Some like it cold –

Consequences of warming seas for the distribution of large bodied fish

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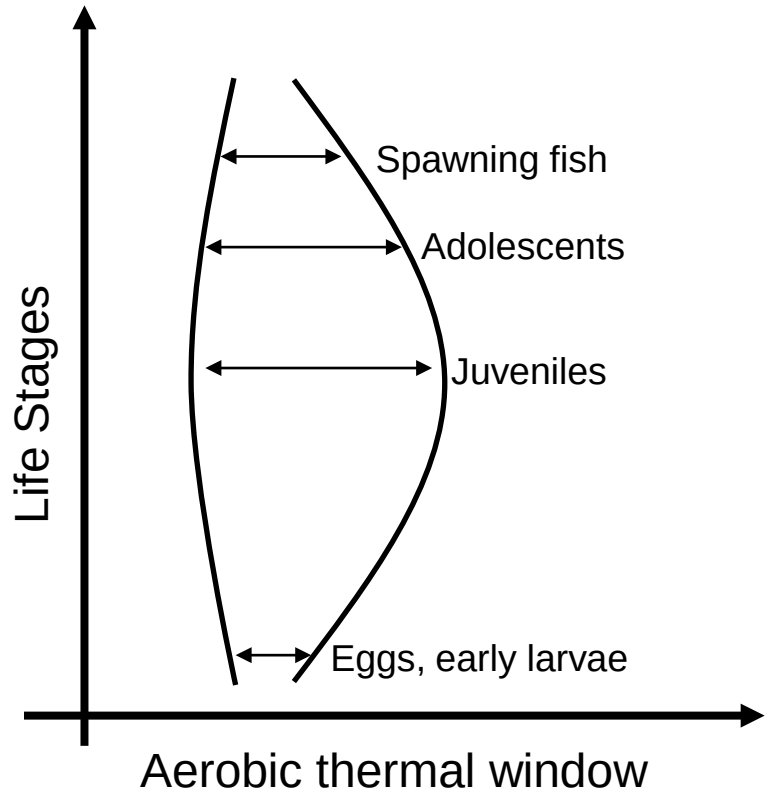
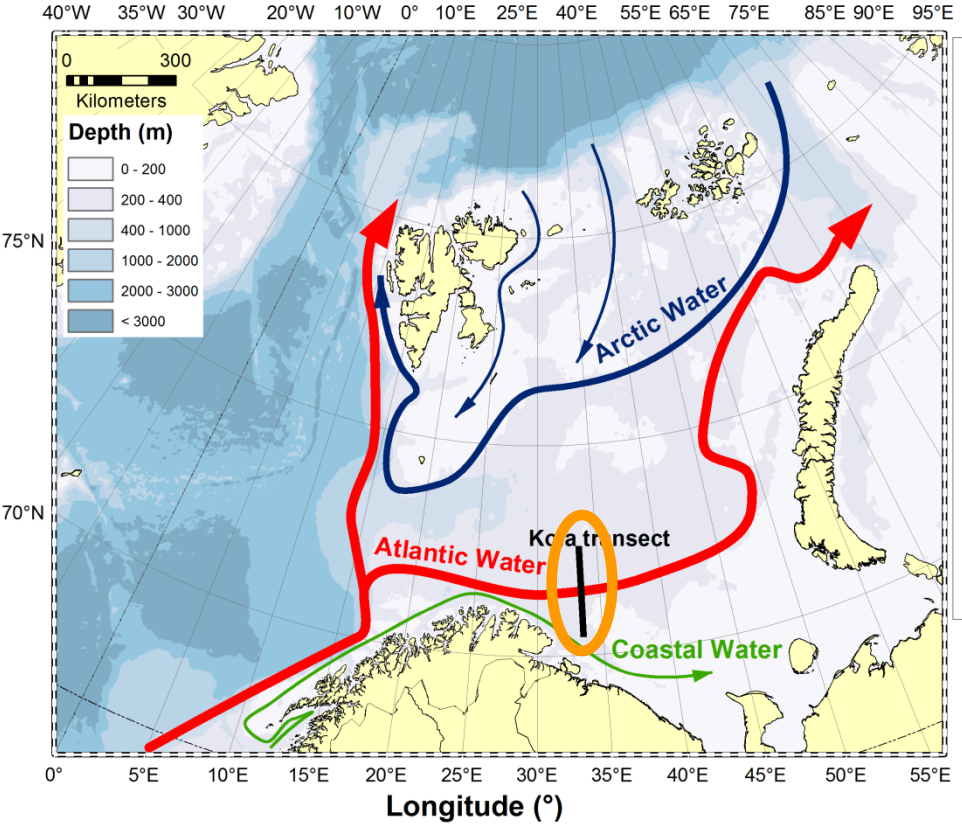
Could large fish run out of space?

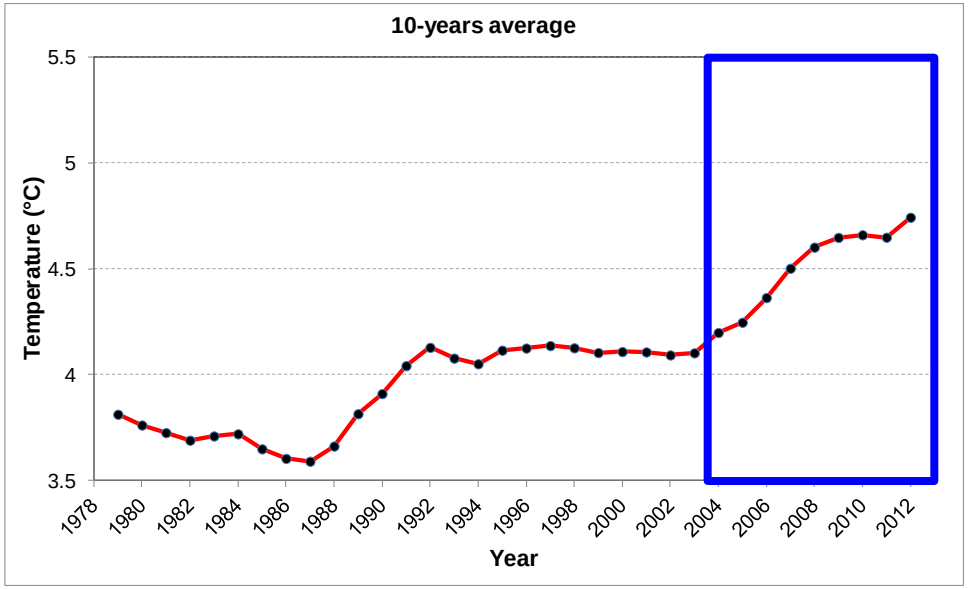
- Less habitat with optimal temperature
- Thermal stress decreases benefits
- More competition in a growing stock



(Redrawn; Pörtner & Farrell 2008)

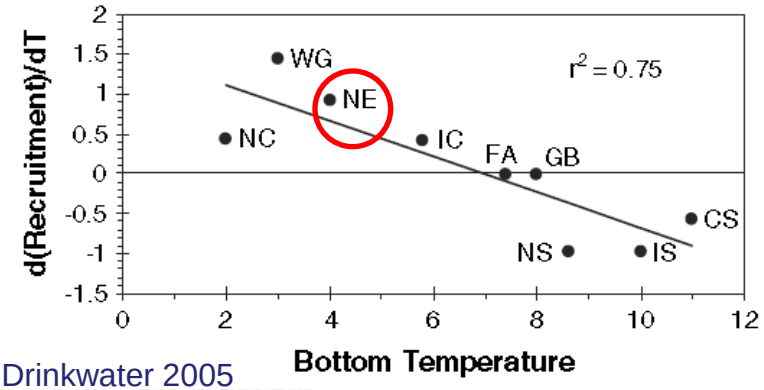
The Barents Sea ecosystem





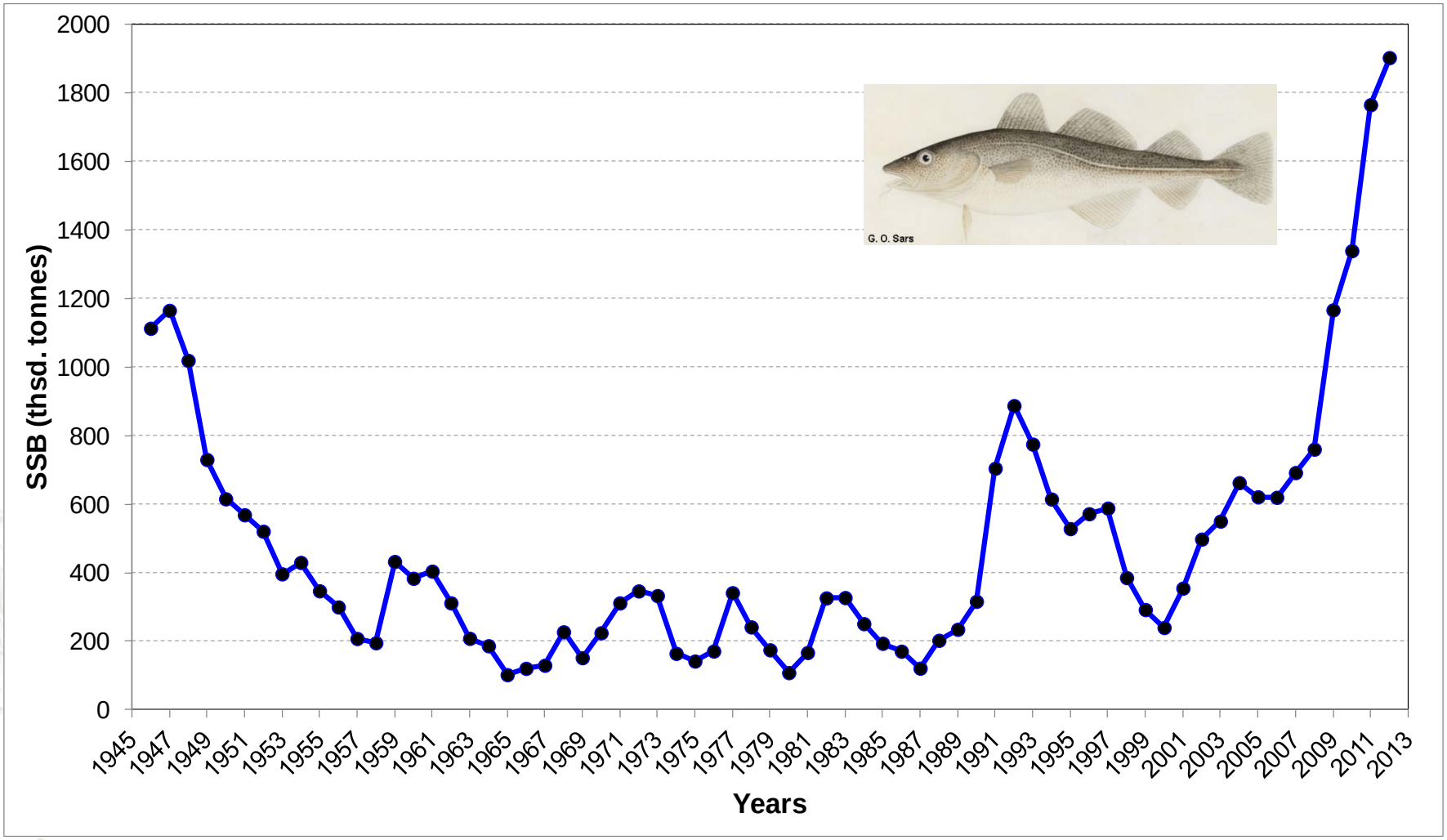
Cod (*Gadus morhua*)

Capelin (*Mallotus vilosus*)



