



What scale(s) to study an ecosystem?

A case study in the Barents Sea

*Husson Bérengère, Lind Sigrid, Fossheim
Maria, Primicerio Raul, Ingvaldsen Randi,
Dolgov Andrei, Mette Skern-Mauritzen*

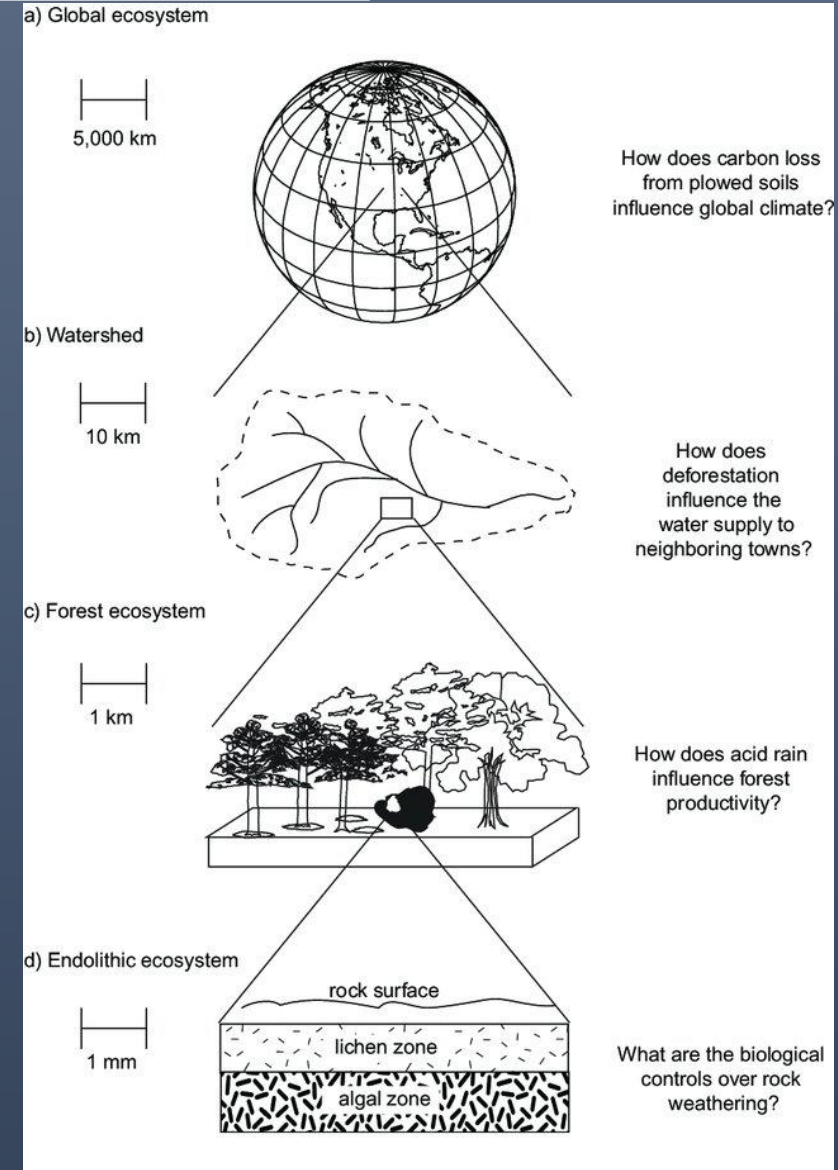


Scales in an ecosystem

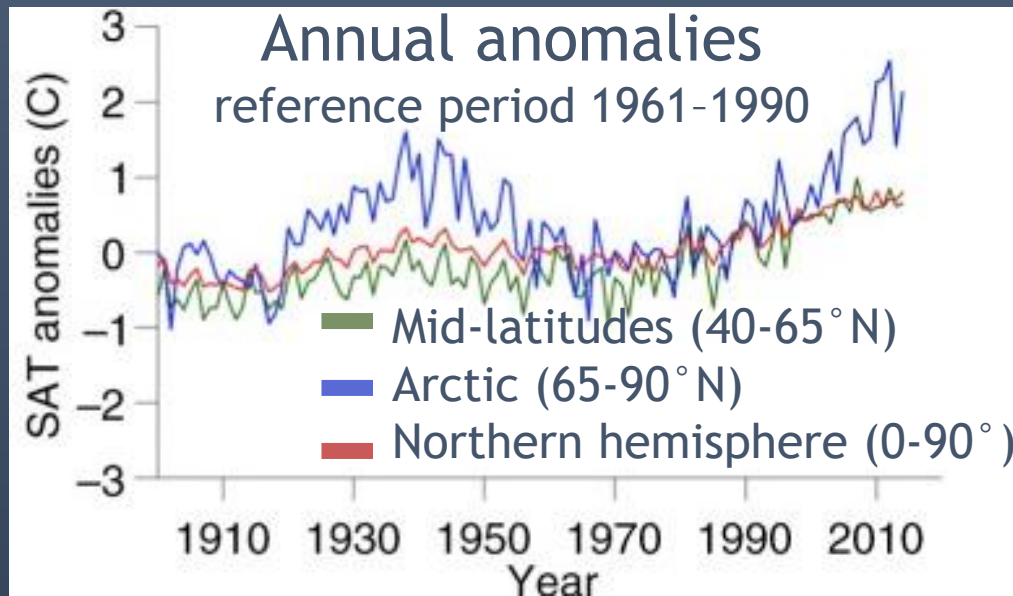


“How big is an ecosystem?”

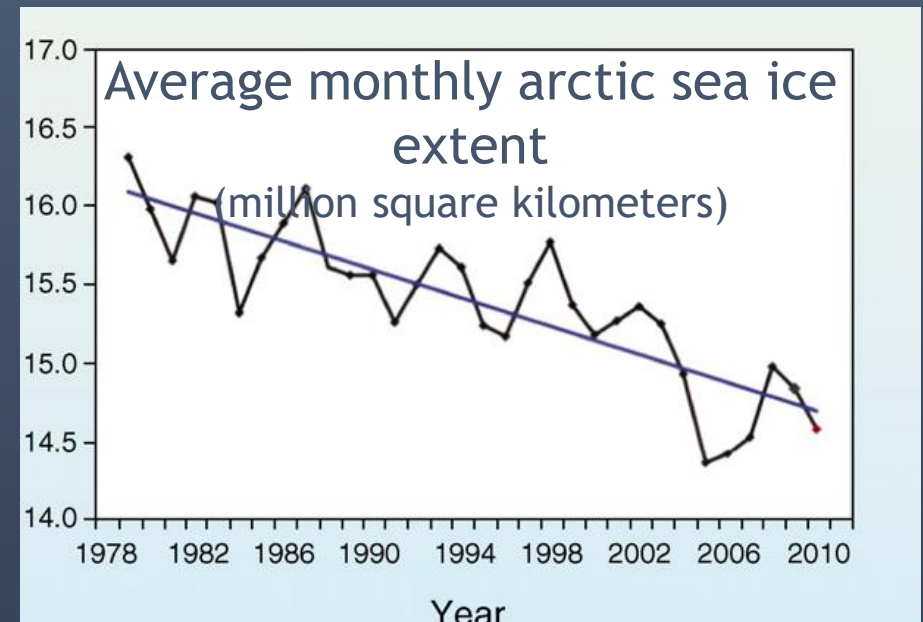
“The appropriate scale of study depends on the question being asked...”



Scales in an ecosystem



Johannessen et al. (2016) *Tellus A: Dynamic Meteorology and Oceanography*



Hoegh-Guldberg and Bruno (2010) *Science*

Scales in an ecosystem

Arctic warming favours extremes

The twenty-first century will see amplified warming in the Arctic. Understanding the origin of these extremes is crucial for predicting future changes.

Vladimir A. Semenov

PHILOSOPHICAL
TRANSACTIONS B

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Extreme weather and climate events with ecological relevance: a review

Caroline C. Ummenhofer¹ and Gerald A. Meehl²

<http://france.elsevier.com/direct/CRAS2A/>

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Frontiers in Ecology and the Environment

Review

A new generation of climate-change experiments: events, not trends

Anke Jentsch✉, Jürgen Kreyling, Carl Beierkuhnlein

First

Journal of Animal Ecology

Journal of Animal Ecology 2016, **85**, 85–96

FORUM

Tackling extremes: challenges for ecological and evolutionary research on extreme climatic events

