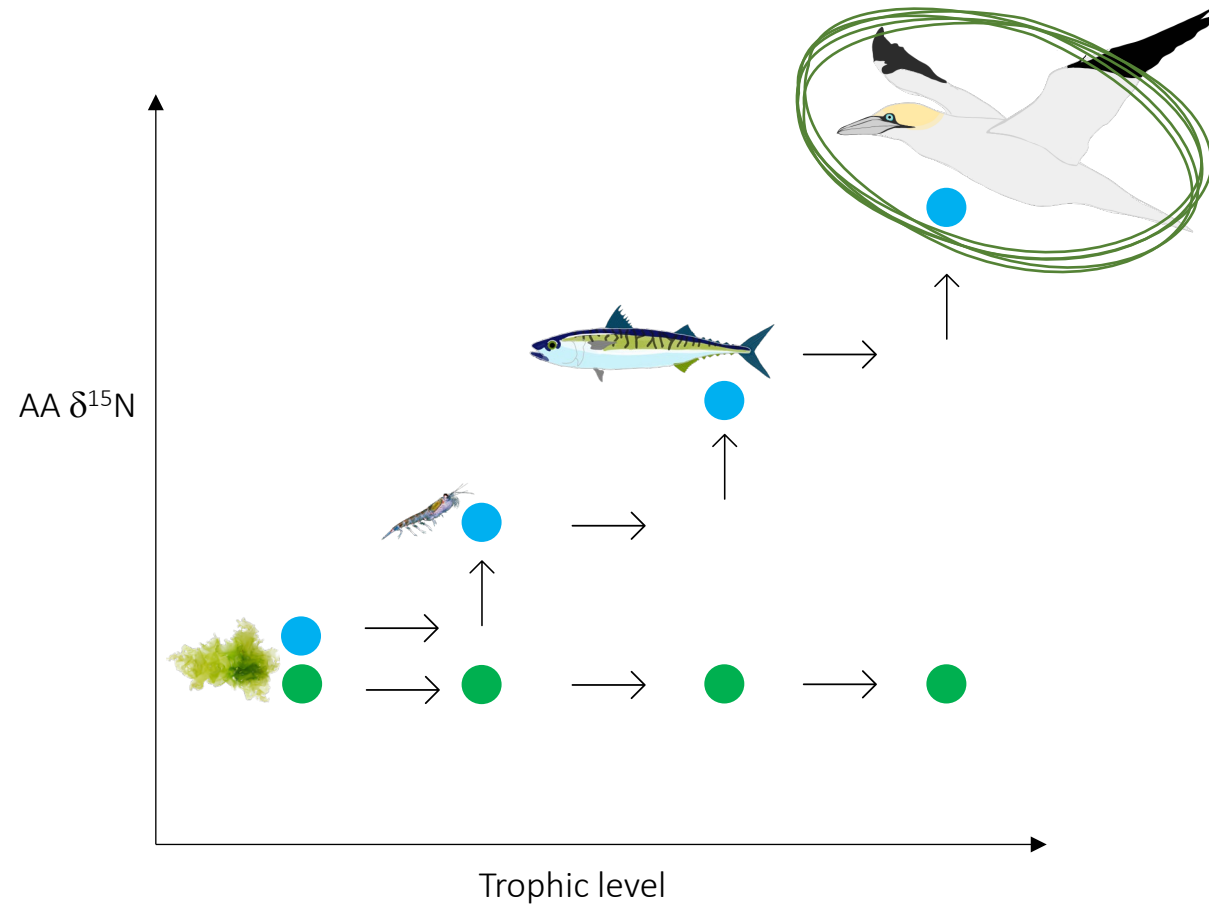
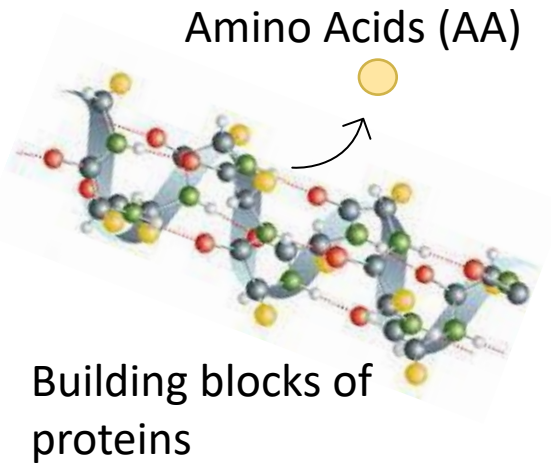
Useful to track Hg transfer through food webs

BULK $\delta^{15}\text{N}$ SPATIAL BIAS



Biased trophic position = biased biomagnification assessment

STABLE ISOTOPES IN AMINO ACIDS



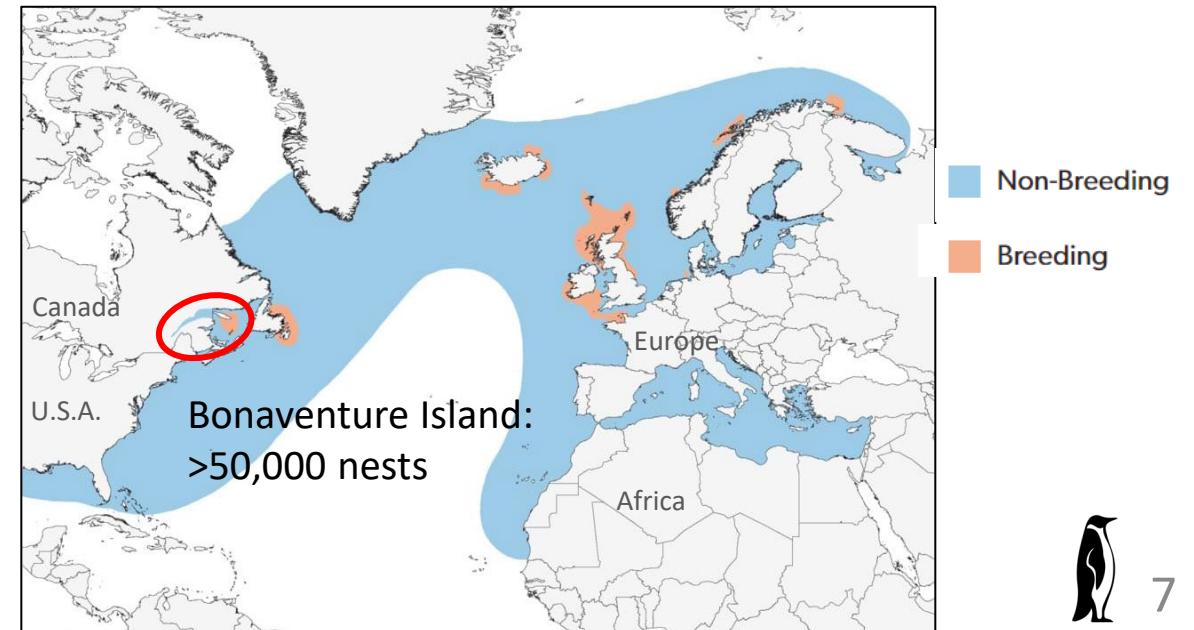
$$\text{Trophic AA} - \text{Source AA} = \text{Baseline-adjusted } \delta^{15}\text{N}$$