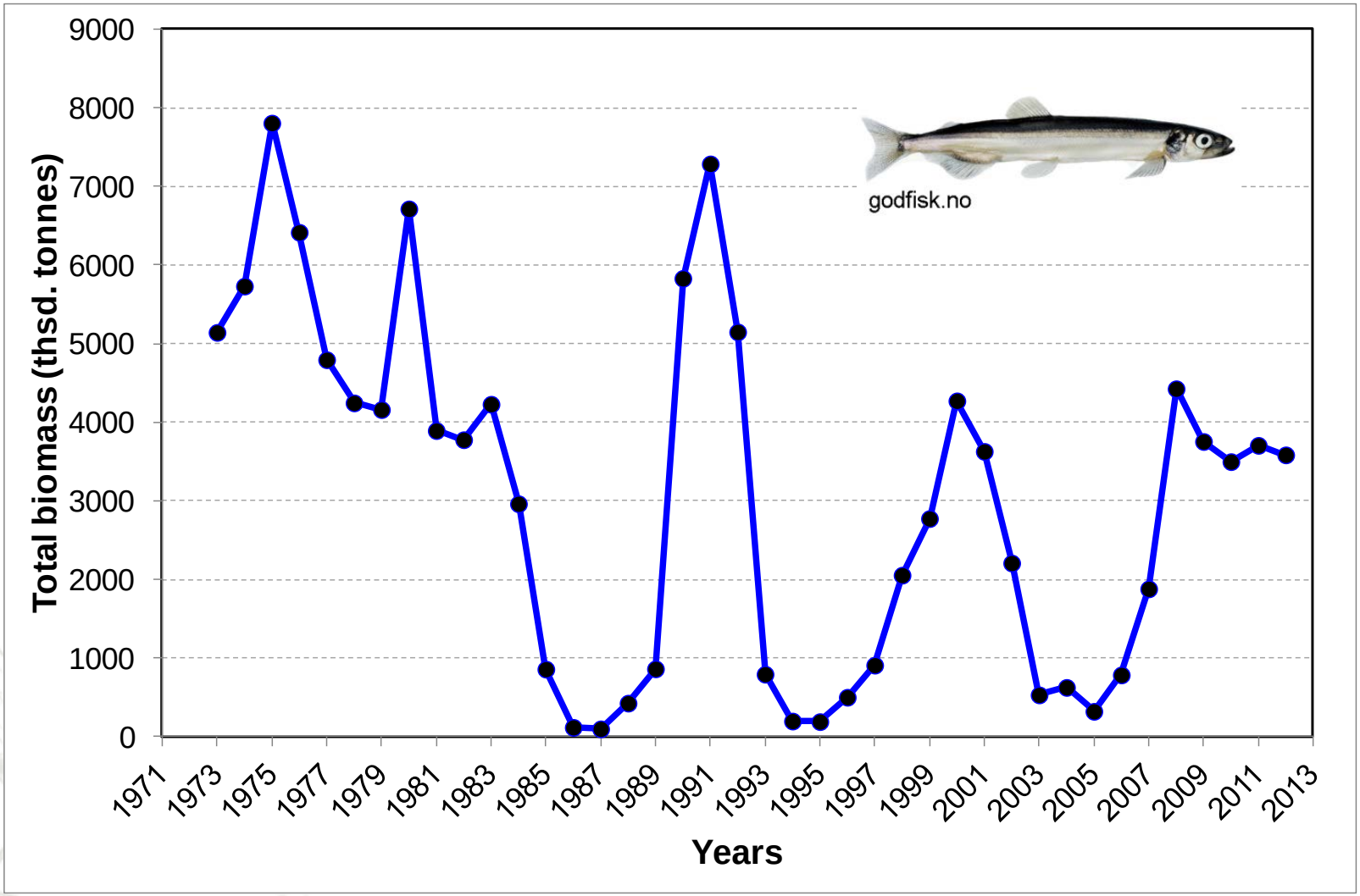
The Barents Sea ecosystem

North East Arctic cod

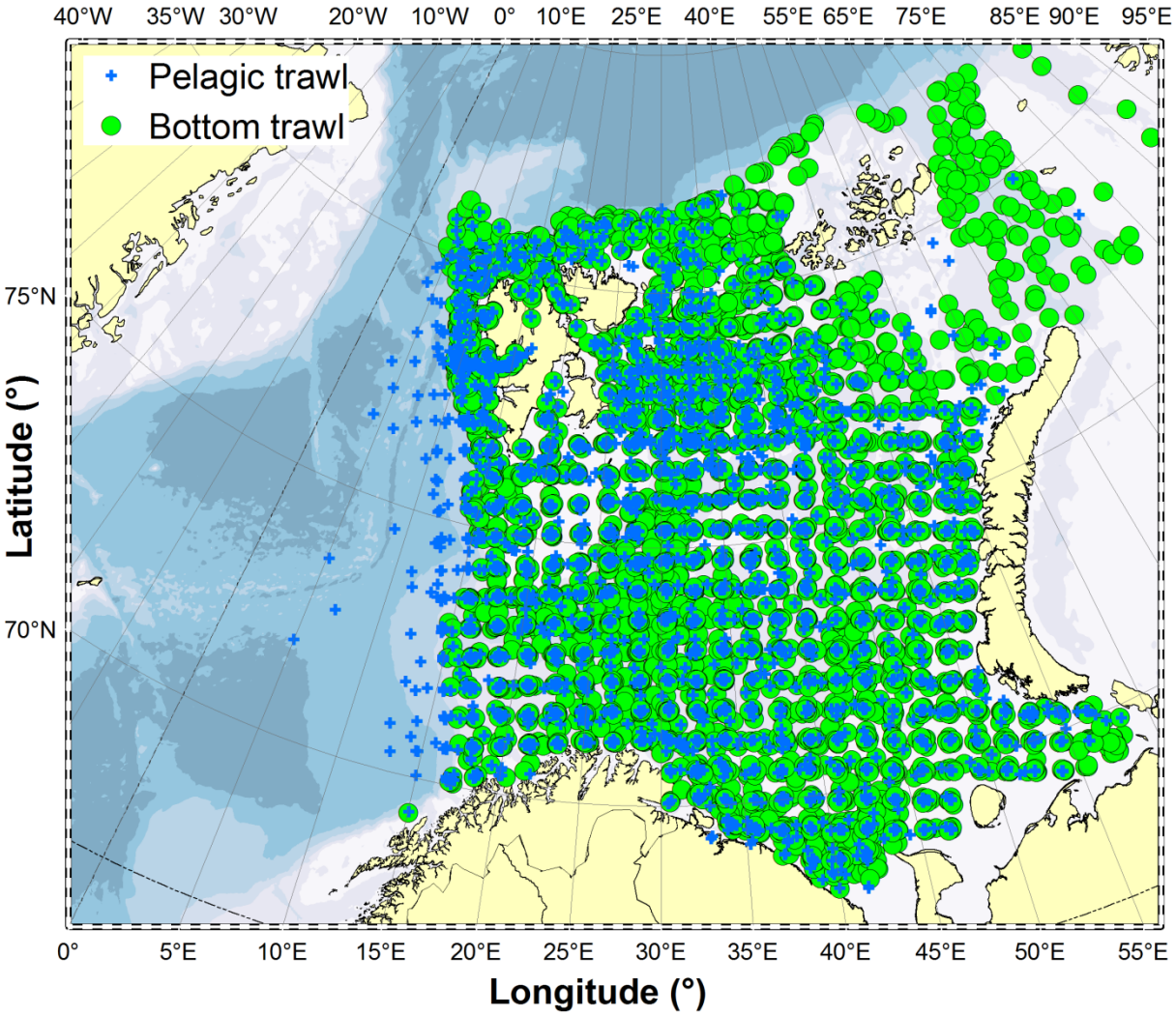


The Barents Sea ecosystem

Barents Sea capelin



Joint Ecosystem Survey



Since 2004

Aug. – Sept.

Acoustic and Trawl

Norway & Russia
4 – 5 Ships

Bottom trawls: 4839
Pelagic trawls: 3590

Average distribution 2004 - 2013

Length class	Range (cm)
1	0-10
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Centre of gravity:

$$\bar{x} = \frac{\sum x \times z}{\sum z}$$

x ... Longitude or Latitude (y)

z ... Cod (NM^{-2})

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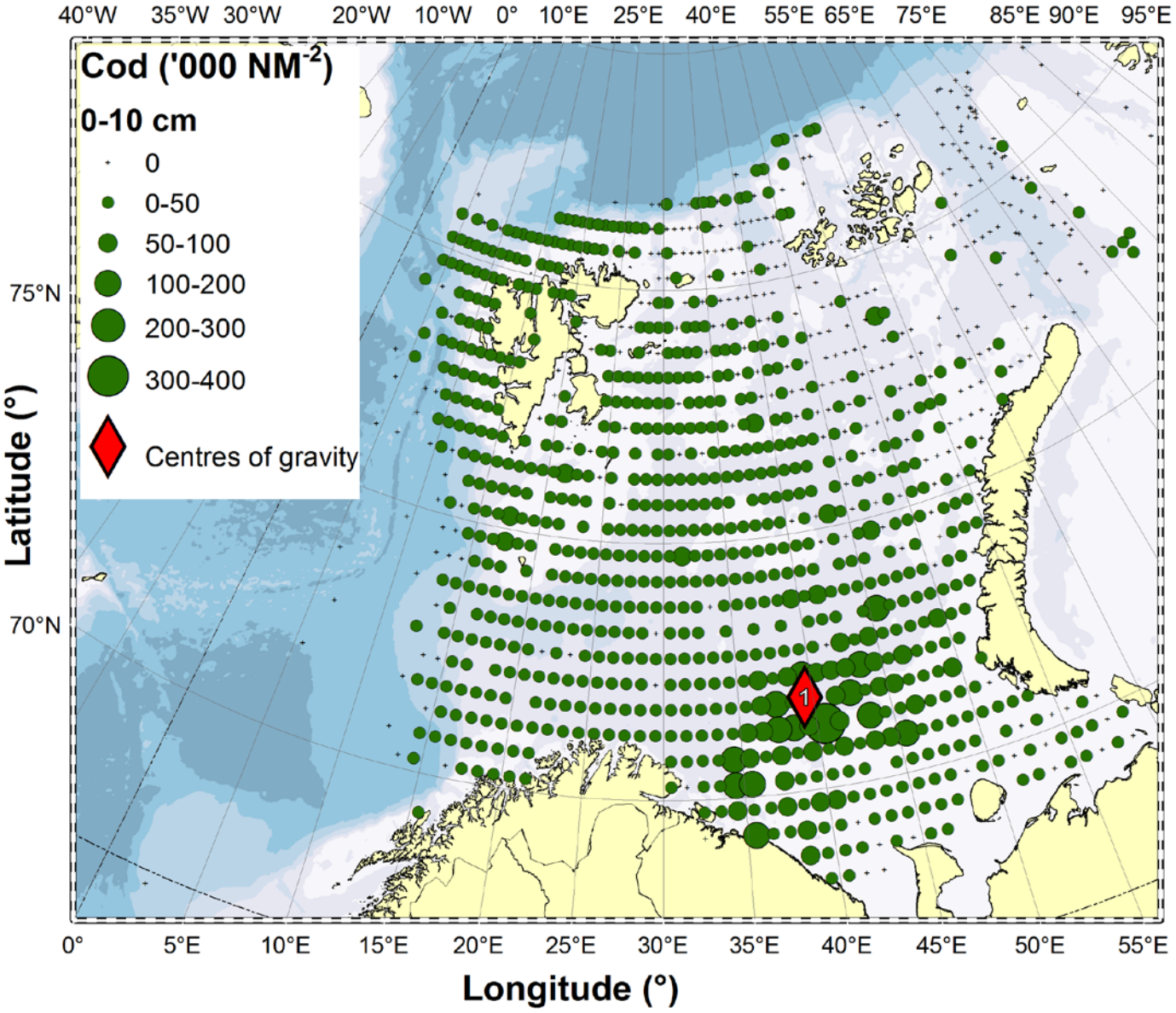

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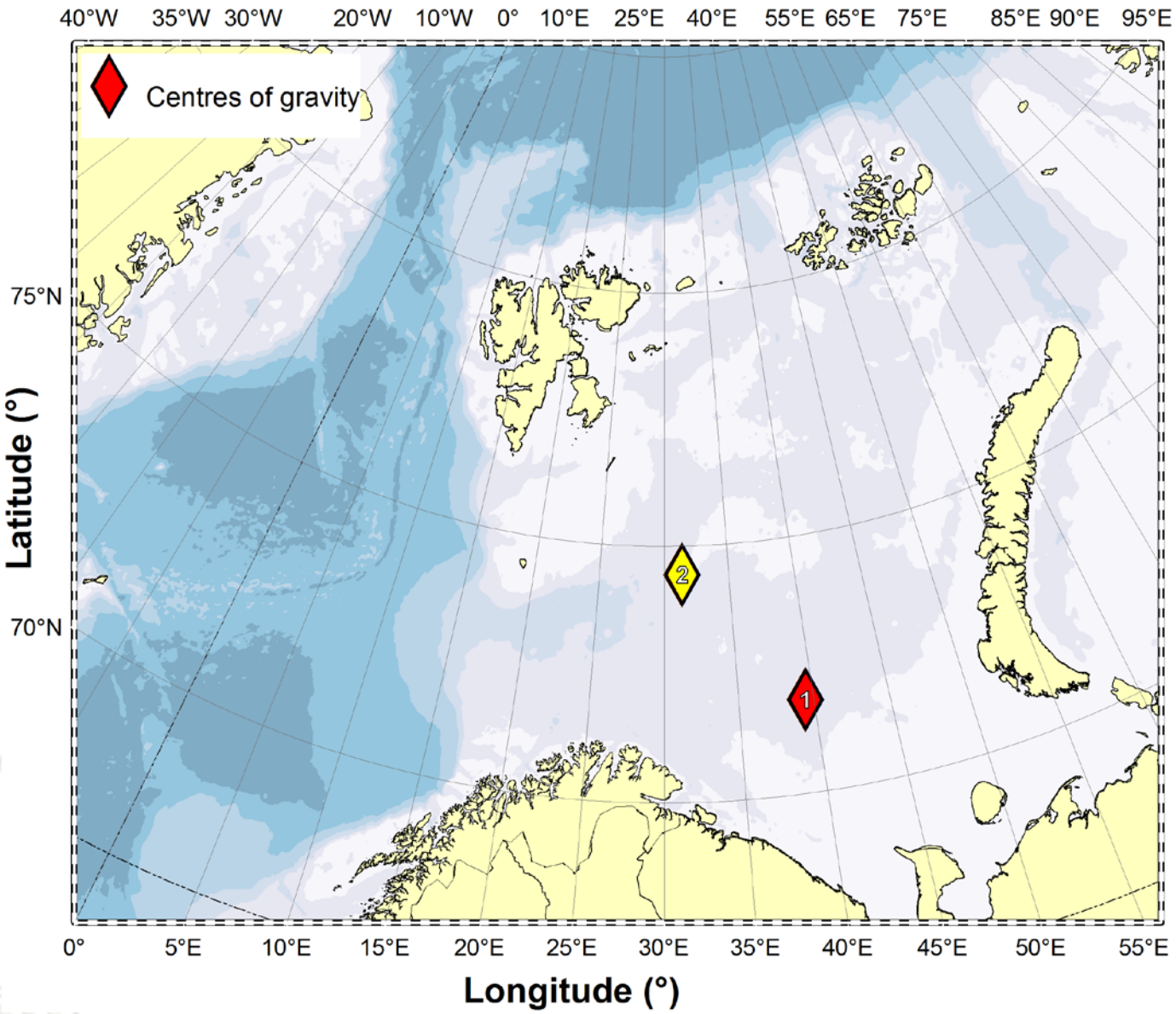

