Importance of Accurately Identifying Food Web Structure in Bioaccumulation Studies

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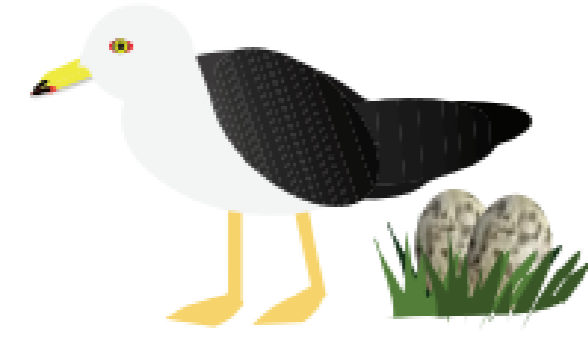PICES-2024 Annual Meeting
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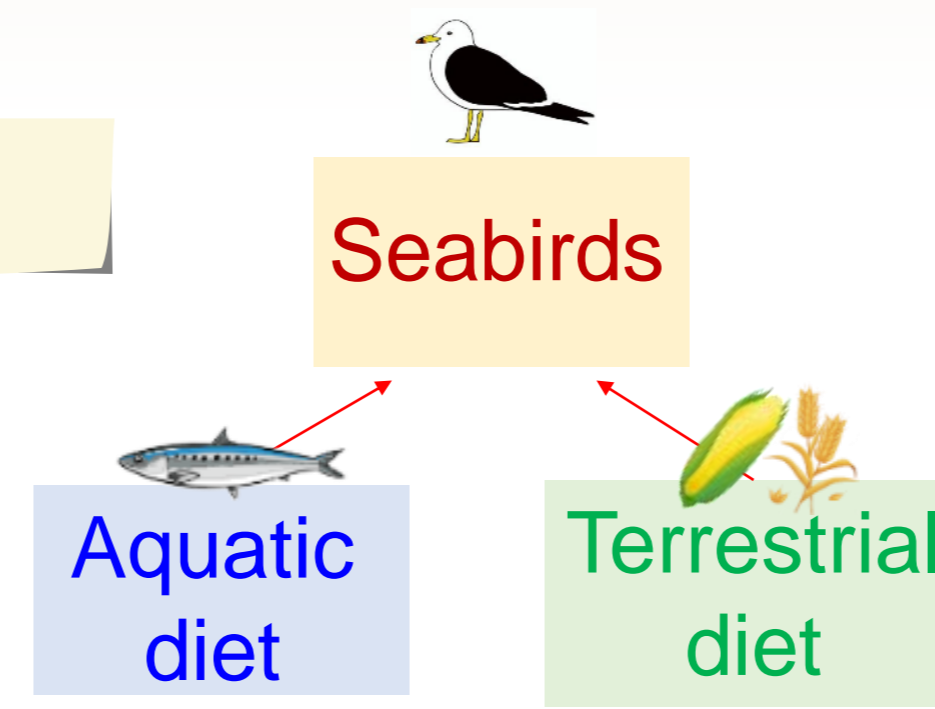
Introduction and Methods
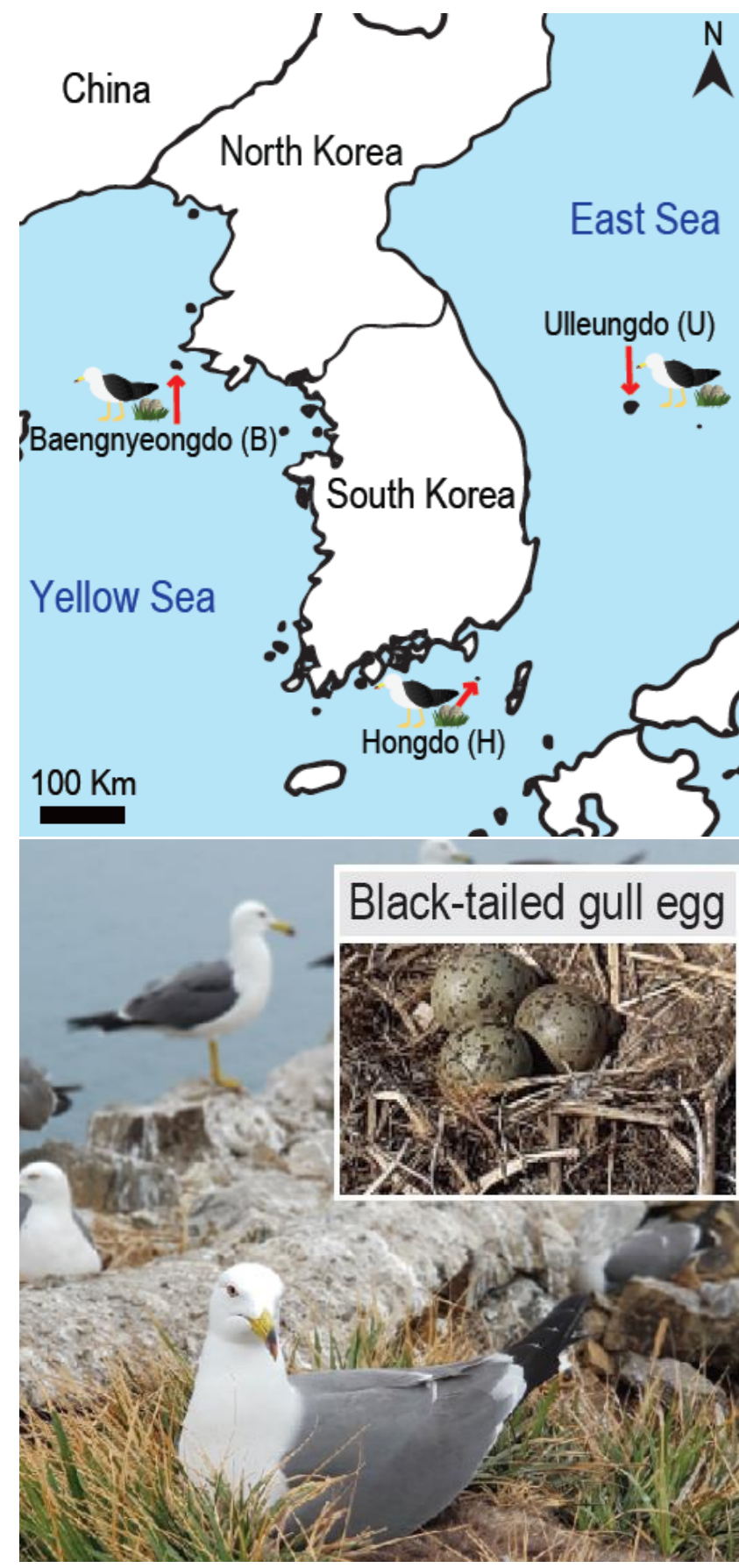
Good bioindicator!