NORTHERN GANNETS (*Morus bassanus*)



- Forage over long distances, covering large portions of their breeding area
- Bioindicator species for the ecosystem
- Regurgitate prey (easy collection), allows us to study:
 - spatial variation of Hg in their prey
 - how feeding in different food webs impacts Hg biomagnification



St. Lawrence



Multiple stressors

- ~45 million people + industries
- Major transportation corridor
- Climate change
- Pollution

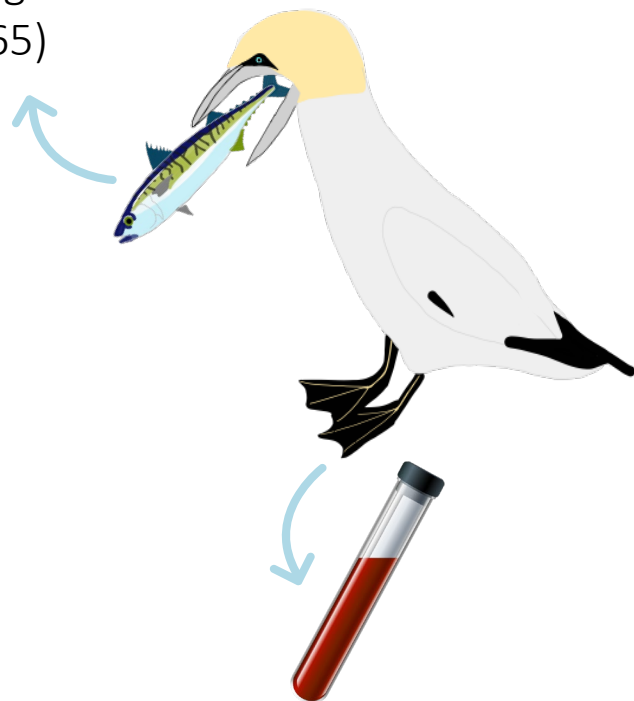
Productivity and diversity

- Several protected areas
- Critical habitat for >1,000,000 seabirds



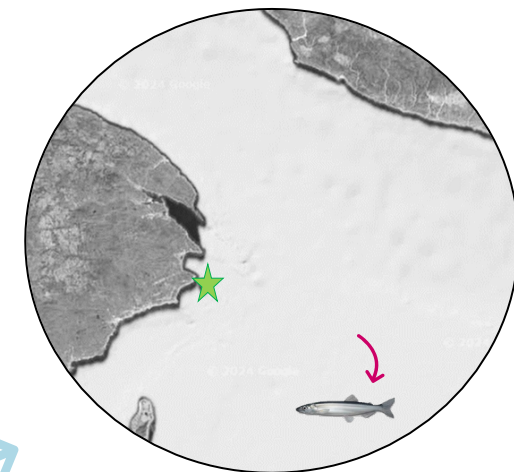
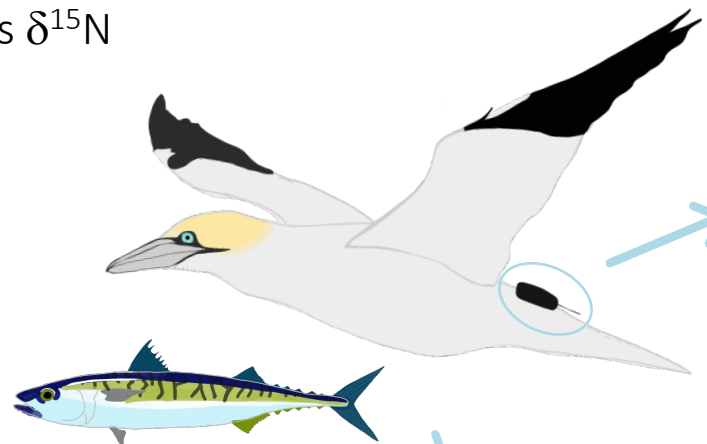
Collection & analyses

1 Collected fish regurgitations ($n = 65$)



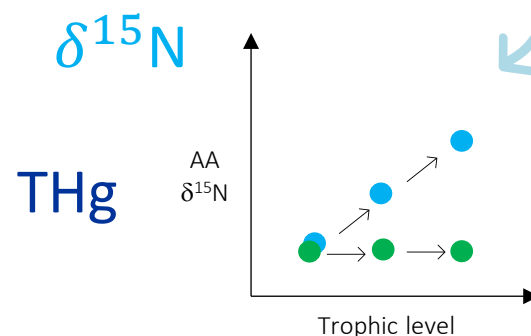
3 Chemical analyses in fish muscle and gannet blood

- Total Hg (THg) concentrations
- Bulk $\delta^{15}\text{N}$
- AAs $\delta^{15}\text{N}$