Liam D. Bailey^{1*} and Martijn van de Pol^{1,2}

nature
climate change

PERSPECTIVE

<https://doi.org/10.1038/s41558-018-0187-9>

Corrected: Author Correction

Biological responses to the press and pulse of climate trends and extreme events

R. M. B. Harris^{1,2*}, L. J. Beaumont³, T. R. Vance¹, C. R. Tozer^{1,4}, T. A. Remenyi¹, S. E. Perkins-Kirkpatrick^{5,6}, P. J. Mitchell⁷, A. B. Nicotra⁸, S. McGregor^{6,9}, N. R. Andrew¹⁰, M. Letnic¹¹, M. R. Kearney¹², T. Wernberg¹³, L. B. Hutley¹⁴, L. E. Chambers²¹, M.-S. Fletcher¹⁵, M. R. Keatley¹⁶, C. A. Woodward^{17,18}, G. Williamson¹⁹, N. C. Duke²⁰ and D. M. J. S. Bowman¹⁹

Scales in an ecosystem

PROCEEDINGS
OF
THE ROYAL
SOCIETY **B**

Proc. R. Soc. B (2009) **276**, 4197–4205
doi:10.1098/rspb.2009.0921
Published online 9 September 2009

Taxonomic scale-dependence of habitat niche partitioning and biotic neighbourhood on survival of tropical tree seedlings

Simon A. Qu [Coral Reefs](#)

Nancy [September 1992, Volume 11, Issue 3, pp 147–154 | Cite as](#)

Persistence of community structure: what happens when you change taxonomic scale?

Trends in Ecology & Evolution

CellPress

Authors

Authors Volume 34, Issue 3, March 2019, Pages 260–273

Peter F. Sale, Jeffrey A. Guy

Review

ECOLOGY
ECOLOGICAL SOCIETY OF AMERICA

Special Issue | [Free Access](#)

PHYLOGENETIC STRUCTURE OF FLORIDIAN PLANT
DEPENDS ON TAXONOMIC AND SPATIAL SCALE

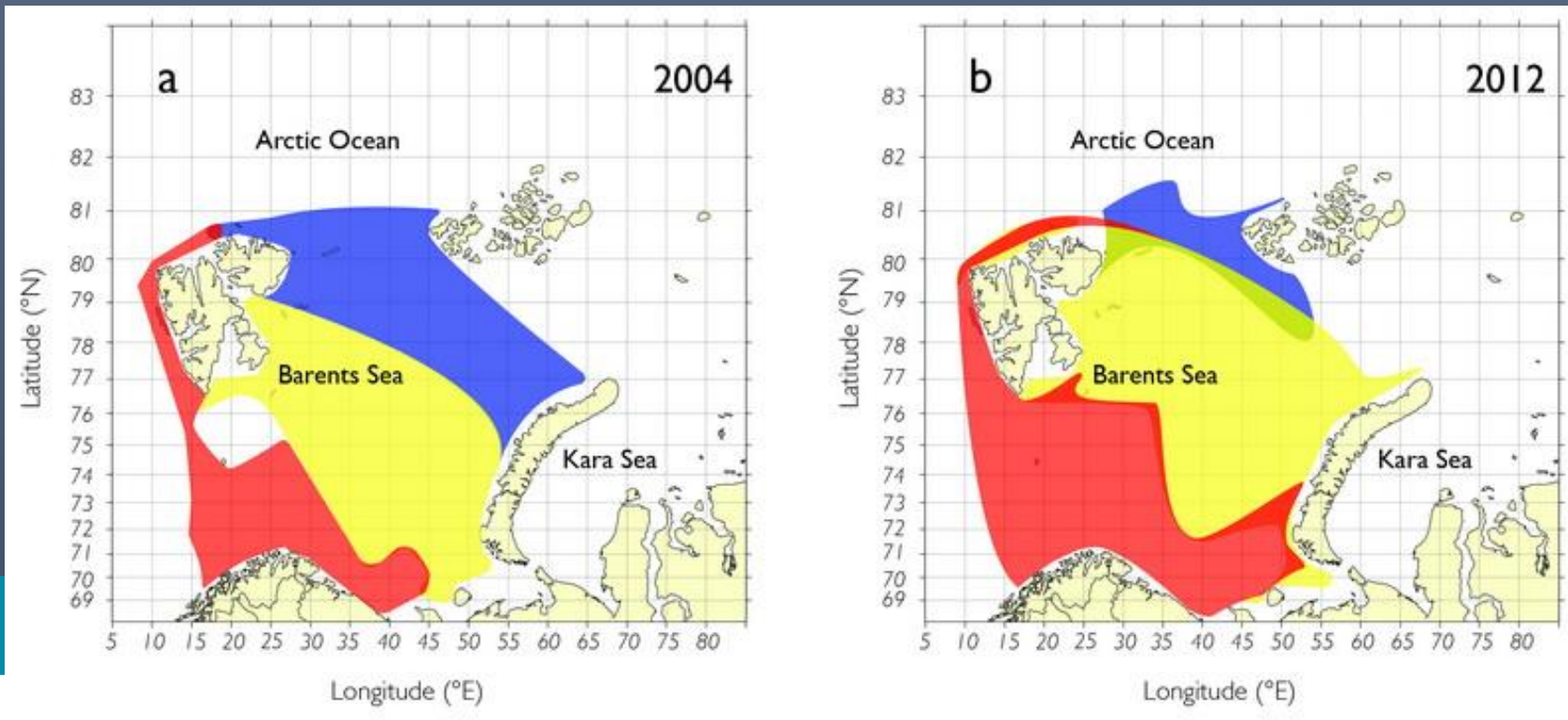
Jeannine Cavender-Bares, Adrienne Keen, Brianna Miles