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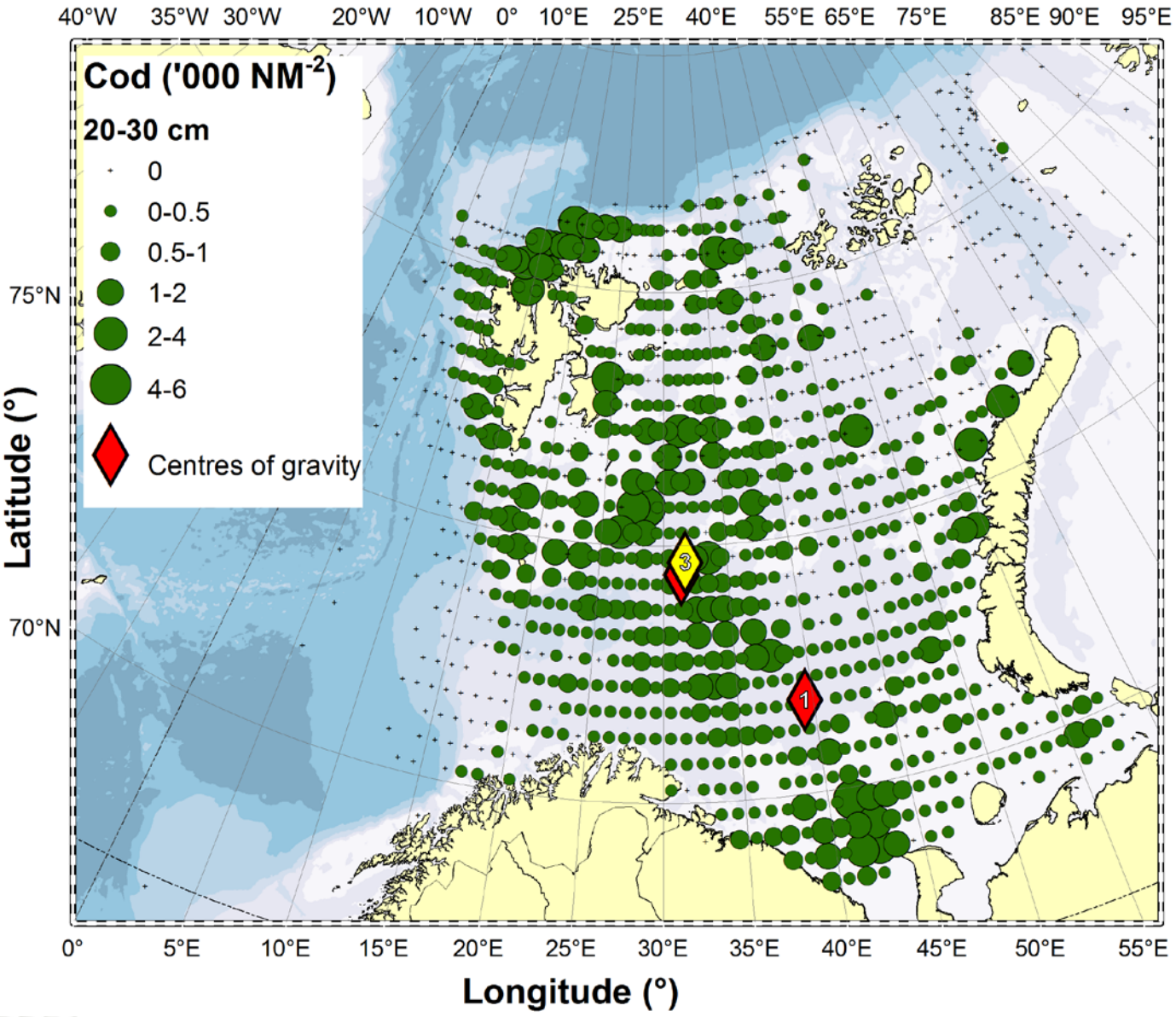

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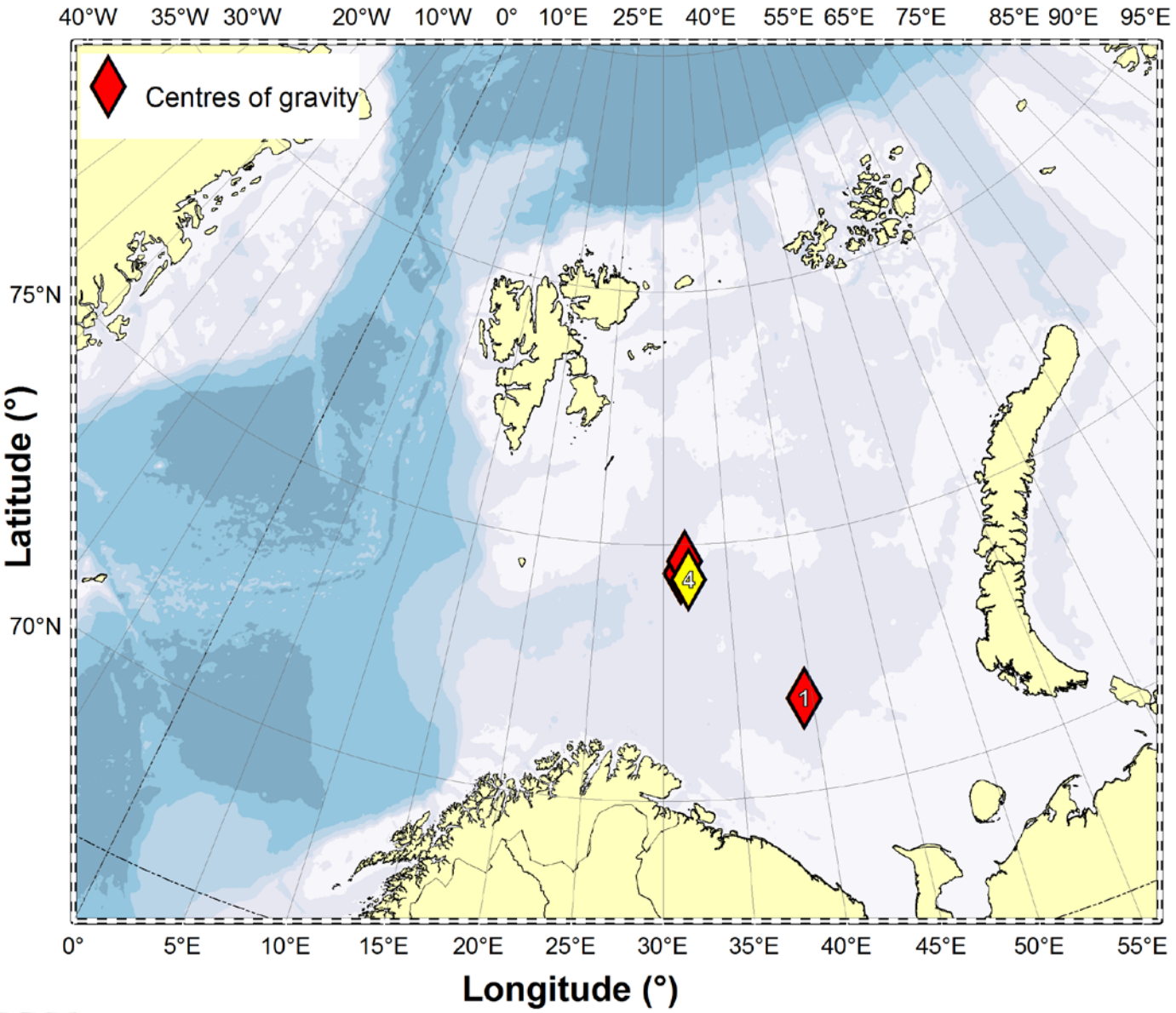

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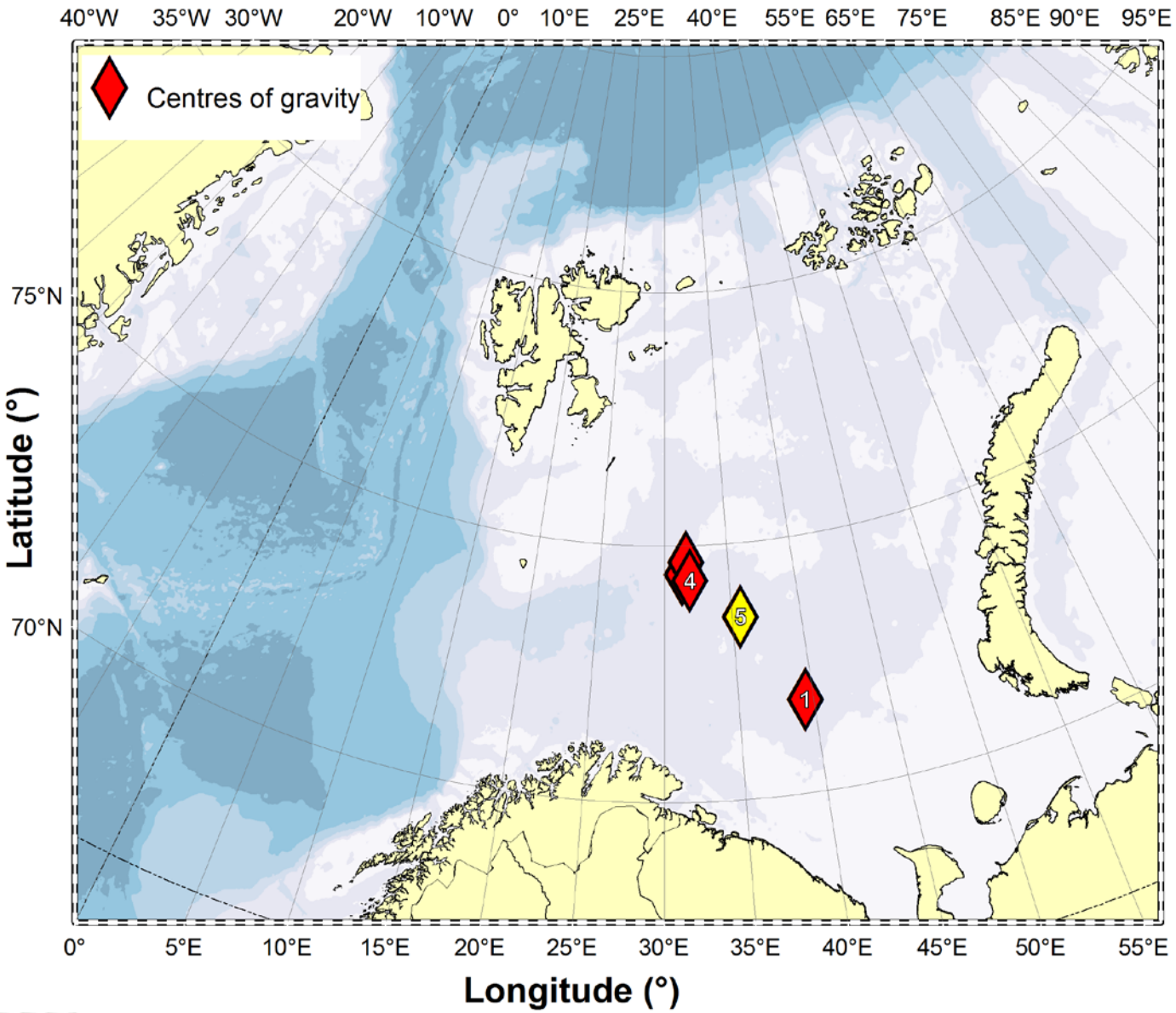