4 Analysed GPS tracks and identified “fish catch location”

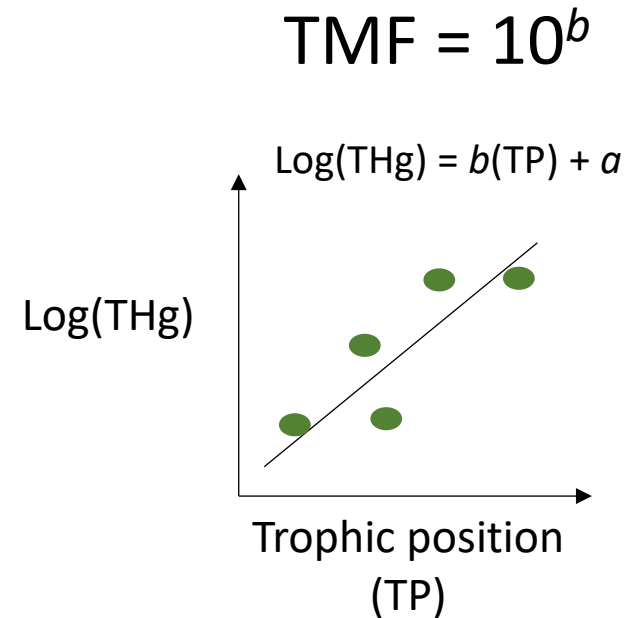
2 Collected blood from northern gannets ($n = 40$)



BIOMAGNIFICATION METRICS

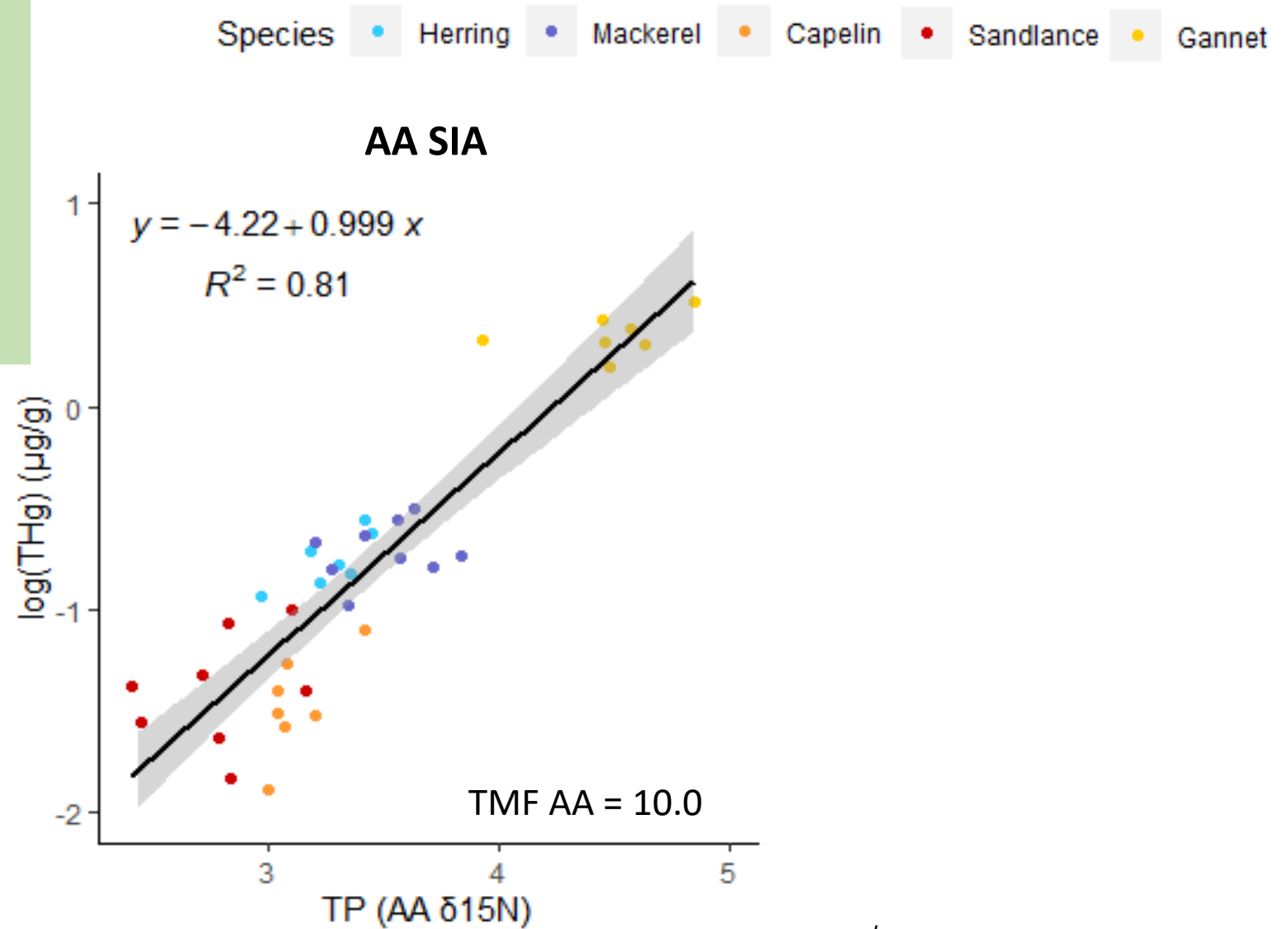
- Trophic magnification factors (TMFs):
 - Increase in contaminant between trophic levels
 - Determined by the slope (b) between $\log(\text{THg})$ and trophic position

Calculated TMF using: **bulk TP** &
AA-derived TP_{AA}



TROPHIC MAGNIFICATION FACTORS

Read our paper!