Black-tailed gull eggs

Indicator species
- non-bioinvasive
- representative (predator)
- cost-effective
- long-term storage

1 How to get the TP?

Seabirds
Aquatic diet
Terrestrial diet

Basic formula of TP (Chikaraishi et al., 2009)
$$TP = \frac{\delta^{15}N_{Glu} - \delta^{15}N_{Phe} - \beta}{TDF} + 1$$

Mixing β approach (Hebert et al., 2016)
$$TP = \frac{\delta^{15}N_{Glu} - \delta^{15}N_{Phe} - (f_a \cdot \beta_a + f_t \cdot \beta_t)}{f_a \cdot TDF_a + f_t \cdot TDF_t} + 1$$
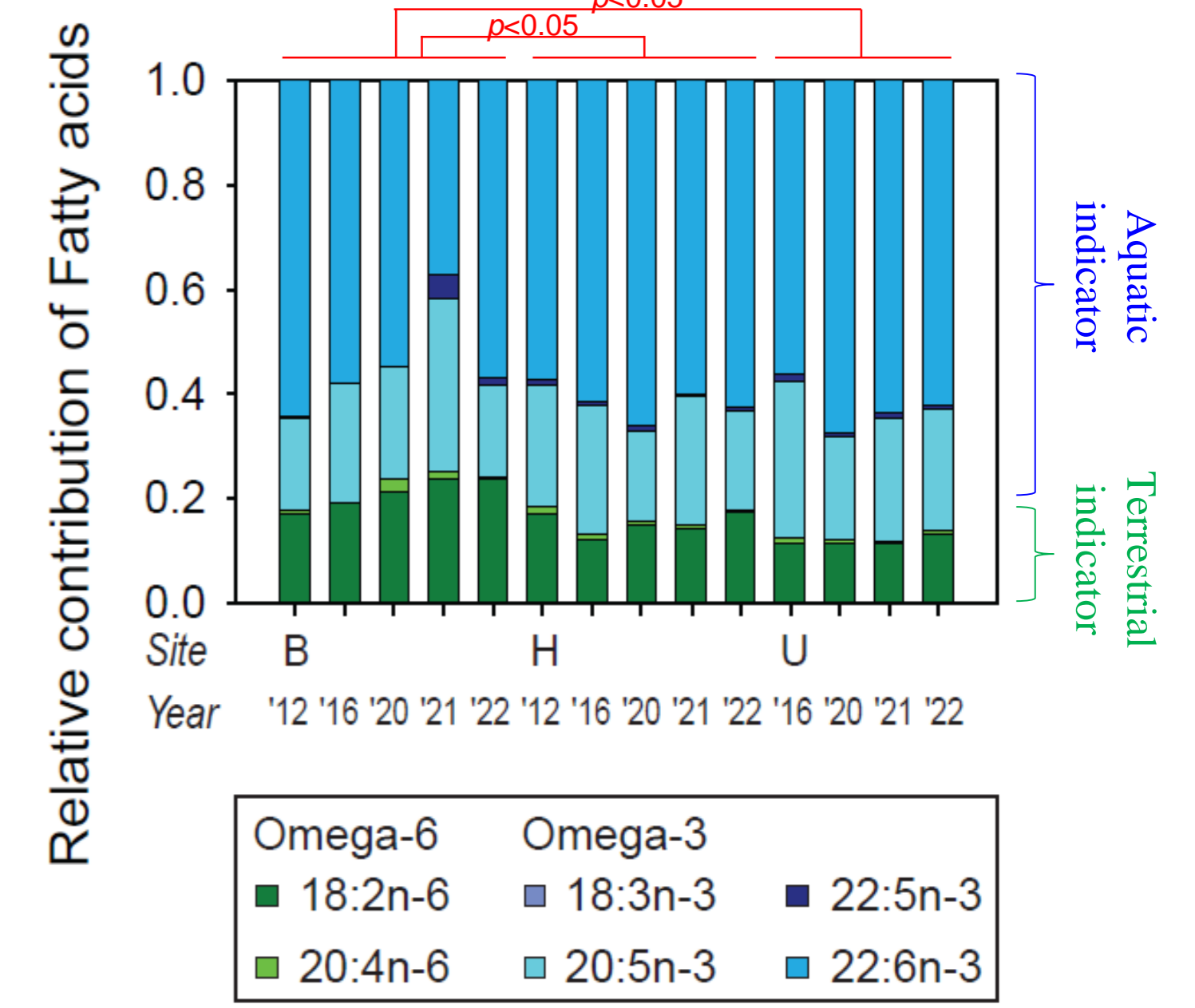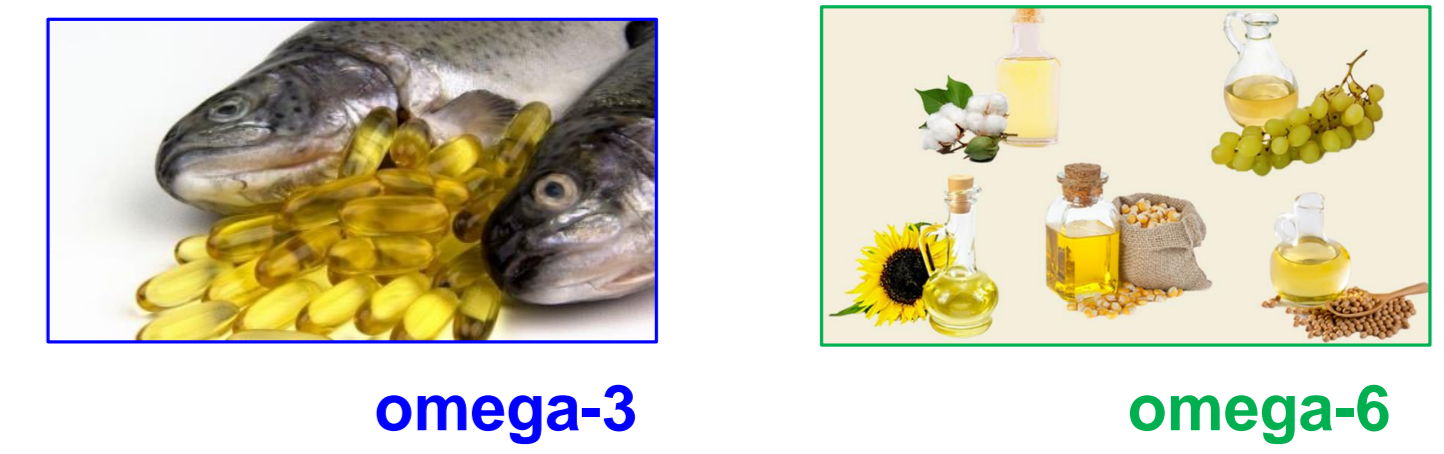
Multi TDF approach (McMahon and McCarthy, 2016)
$$TP = \frac{\delta^{15}N_{Glu} - \delta^{15}N_{Phe} - \beta - TDF_b}{TDF} + 2$$