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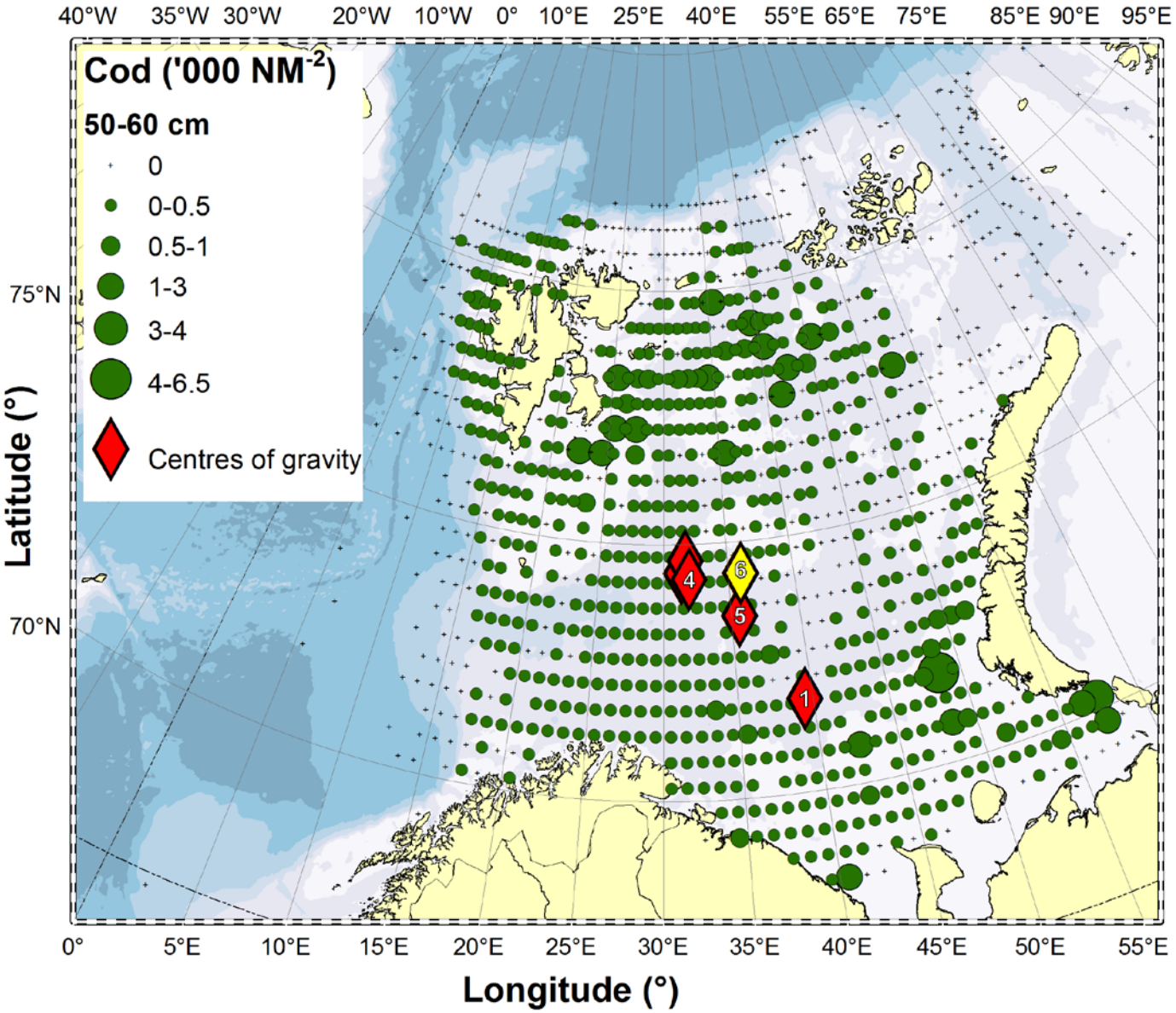

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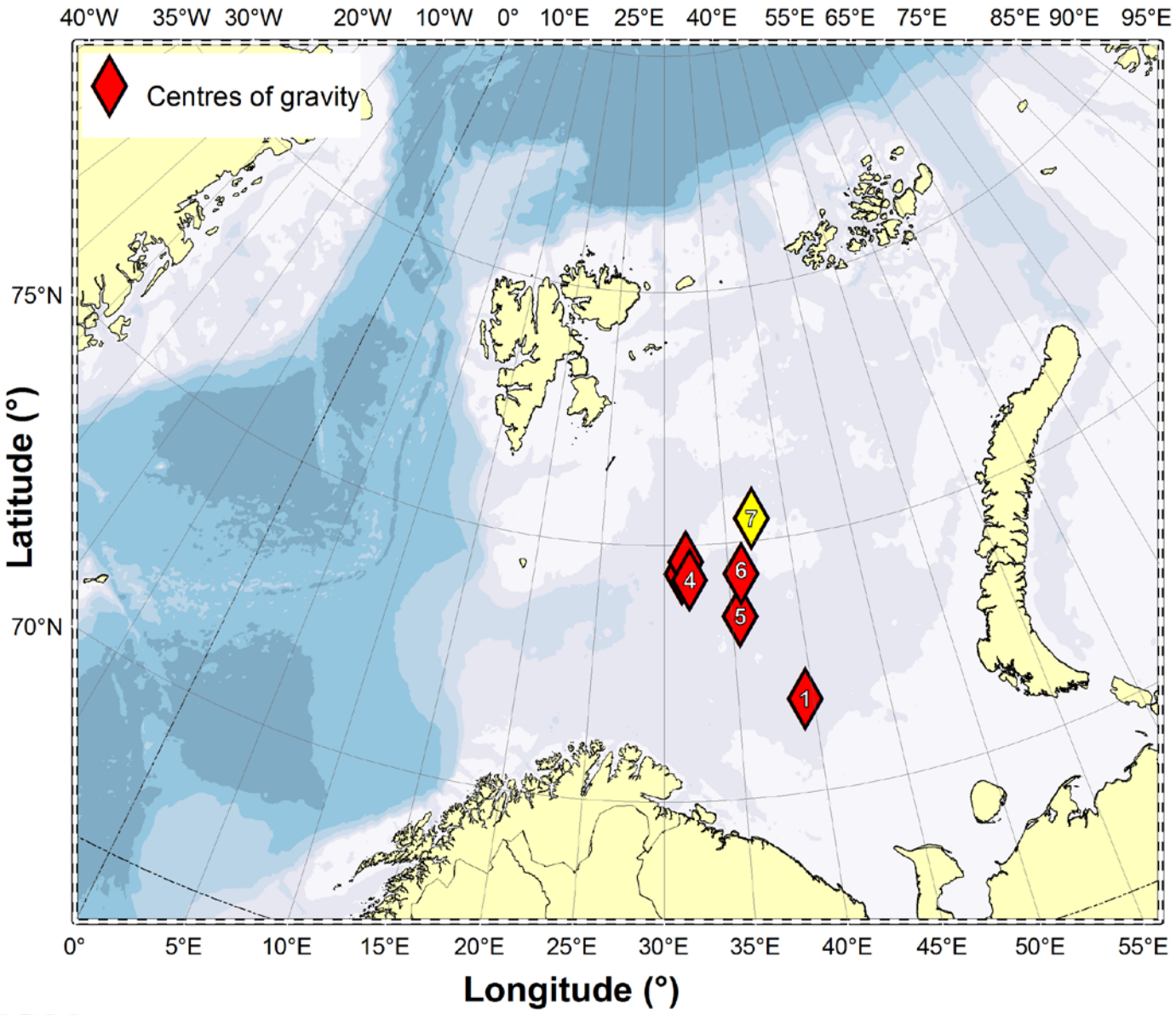

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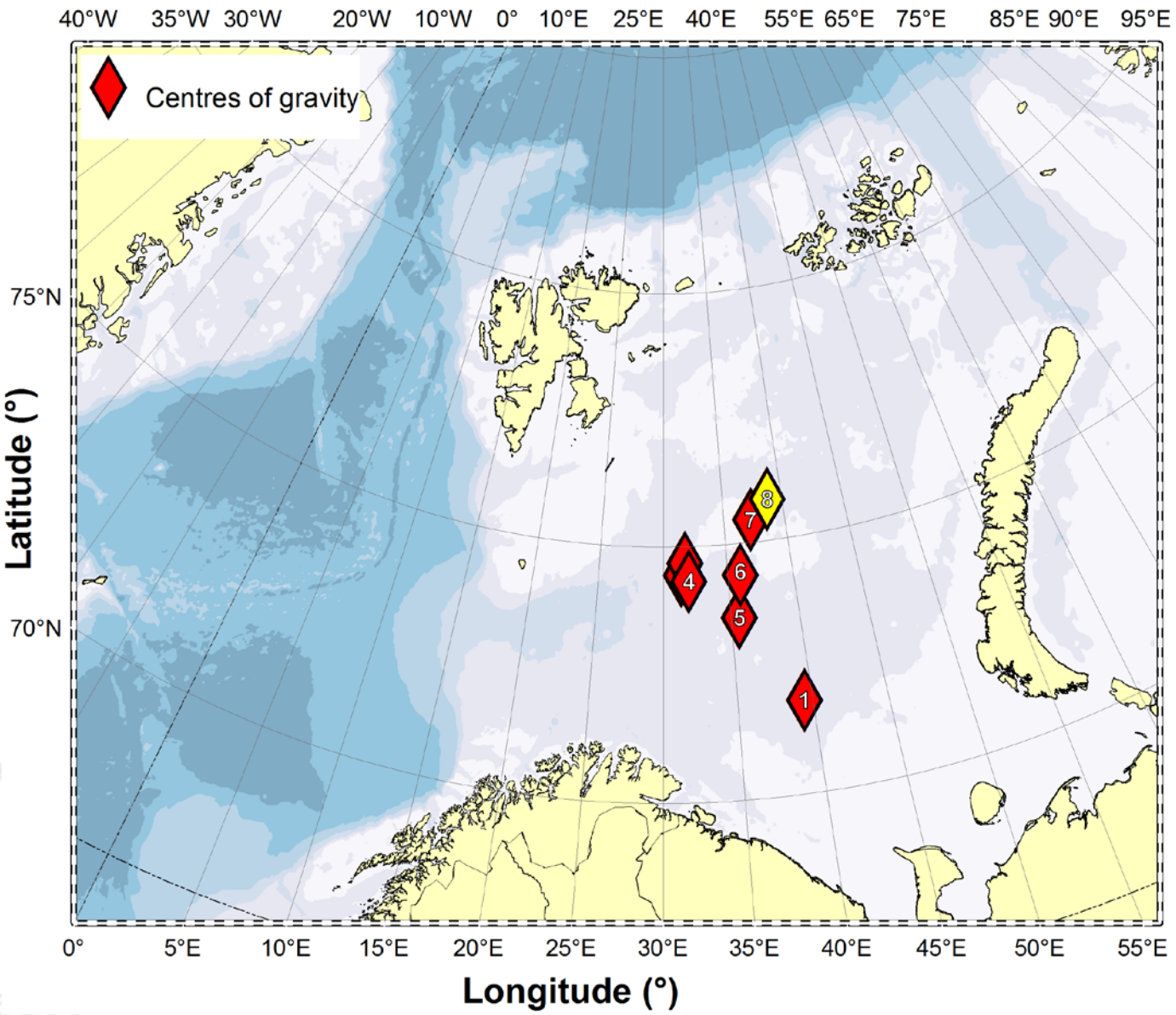