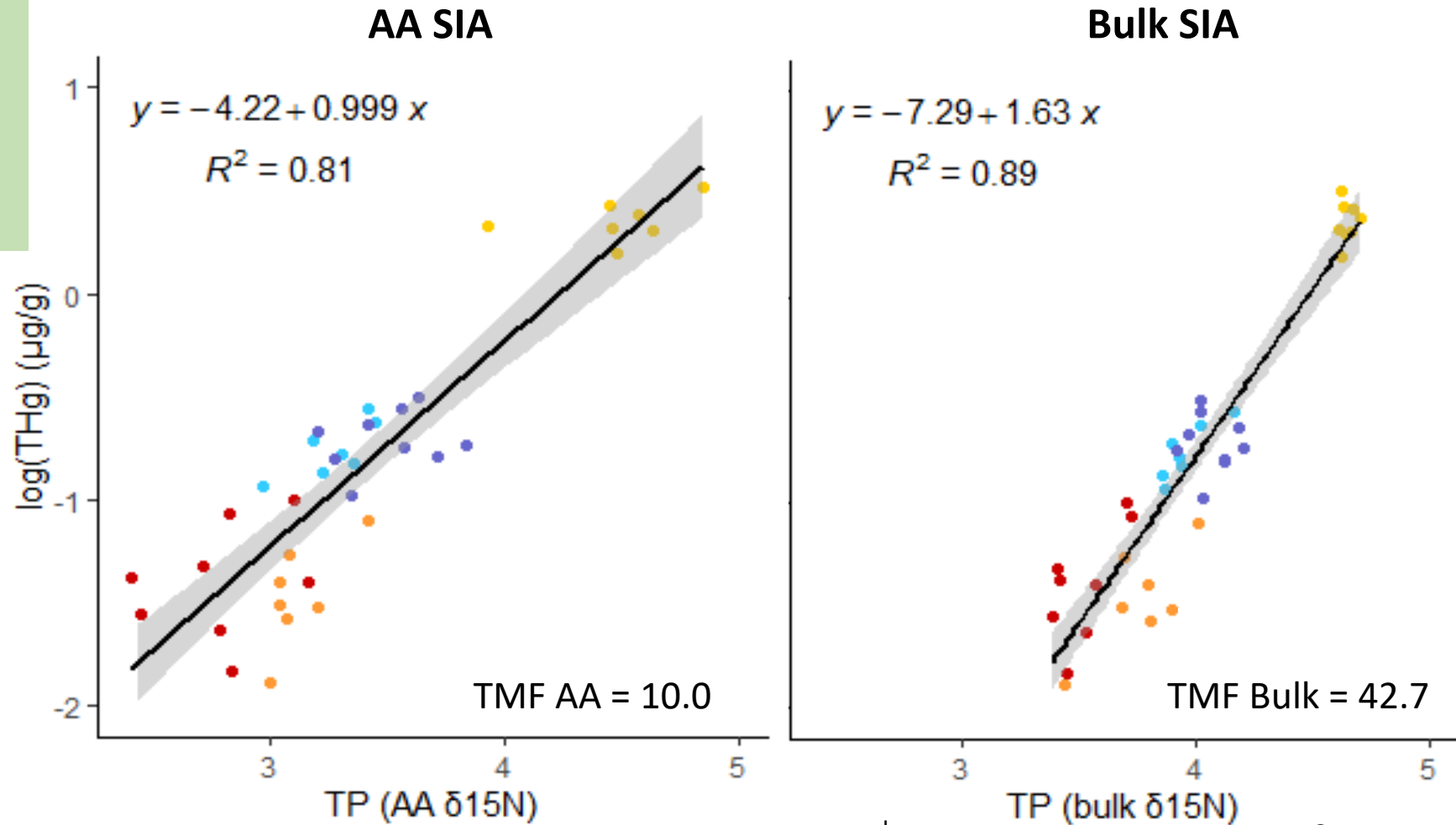


$\text{TMF} = 10^b$
 $b = \text{slope}$



TROPHIC MAGNIFICATION FACTORS

Species ● Herring ● Mackerel ● Capelin ● Sandlance ● Gannet



Read our paper!