Multi-mixing approach (In this study)
$$TP = \frac{\delta^{15}N_{Glu} - \delta^{15}N_{Phe} - TDF_b - (f_a \cdot \beta_a + f_t \cdot \beta_t)}{f_a \cdot TDF_a + f_t \cdot TDF_t} + 2$$
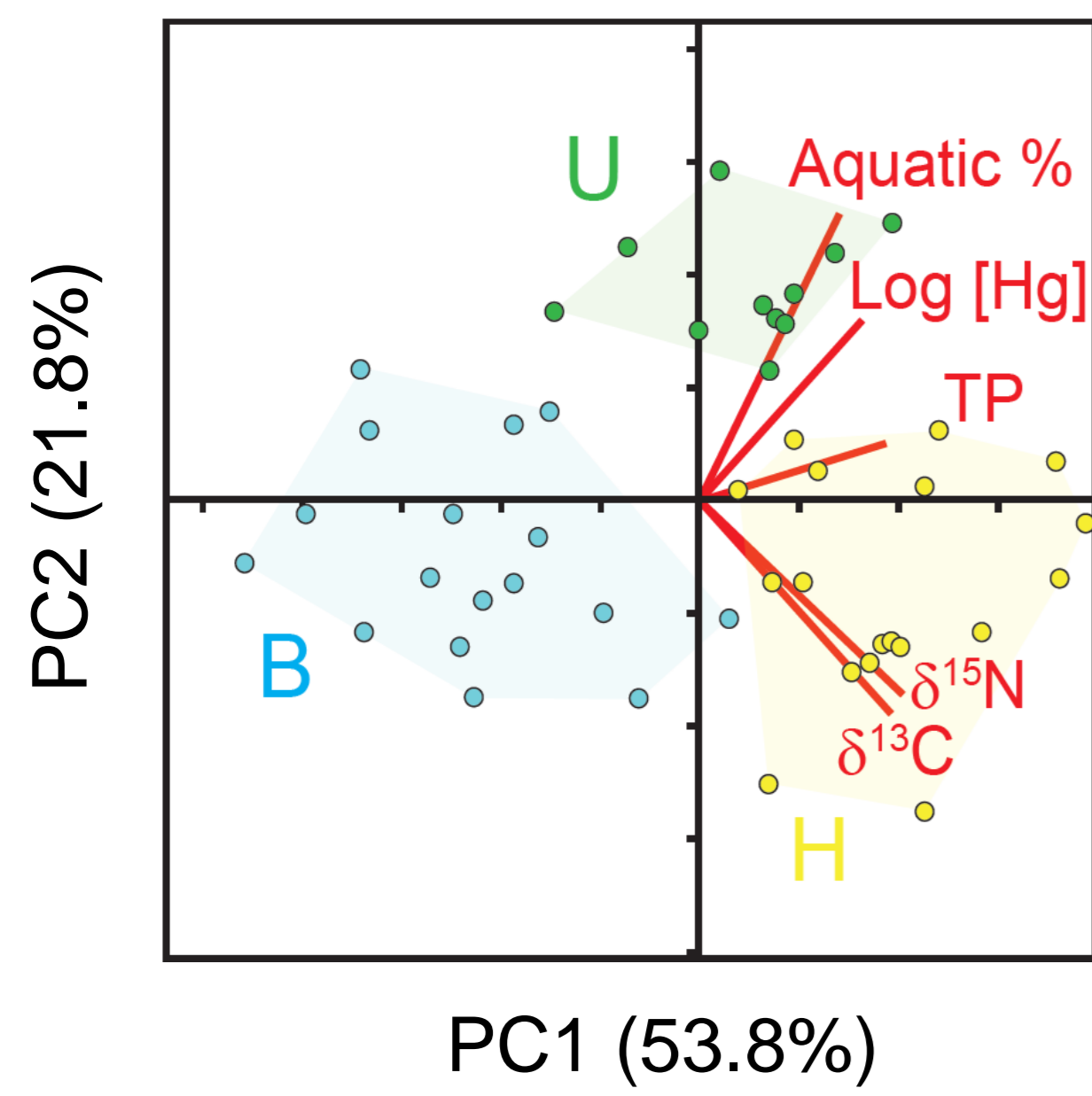
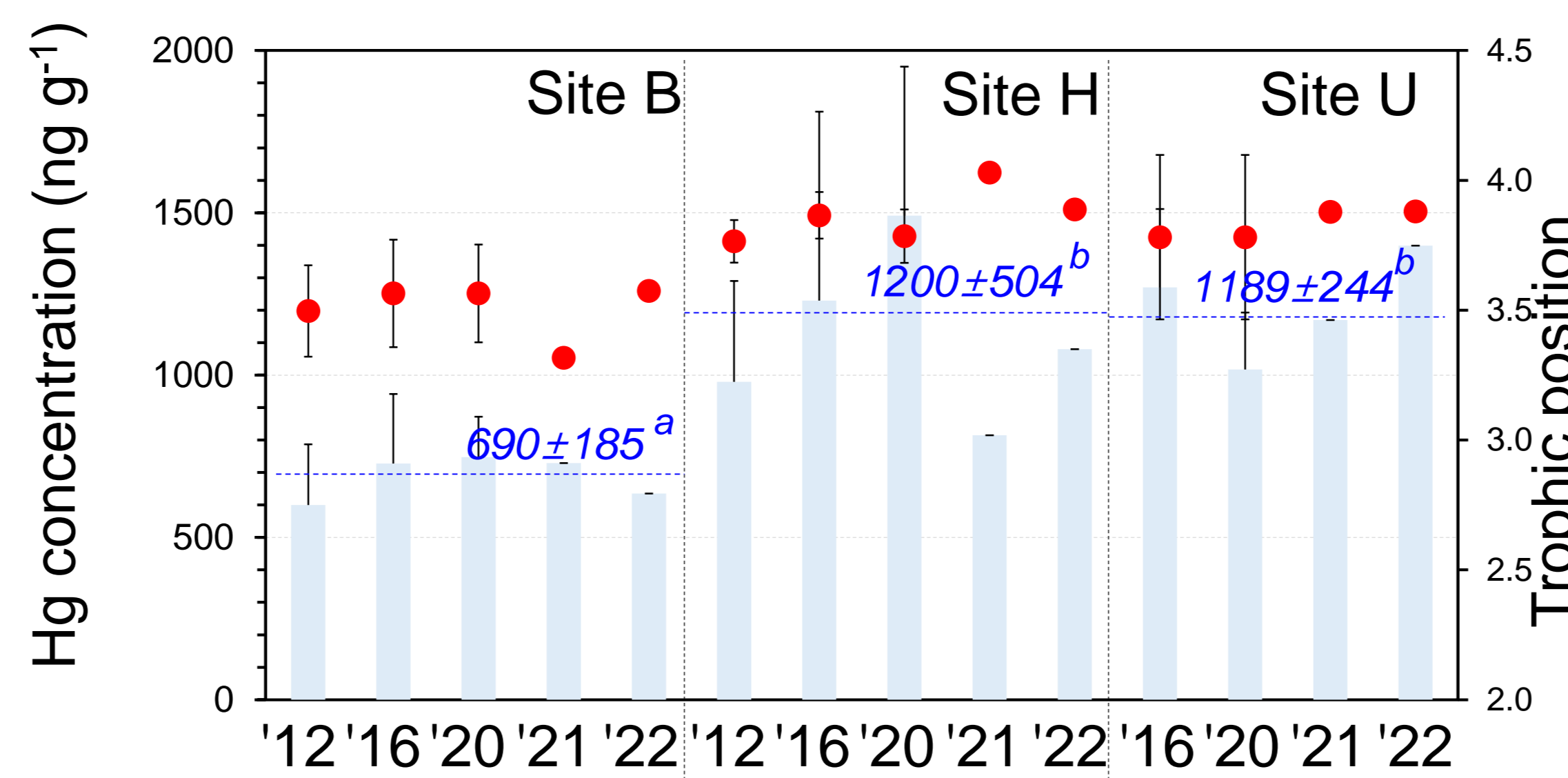**2 