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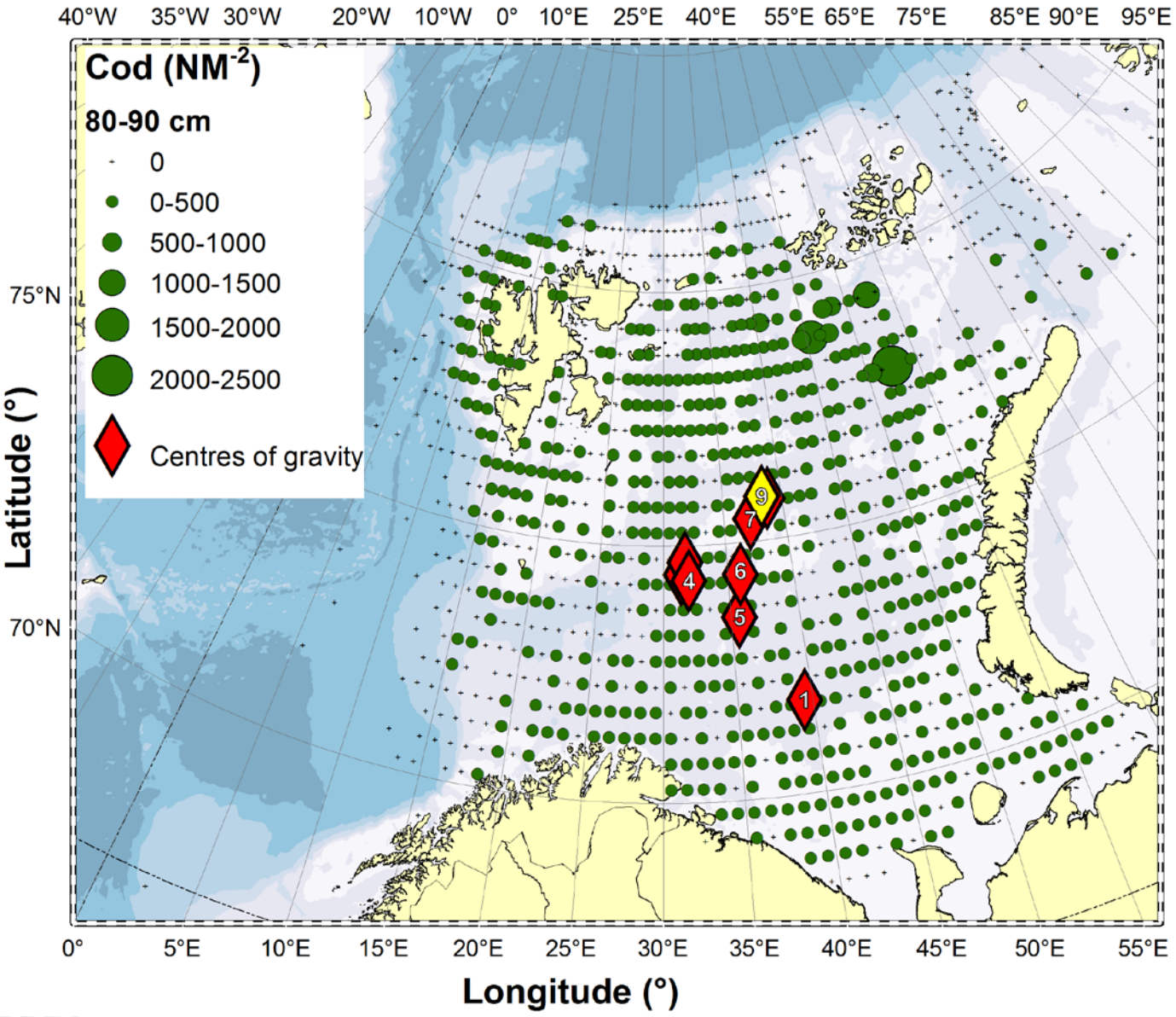

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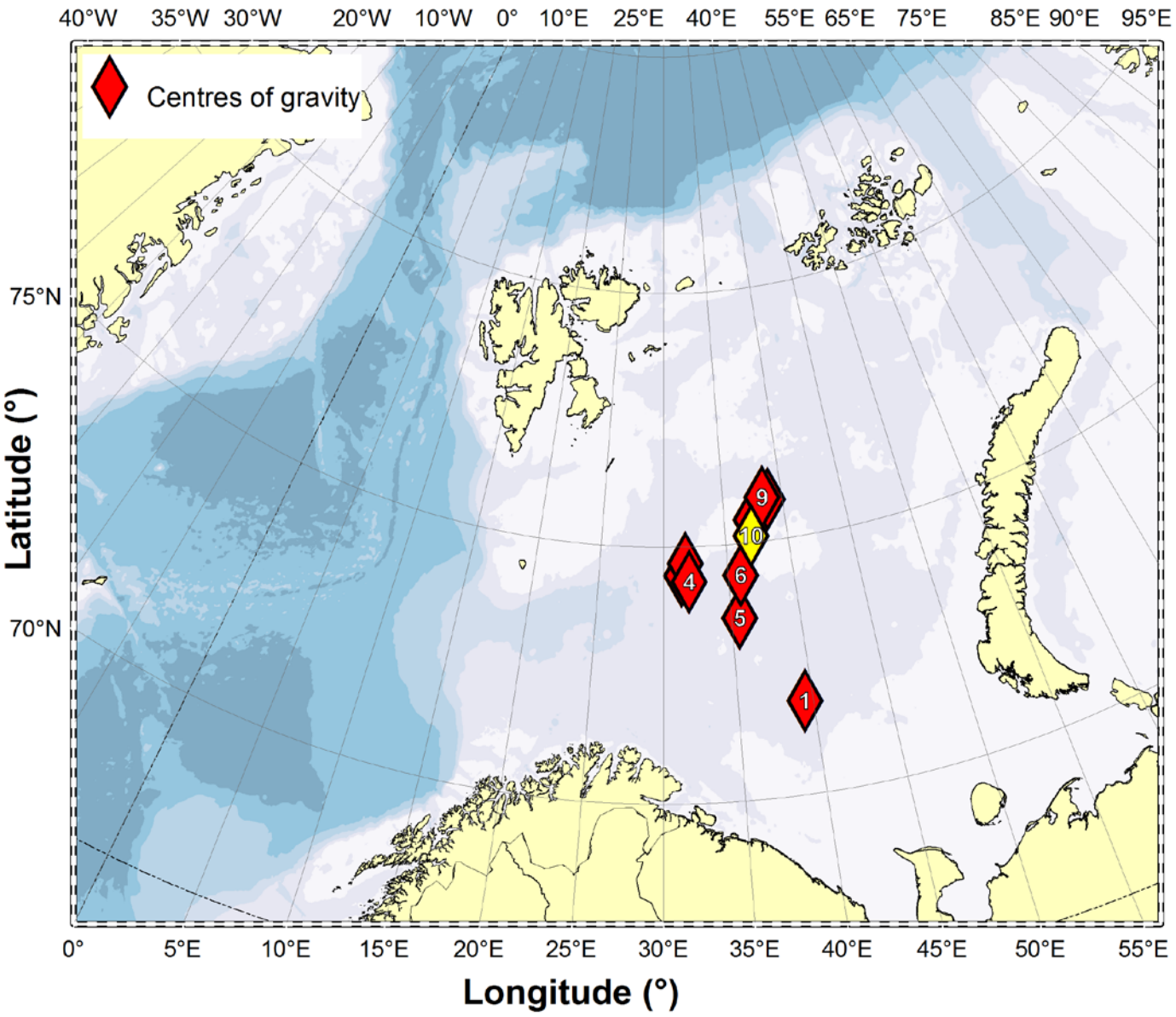

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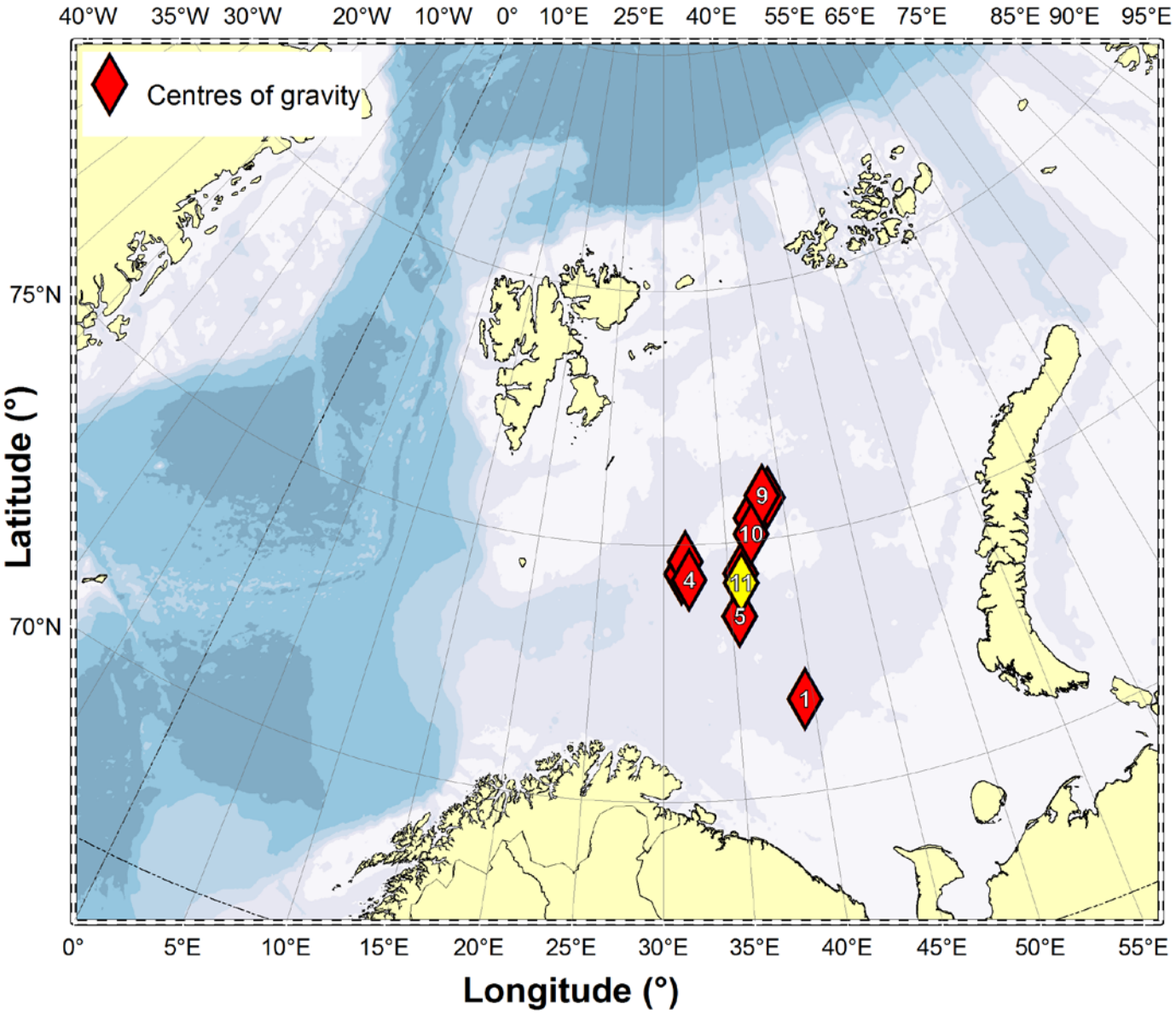

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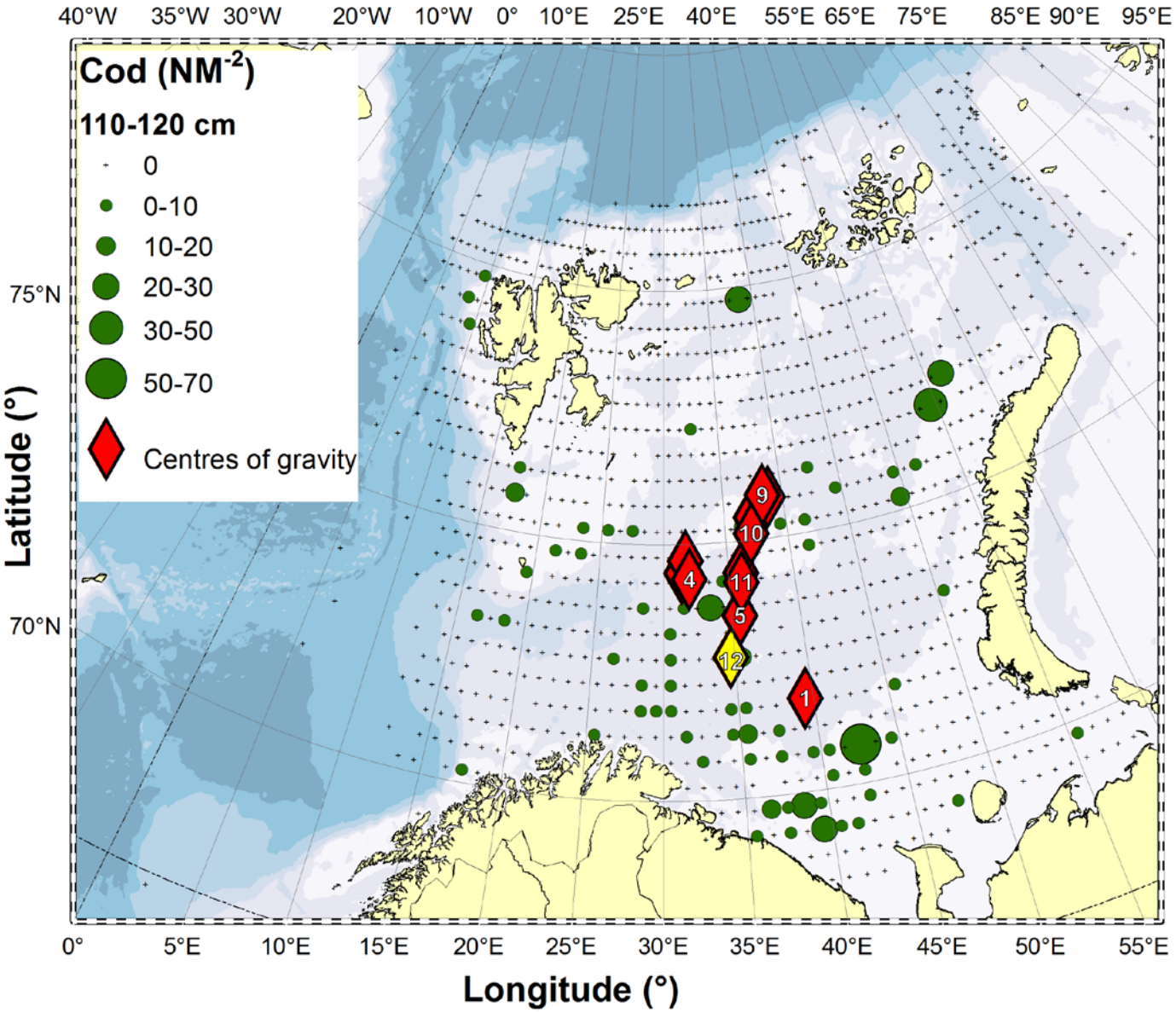