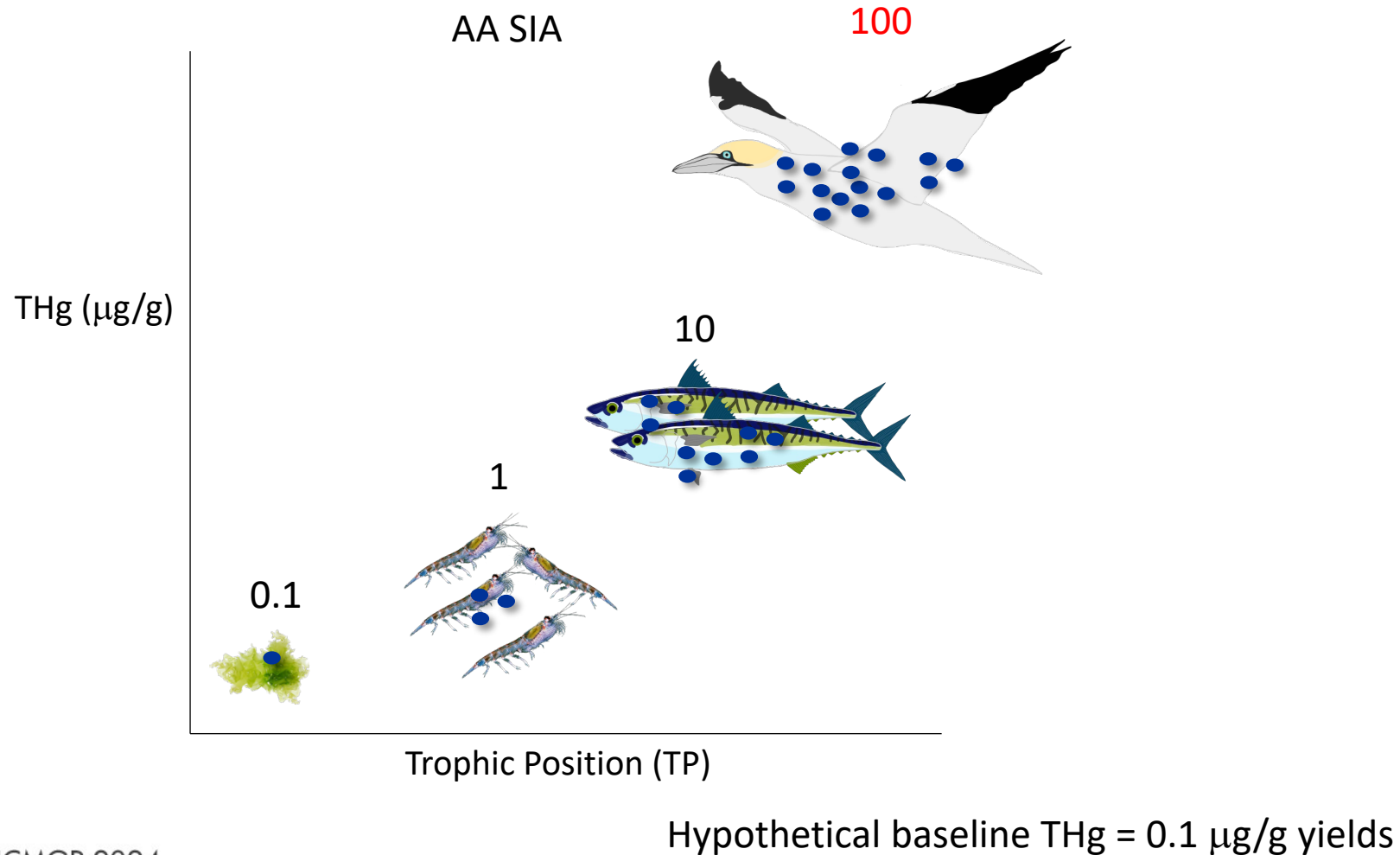


TMF = 10^b
b = slope



TROPHIC MAGNIFICATION FACTORS

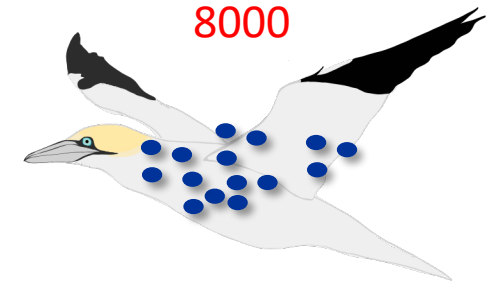
AA SIA: THg increases by 10 times between each trophic level



TROPHIC MAGNIFICATION FACTORS

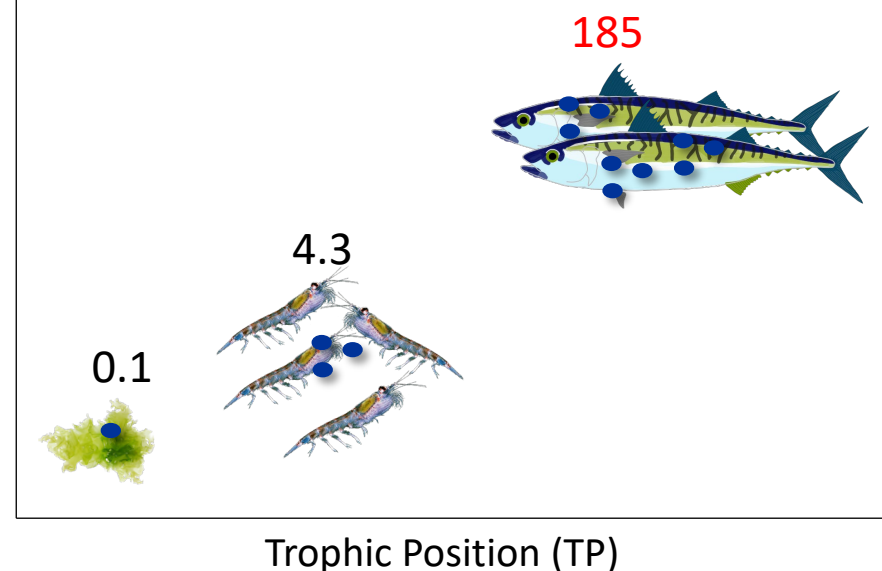
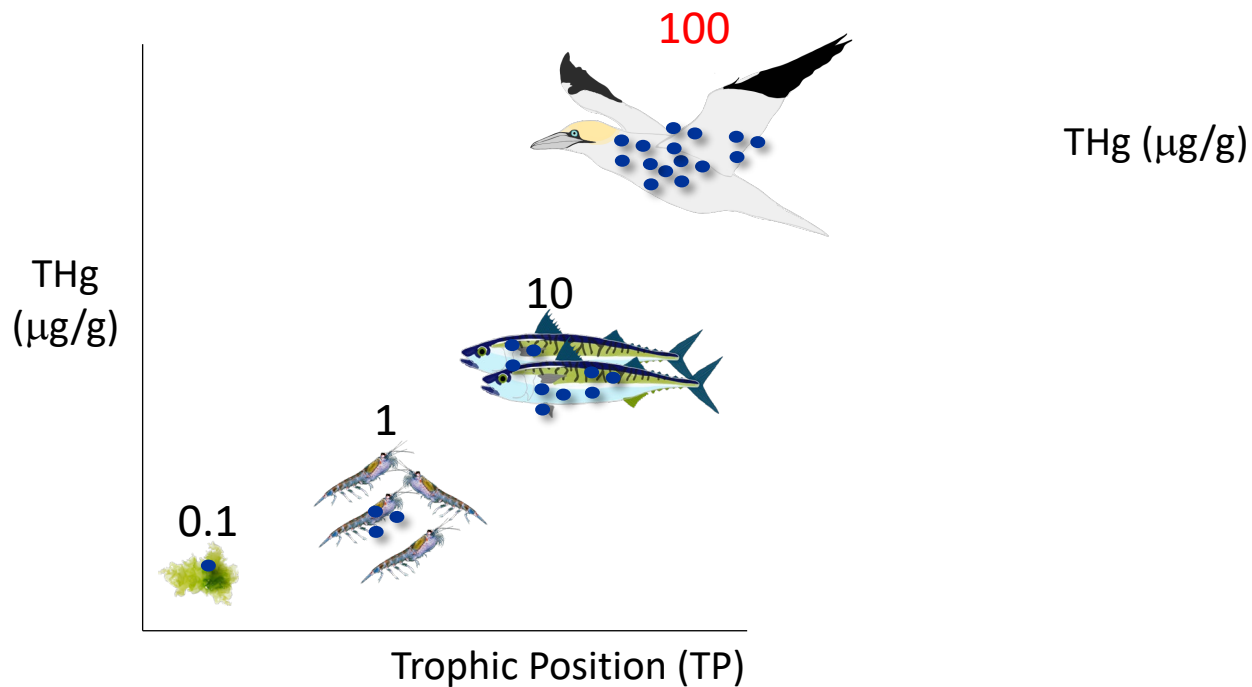
AA SIA: THg increases by 10 times between each trophic level