Niche Estimation Above and Below the Species
Level

Adam B. Smith¹  , William Godsoe², Francisco Rodríguez-Sánchez³, Hsiao-Hsuan Wang⁴, Dan Warren^{5, 6}

First published: 01 July 2006 | [https://doi.org/10.1890/0012-9658\(2006\)87\[109:PSOFPC\]2.0.CO;2](https://doi.org/10.1890/0012-9658(2006)87[109:PSOFPC]2.0.CO;2) |


In the Barents sea: A large scale change



nature
climate change

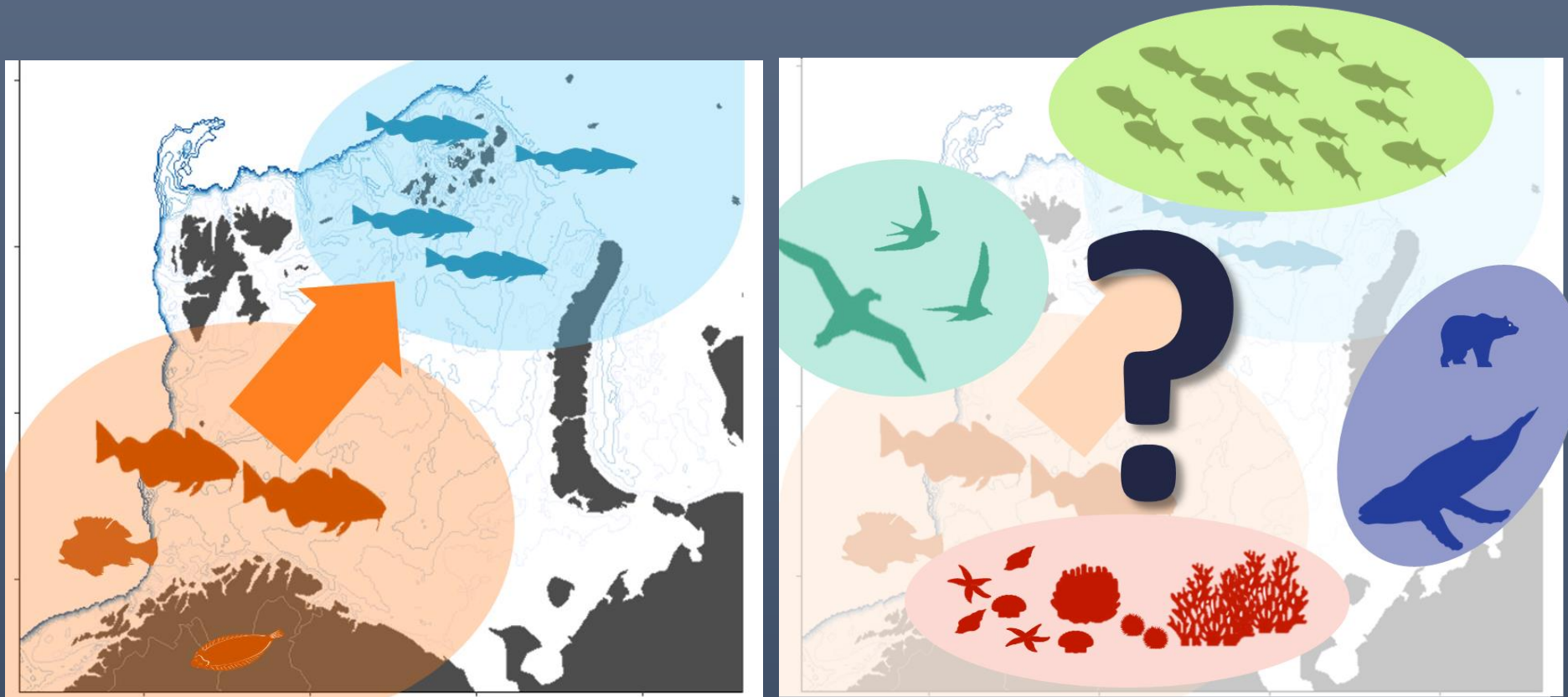
Letter | Published: 18 May 2015