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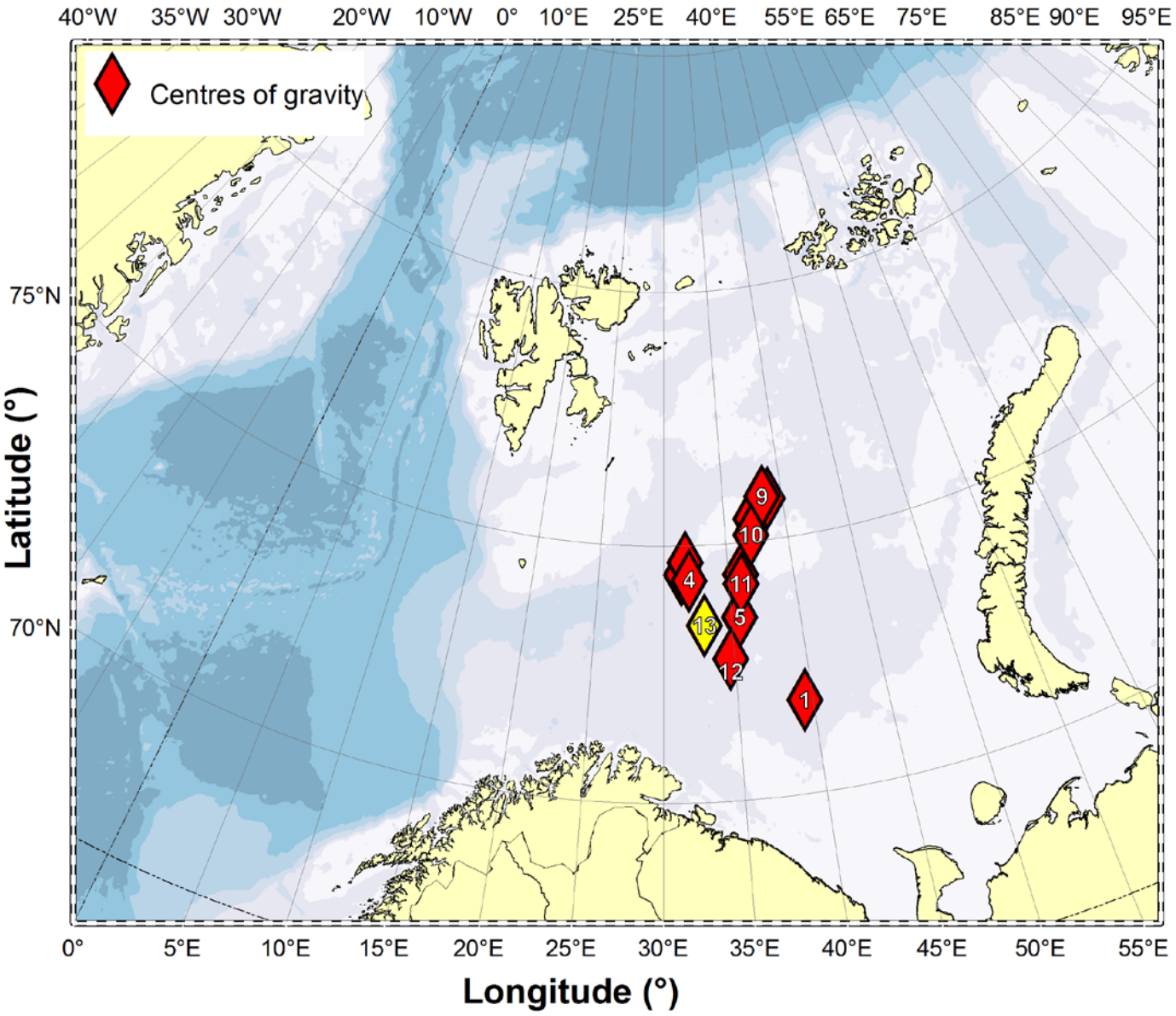

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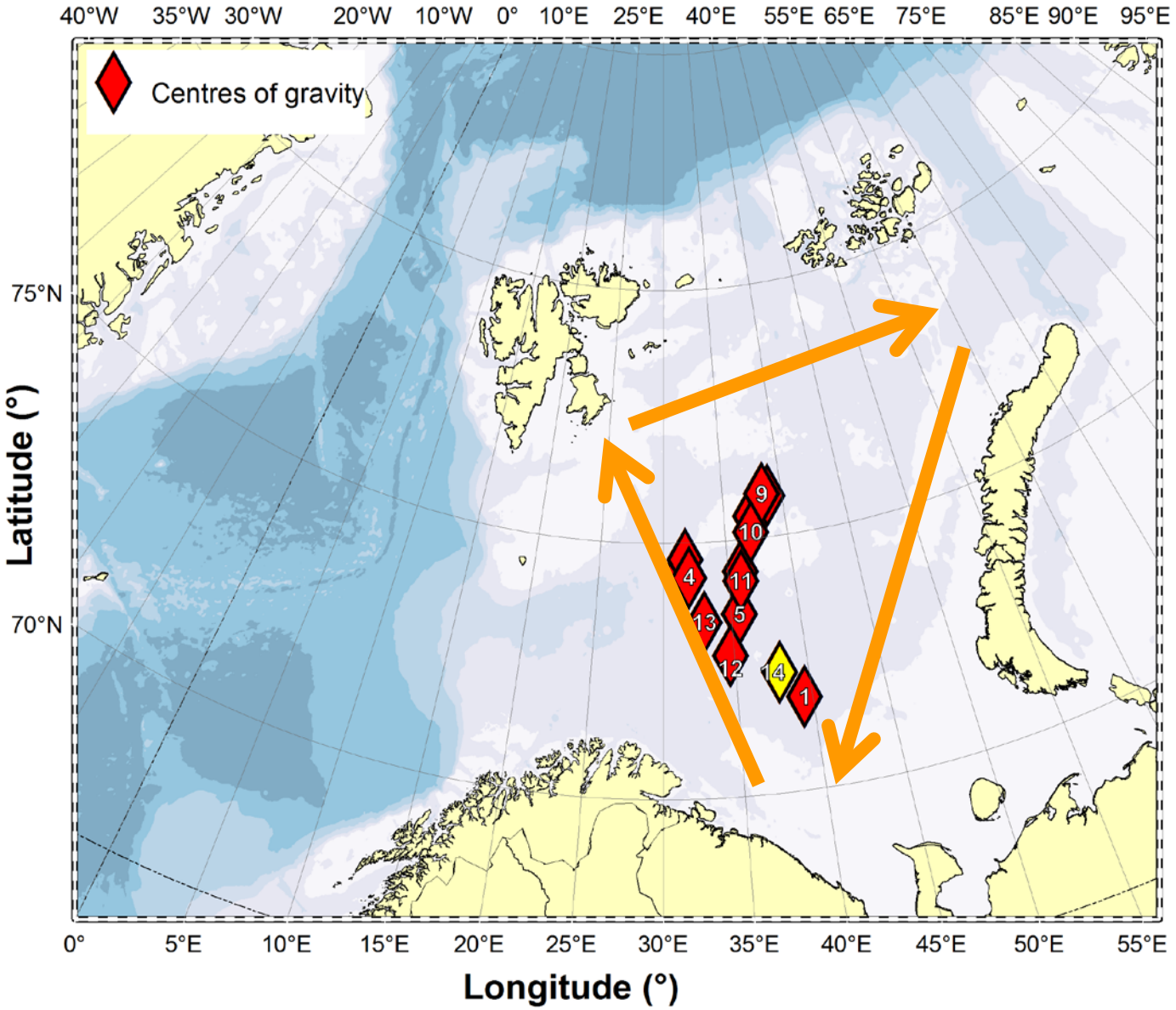
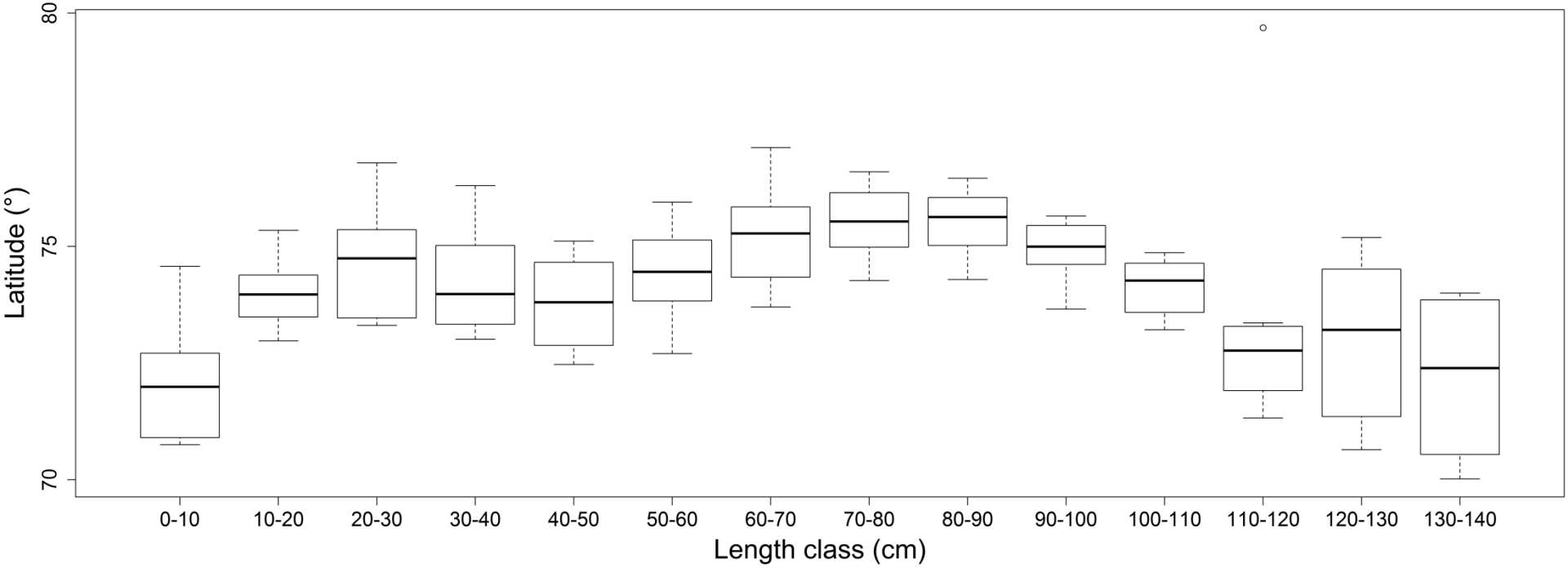
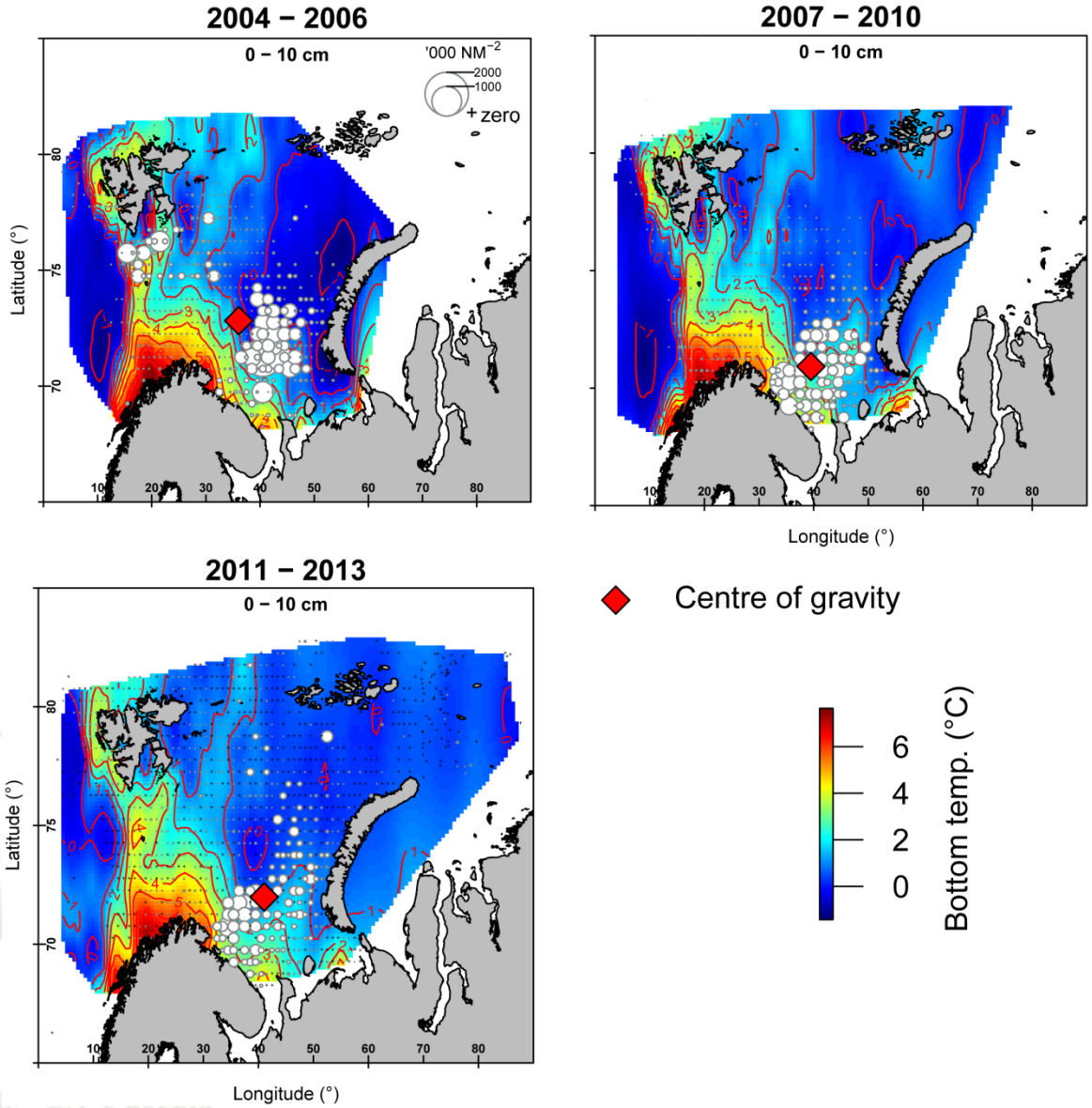