Bulk SIA: THg increases by 40 times between each trophic level



AA SIA

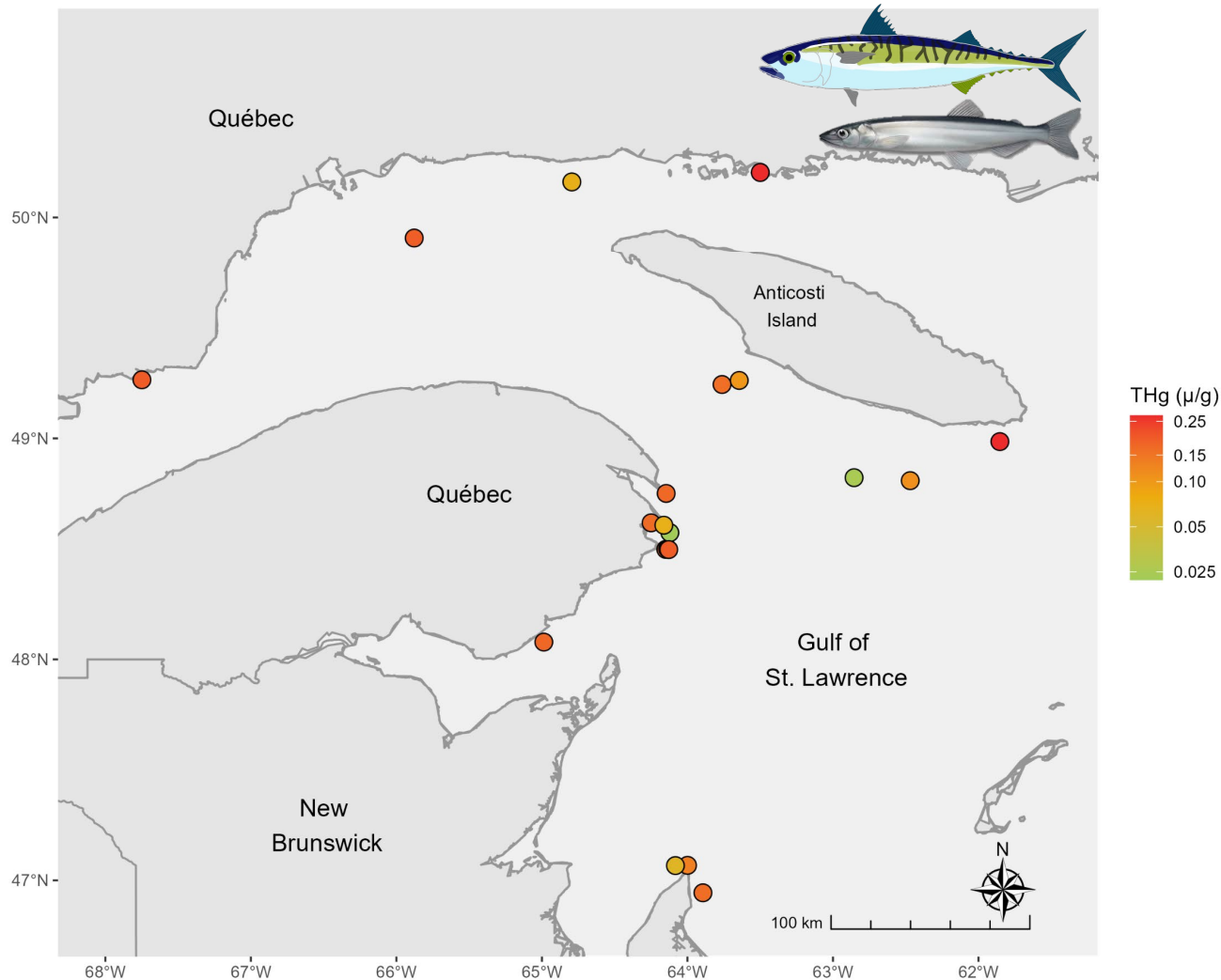
Bulk SIA



Hypothetical baseline THg = 0.1 µg/g yields



THg IN FISH ACROSS THE GULF



Gannets allowed a random sampling of fish > 60 000 km² of spatial coverage.

Linear mixed effect models including:

- $TP_{CSIA-AA}$ (no spatial component)
- $\delta^{13}C$, $\delta^{34}S$
- Shipping traffic, coastal development, pollution