How to separate proportion of diet origins?**
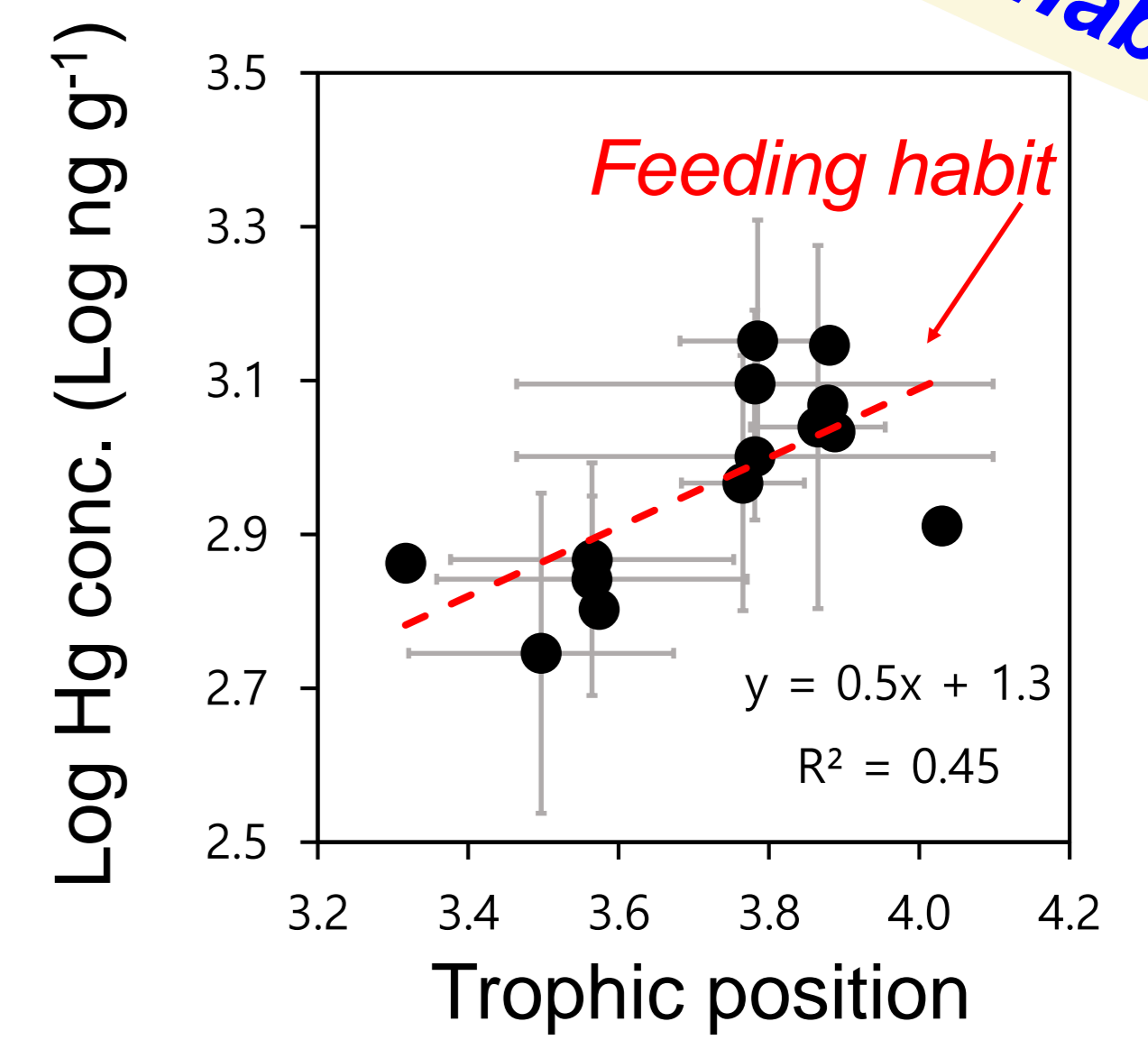
omega-3   omega-6