Weighted mean latitude



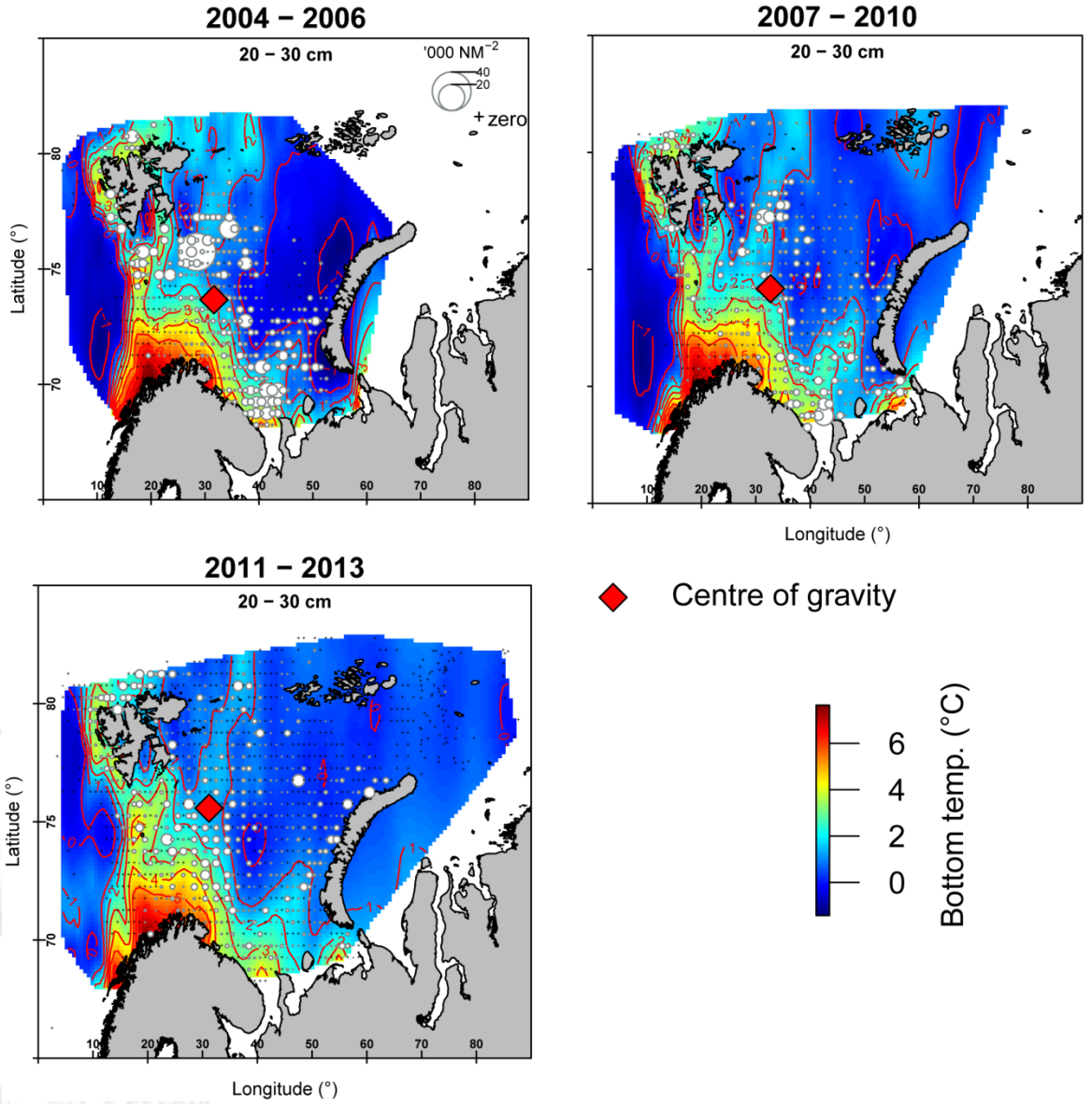
Distribution vs. Environment

Length class 1 vs. Temperature



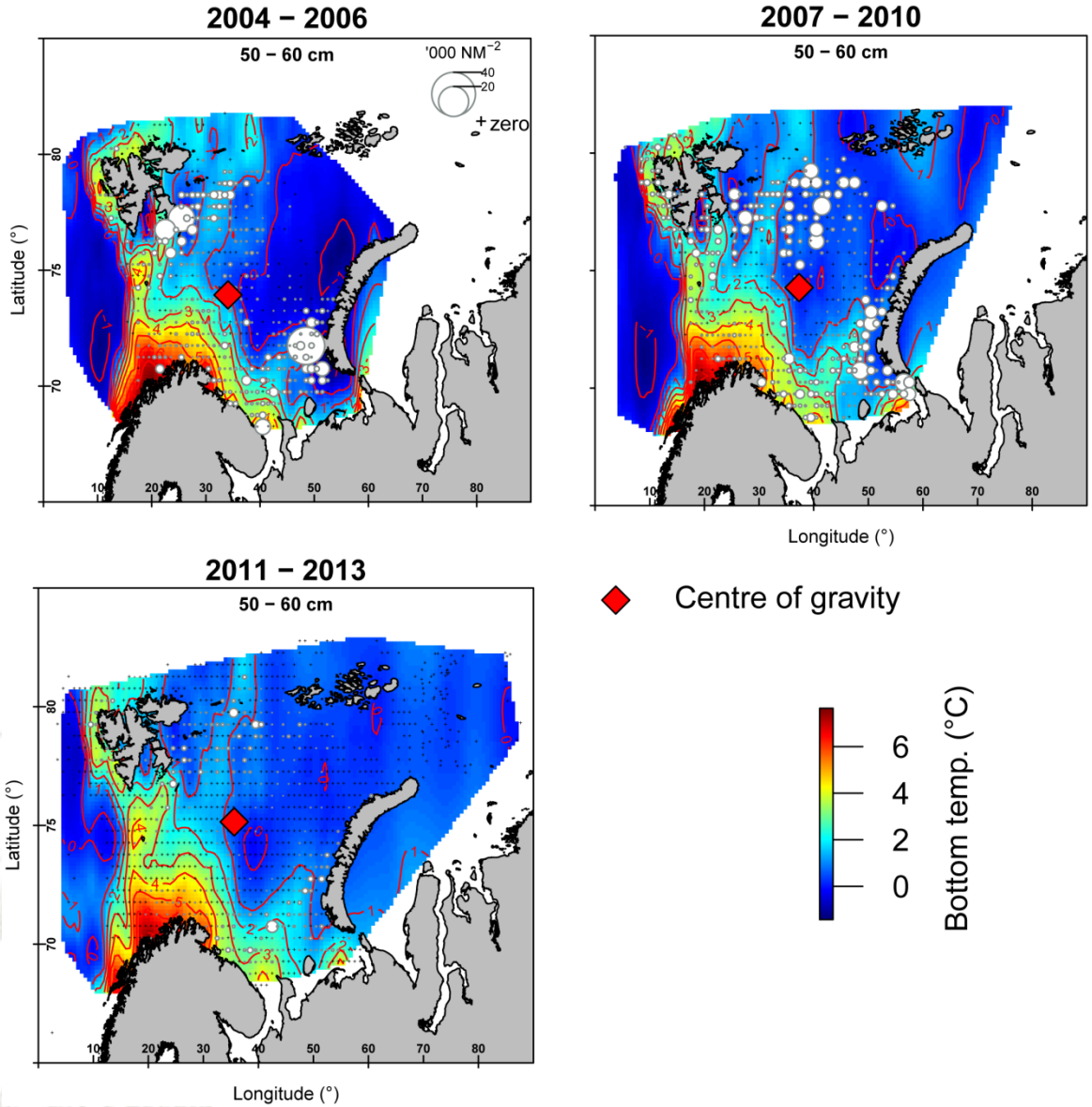
Distribution vs. Environment

Length class 3 vs. Temperature



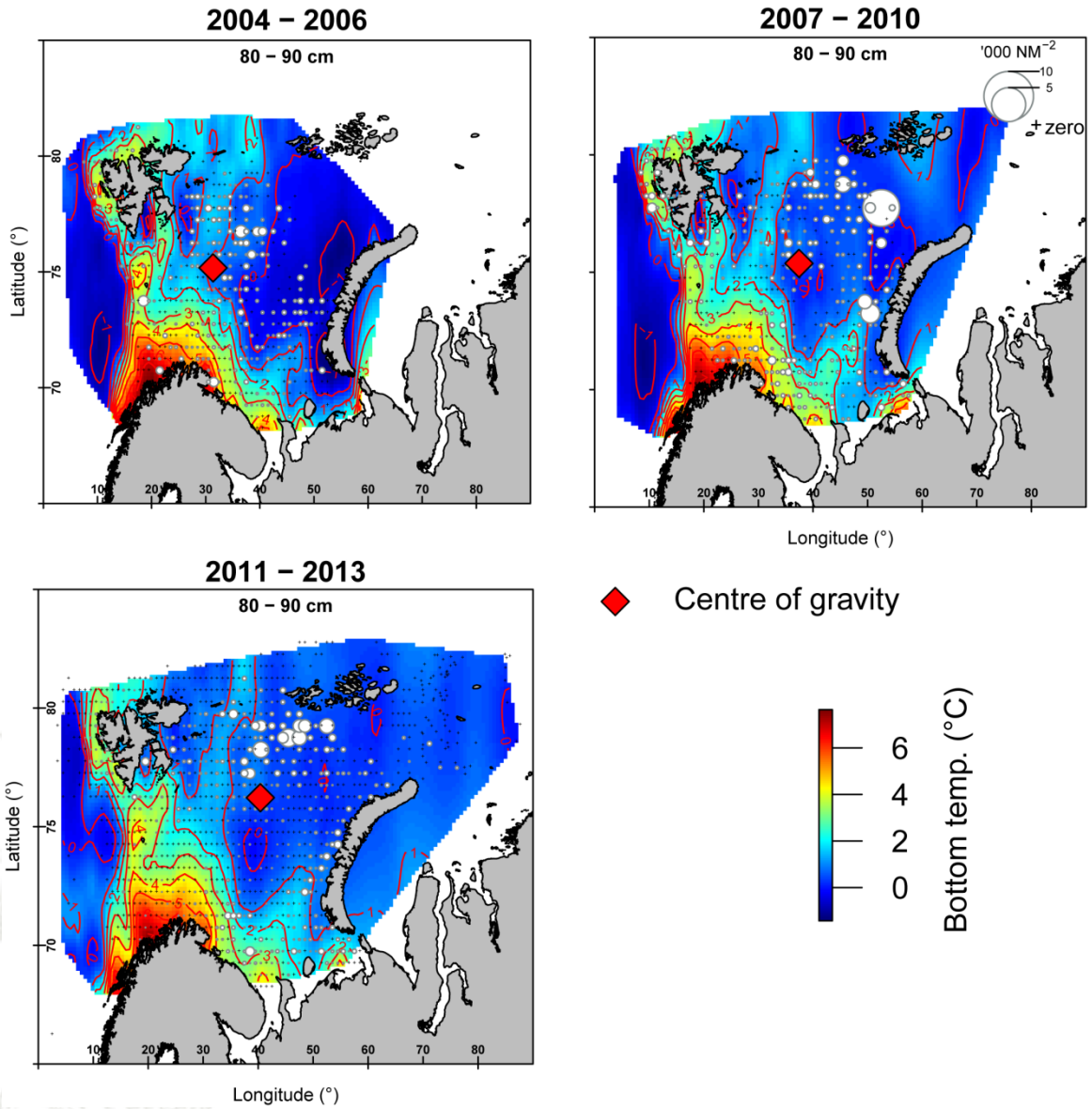
Distribution vs. Environment

Length class 50 – 60 cm vs. Temperature



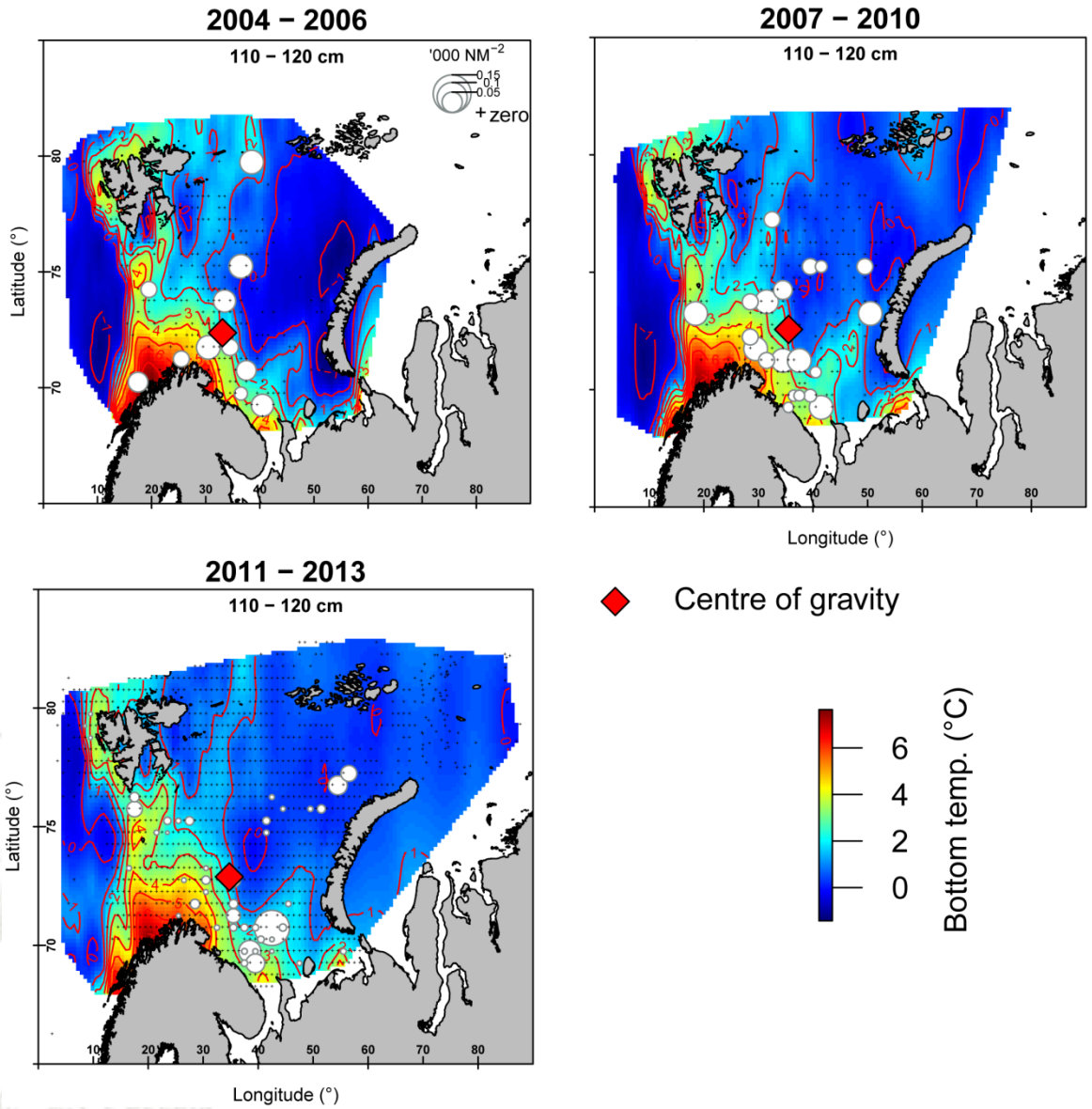
Distribution vs. Environment

Length class 3 vs. Temperature



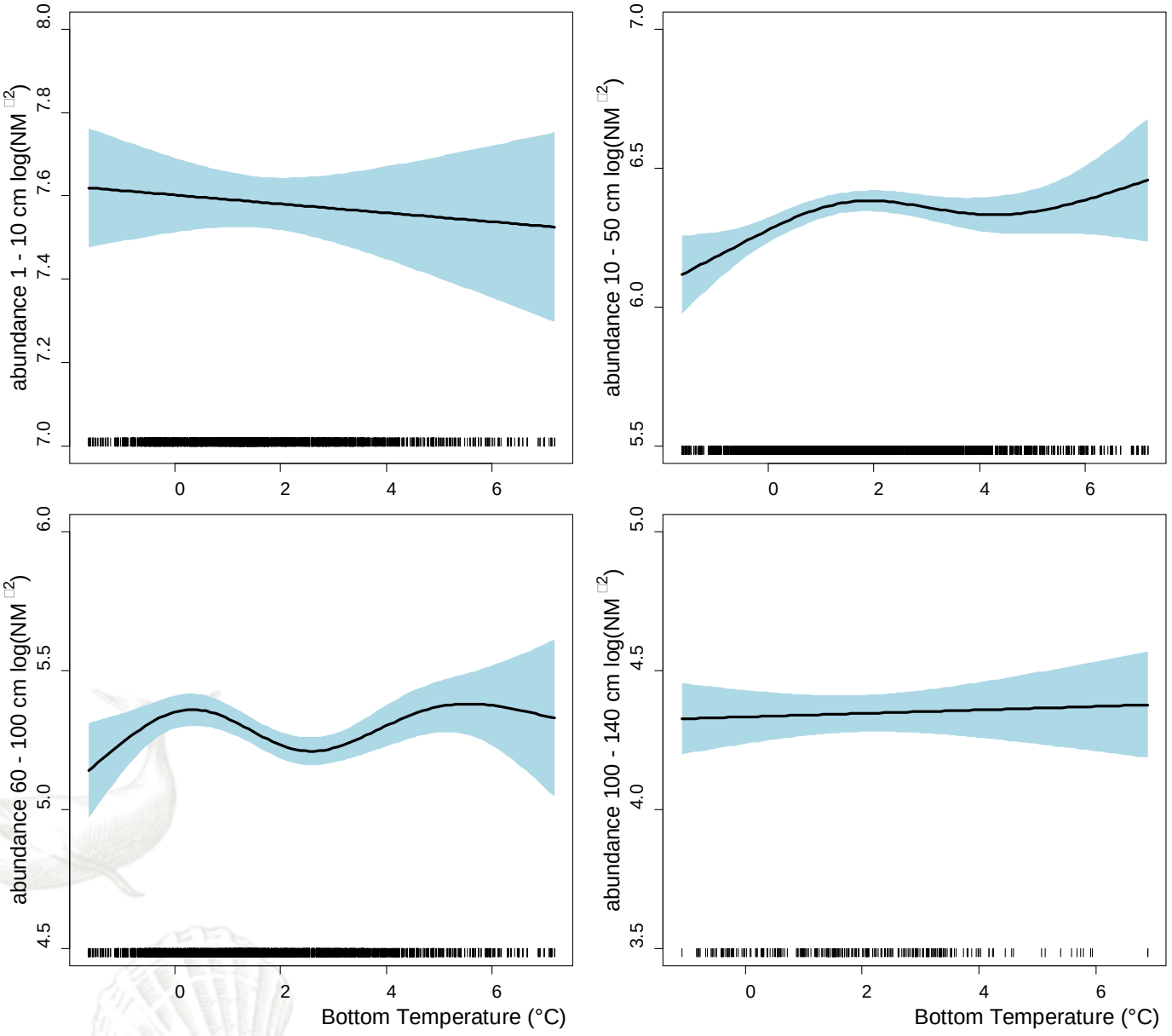
Distribution vs. Environment

Length class 12 vs. Temperature

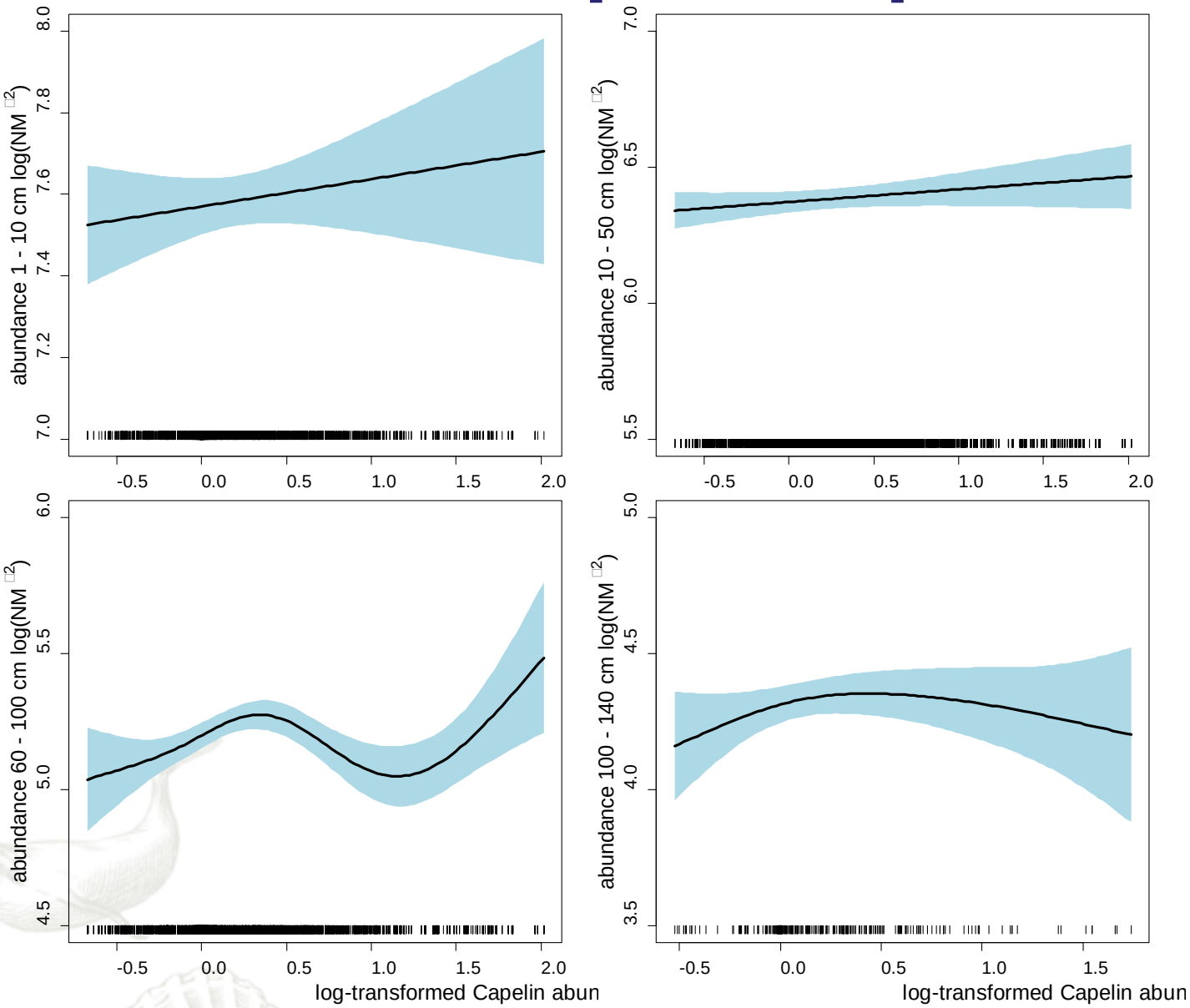


Relationship to temperature

$$g(\mu_i) = \beta_0 + f_1(x_{1i}) + f_2(x_{2i}) + \cdots + f_n(x_{ni})$$



Relationship to Capelin



Conclusions

- The largest fish do not occur in the coldest available water
- Smallest cod show little overlap with capelin
- Medium size classes exhibit the highest weighted mean latitude

Where do we go from here?

- Integrate morphometric measurements
- Apply a spatial statistics framework
- Compare to other regions

Some like it cold?

... And maybe they just **do** like it hot.

Acknowledgements

- Captains and crews of the ships involved

- Edda Johannesen (IMR) for the capelin data

- PINRO for data from the Russian sector of the Barents Sea

Thank you!

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