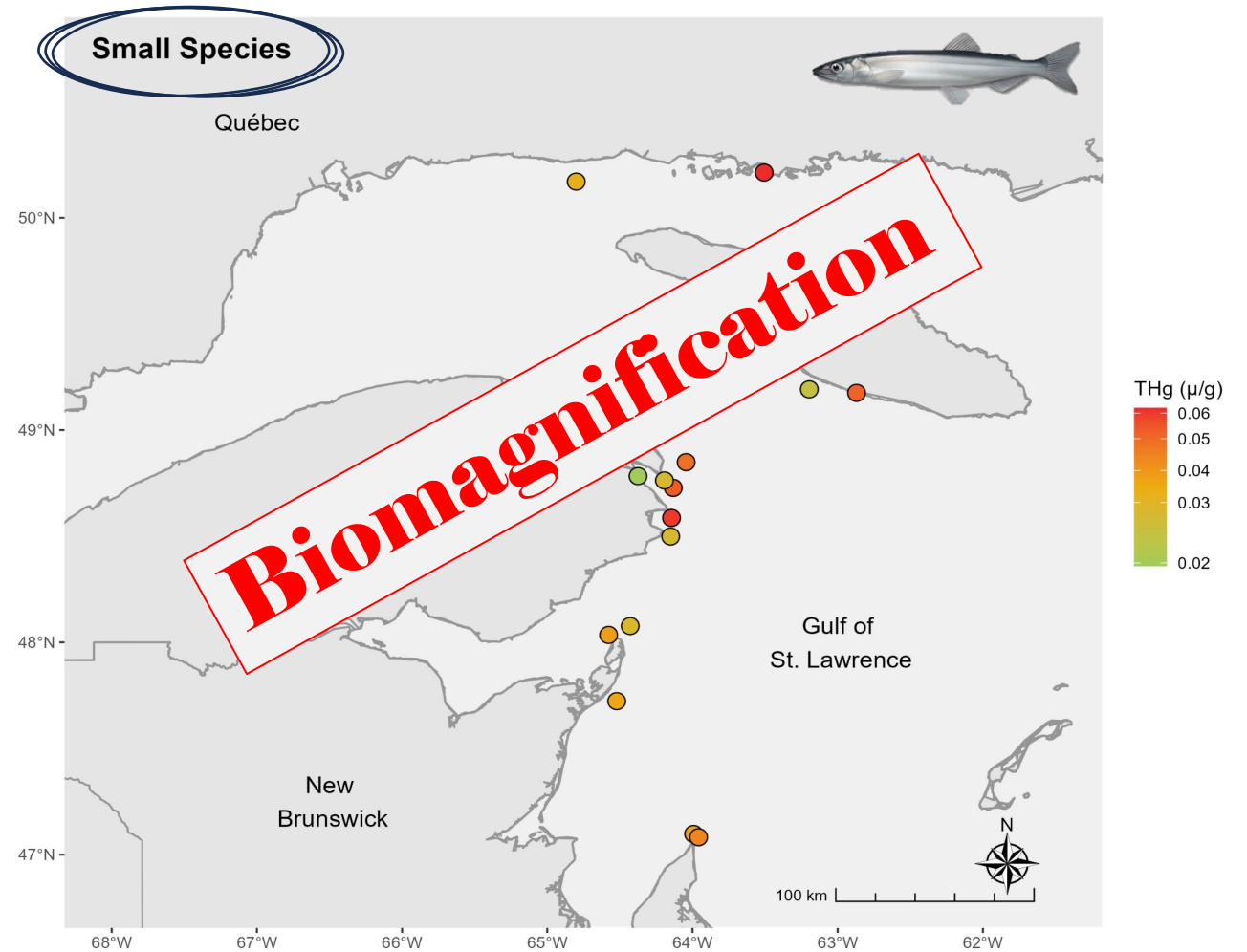
THg IN SMALL FISH

Best predicted by $TP_{CSIA-AA}$

- Spatially-corrected TP
- Suggests biomagnification of THg is main driver of variability

Limitation:

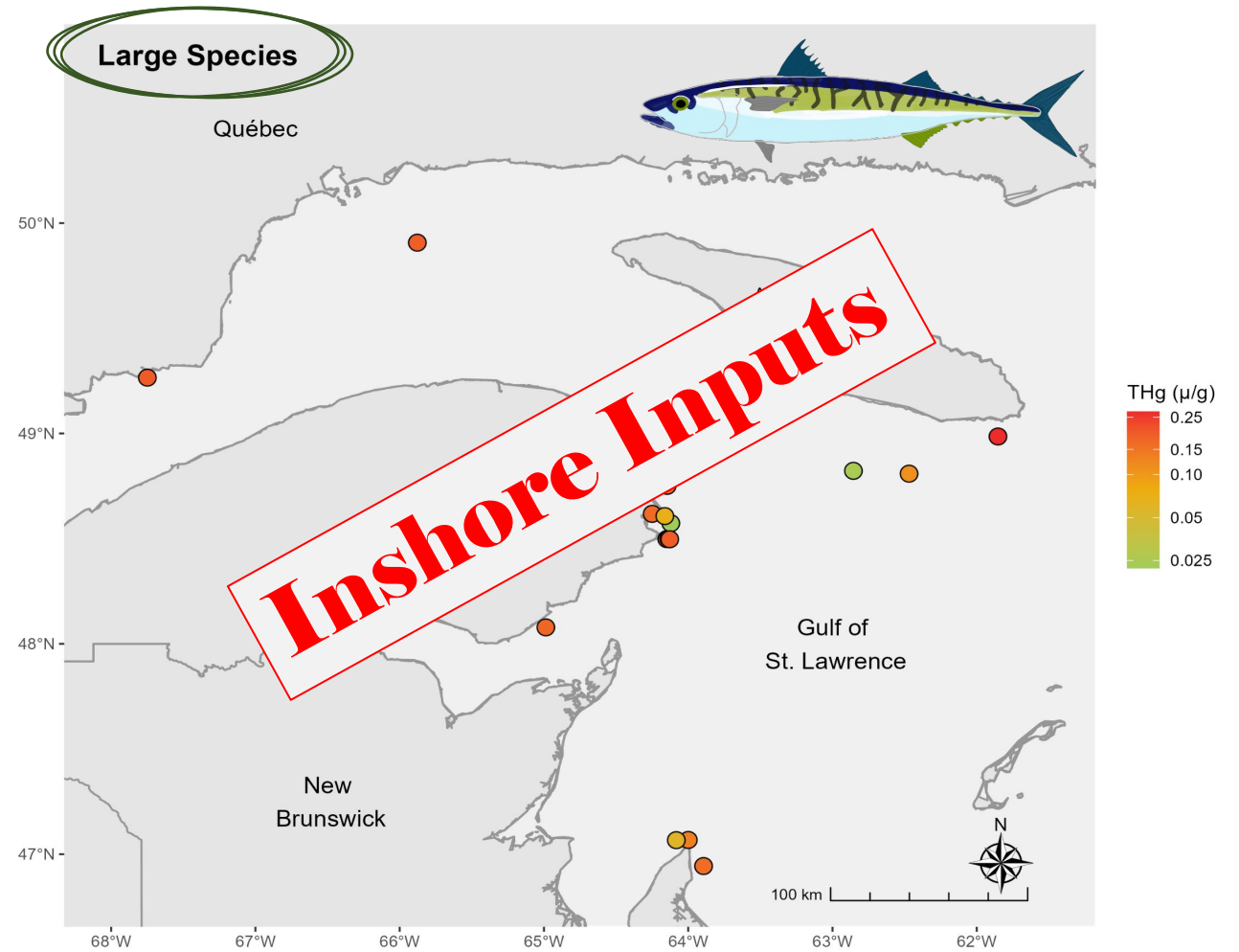
- Small range of concentrations (0.02 – 0.06 $\mu\text{g/g}$) may not allow detection of spatial drivers.