Recent warming leads to a rapid borealization of fish communities in the Arctic

Maria Fossheim , Raul Primicerio, Edda Johannesen, Randi B. Ingvaldsen, Michaela M. Aschan & Andrey V. Dolgov



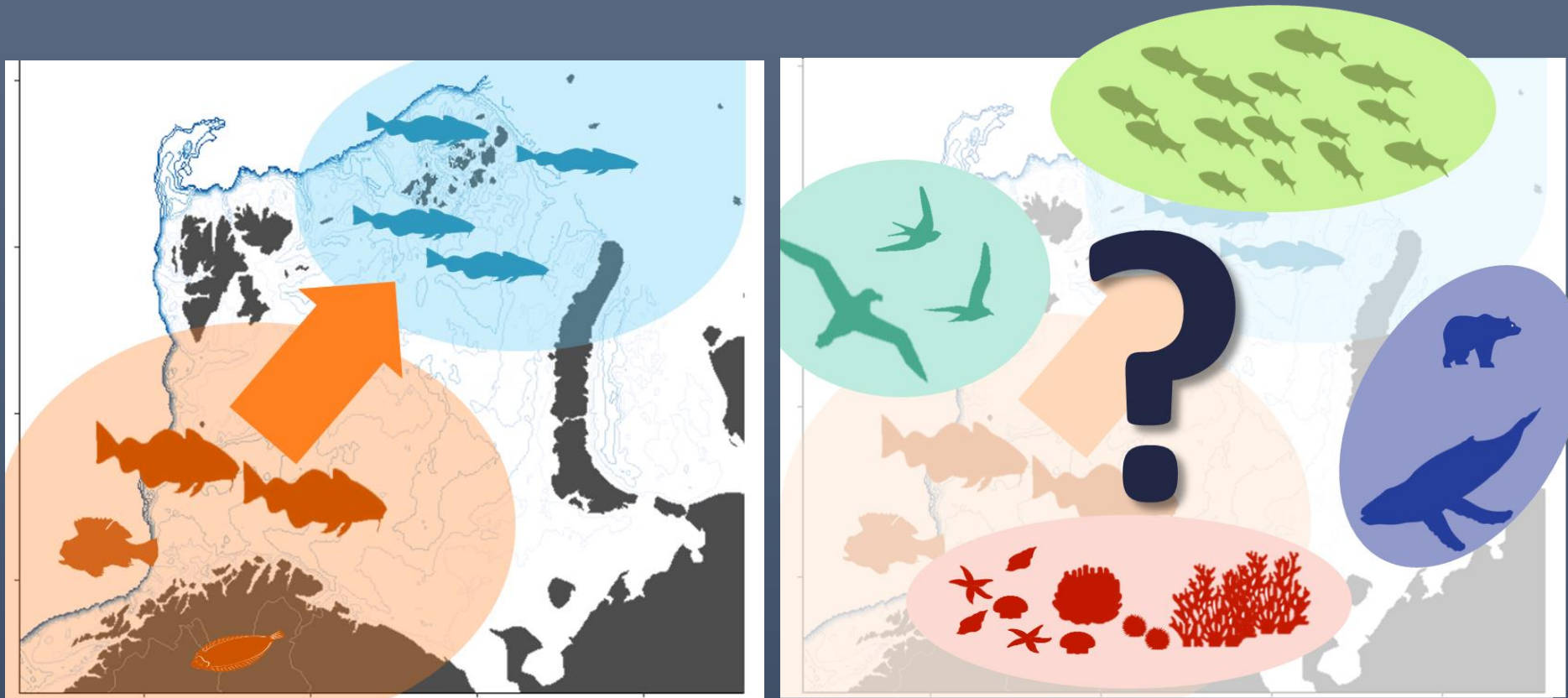
Scales in BSECO



- WP1: shift in abundances and distribution of communities of the ecosystem
- WP2: shift in functional traits distribution and occurrences
- WP3: impacts on the food web structure
- WP4: impacts on the functioning and vulnerability of the ecosystem