Fatty acids (Omega 3 and 6 ratio)

Omega-6: 18:2n-6, 20:4n-6
Omega-3: 18:3n-3, 20:5n-3, 22:5n-3, 22:6n-3

Results and Discussion

3 The biomarkers indicate the habitats

PC1 (53.8%), PC2 (21.8%)
Aquatic %, Log [Hg], TP, $\delta^{15}N$, $\delta^{13}C$

4 Trophic position of gulls and eggs!

Sites: B, B, H, H, U, U
Egg / mother bird

5 Spatio-temporal distributions of Hg and TP were similar!

Site B: 690 ± 185^a
Site H: 1200 ± 504^b
Site U: 1189 ± 244^b

843 ± 221^a, 1094 ± 483^a, 1078 ± 234^a

6 Is this due to feeding habits?

Feeding habit
$y = 0.5x + 1.3$
$R^2 = 0.45$

$$C_{adj} = C_{measured} + slope \cdot (TP_{average} - TP_{measured})$$
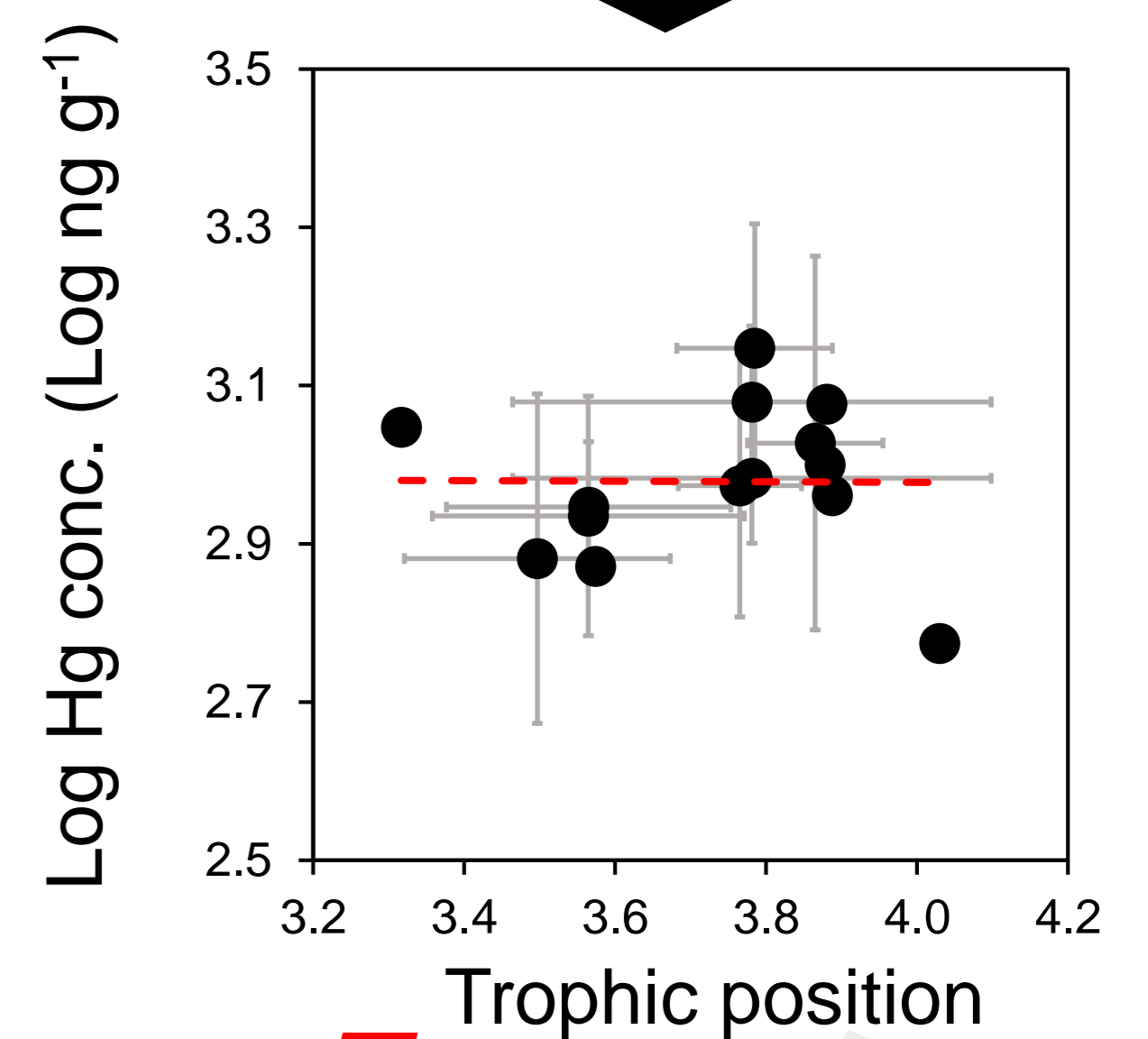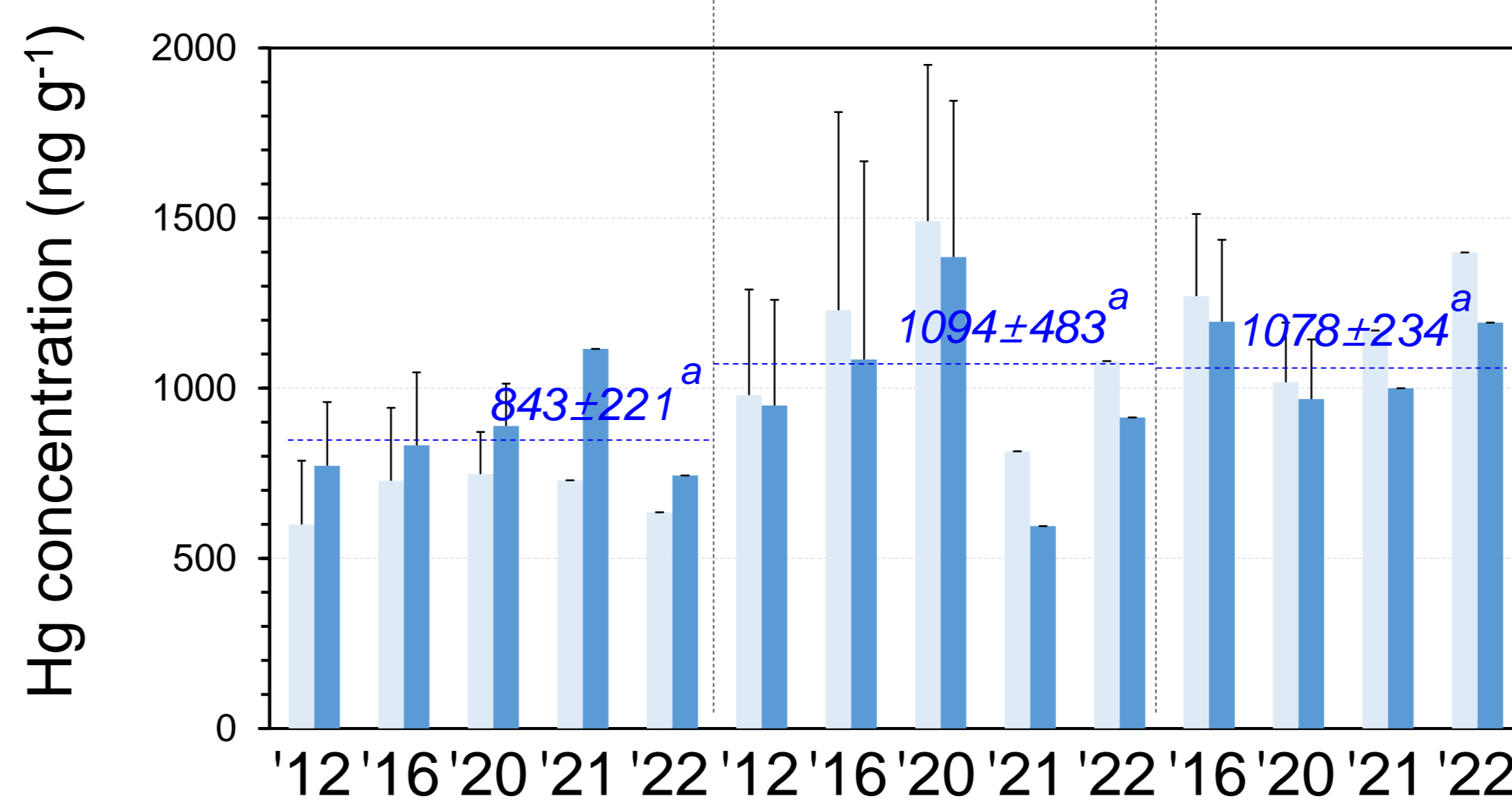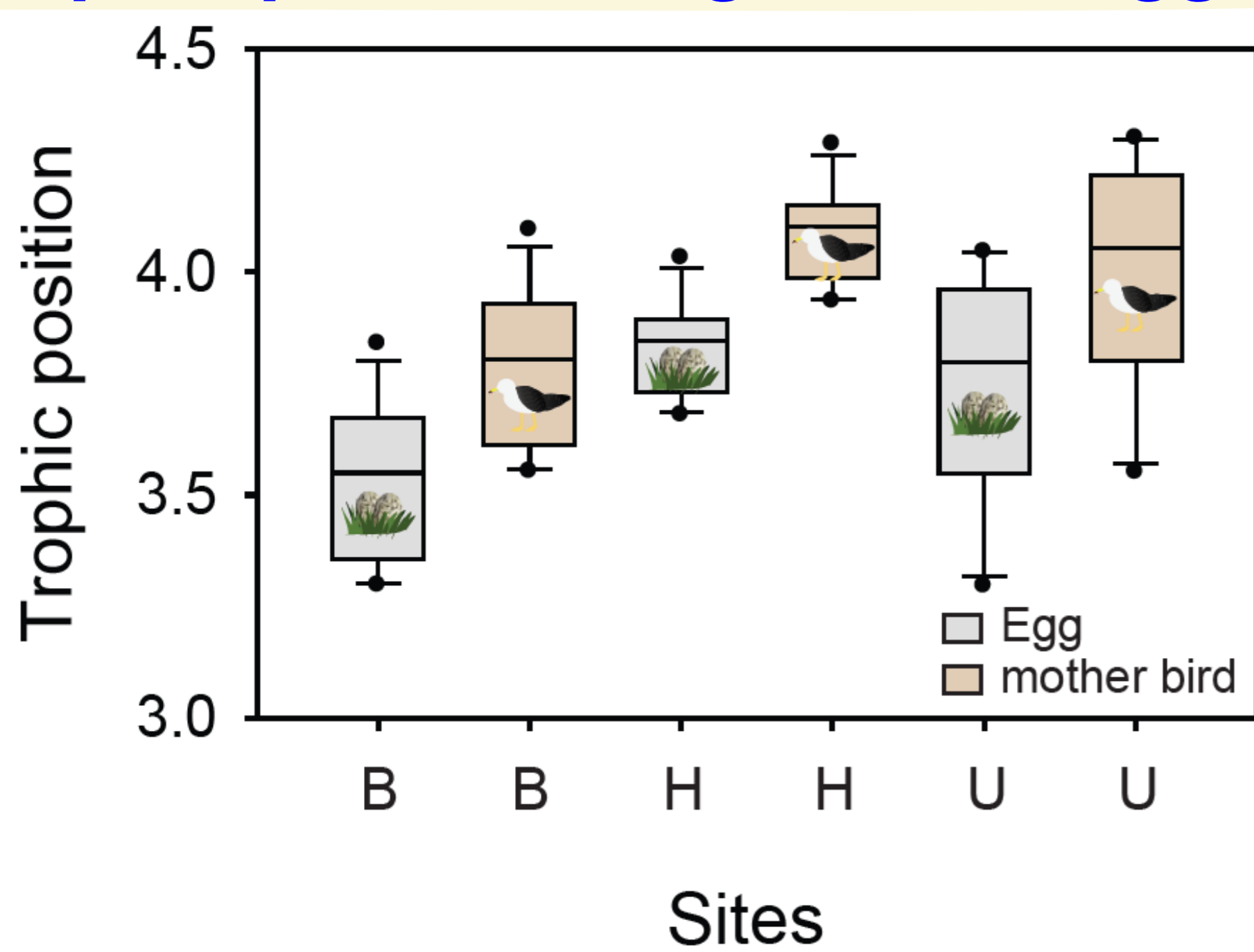
7 TP normalizing!

8 The Hg distributions changed after TP normalization

Take-home message

Feeding habits and **trophic positions** were determined using a combination of **stable isotopes** and **fatty acids**

The mercury concentrations were **adjusted** according to the trophic position of the eggs

Amino acid N stable isotopes are a useful tool for identifying energy flow in **complex food web structure**

Sci. Total Environ.
Kim et al. (2024a) Integrated approach for the isotope trophic position of black-tailed gull (*Larus crassirostris*) eggs over a decade: Combining stable isotopes of amino acids and fatty acids composition. *Sci. Total Environ.*

Mar. Pollut. Bull.
Kim et al. (2024b) Innovative approach for environmental pollution assessment using seabird eggs: mercury in black-tailed gull (*Larus crassirostris*) eggs from the Korean islands (2012–2021). *Mar. Pollut. Bull.*

Water Research
Kim et al. (2023) New insight into biomagnification factor of mercury based on food web structure using stable isotopes of amino acids. *Water Research*