THg IN LARGE FISH

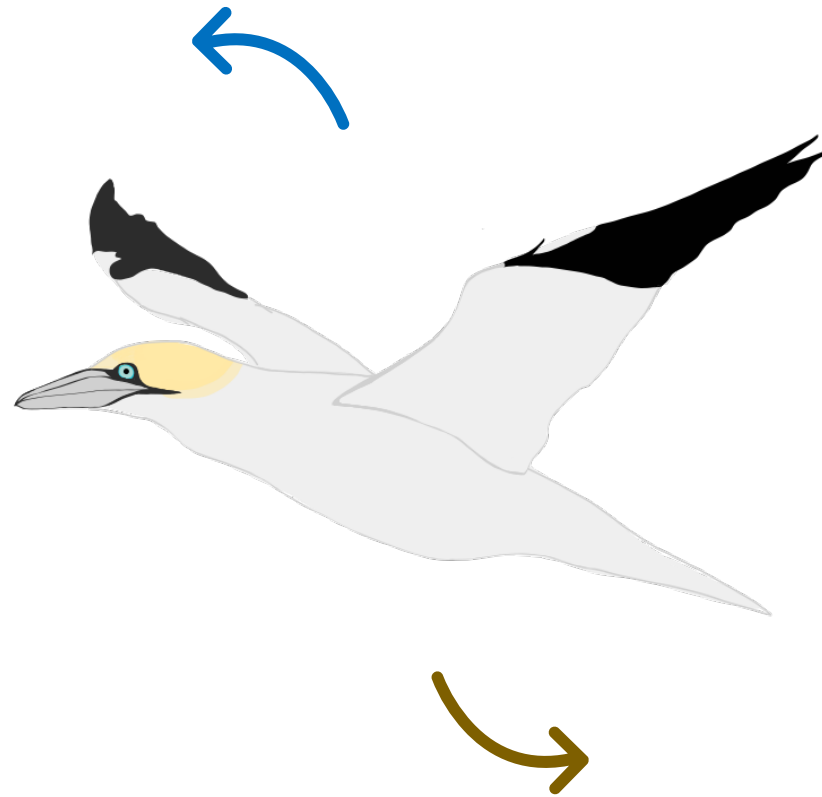
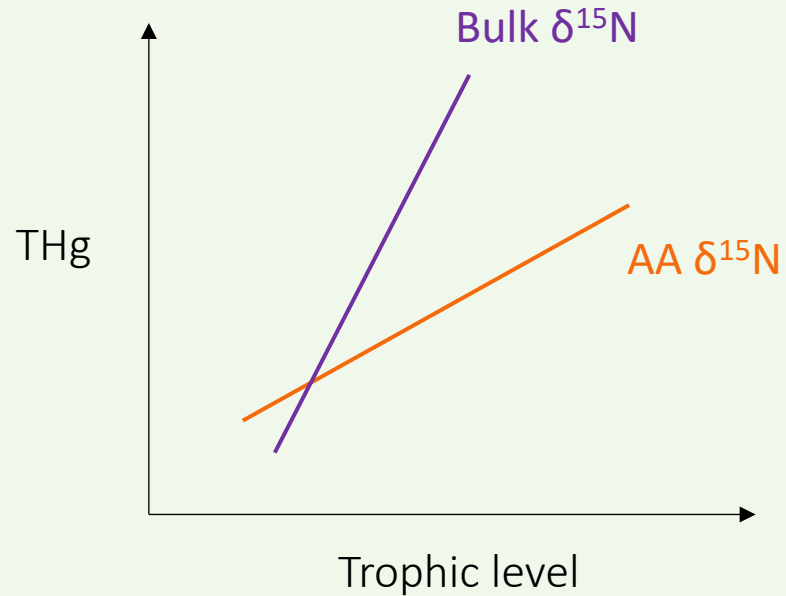
- Best predicted by $\delta^{13}\text{C}$
- Suggests inshore habitats have higher THg
- More disturbances & anthropogenic inputs (rivers, industry)

Read our paper!

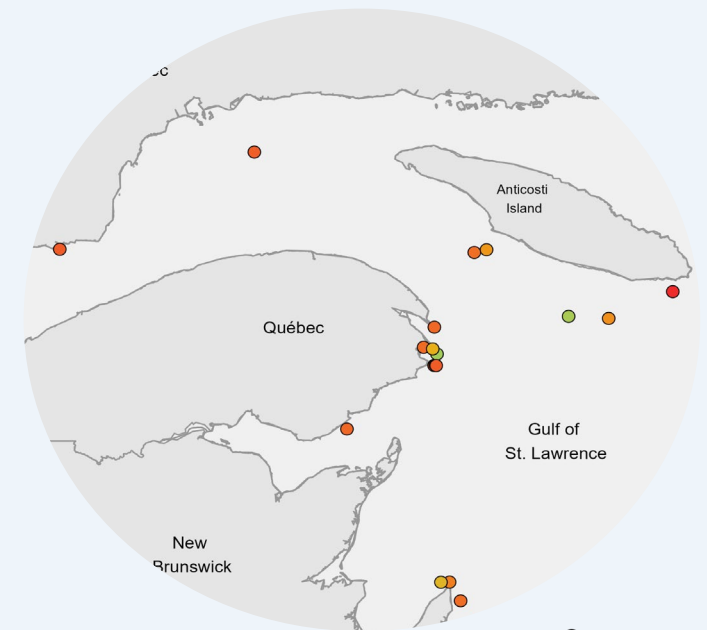


CONCLUSION

CSIA-AA accounts for **spatial bias** in multiple food webs, providing lower TMFs.



Using seabirds as samplers allowed the detection of **spatial trends** in Hg in fish.



Questions

CSIA-AA
Biomagnification



Photo: Roxanne Turgeon

Fish Mercury
Spatial Trends



For any additional questions,
contact

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