EA

Scales in BSECO

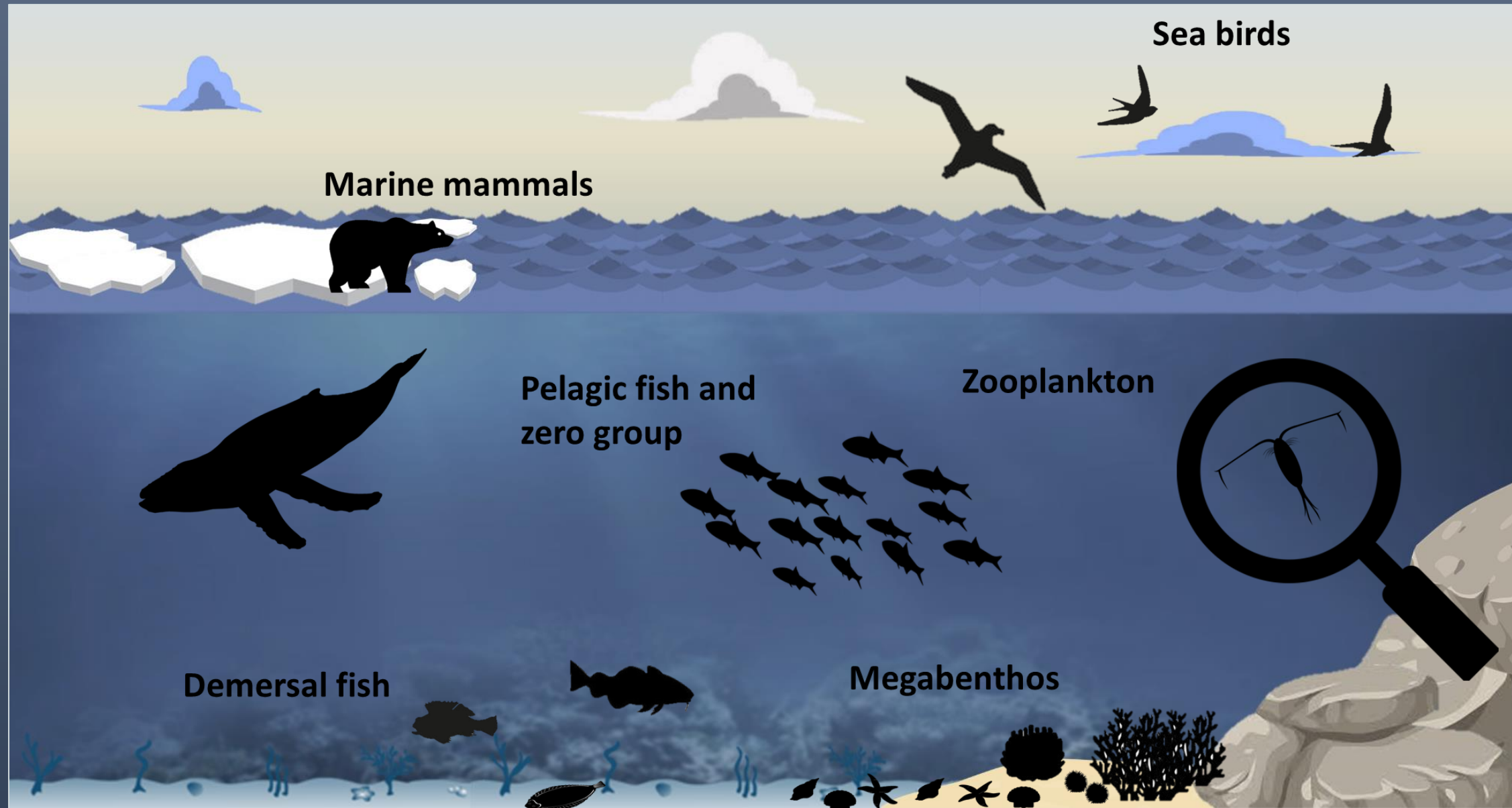


- **WP1:** shift in abundances and distribution of communities of the ecosystem

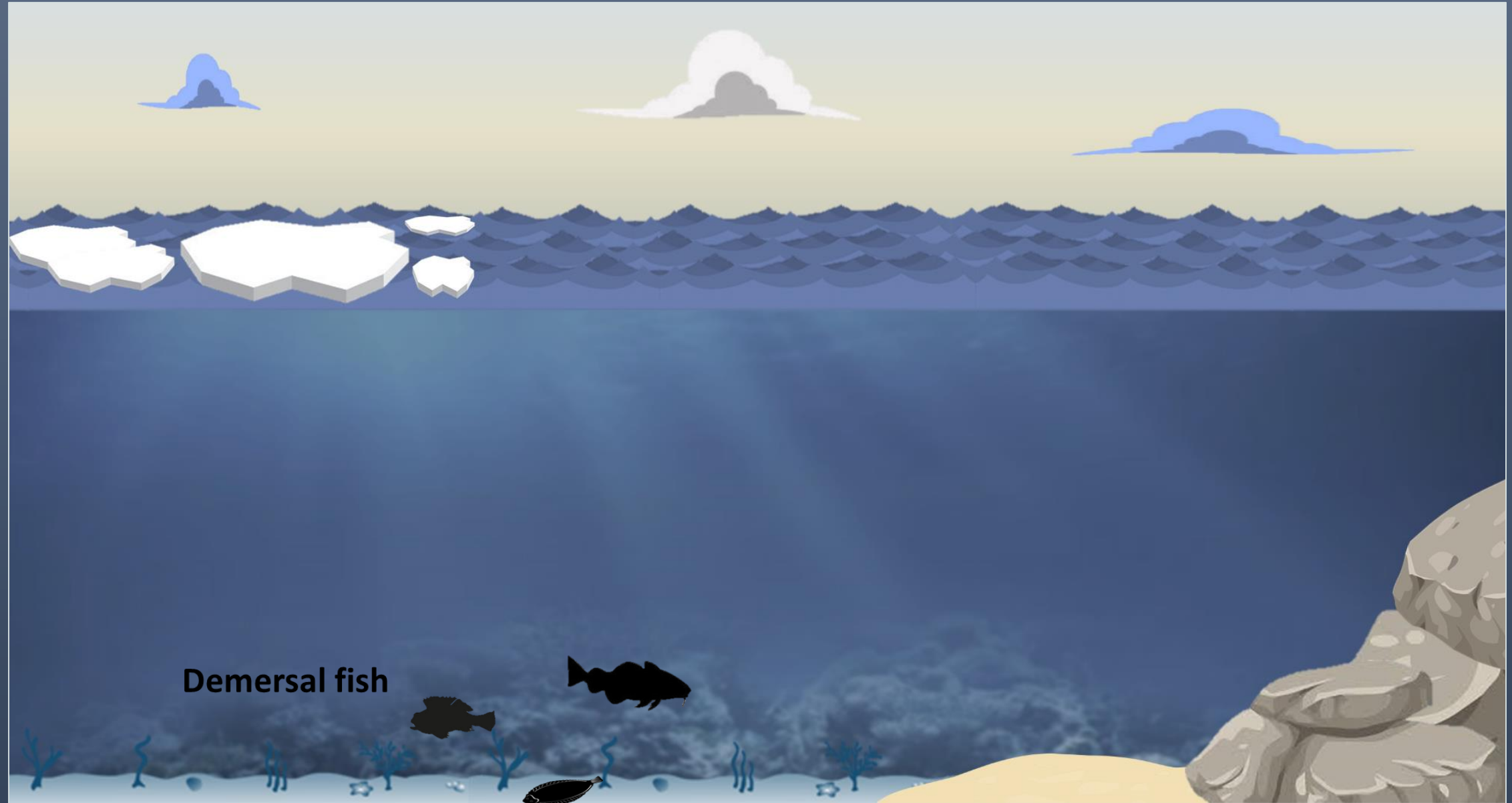
- WP2: shift in functional traits distribution and occurrences
- WP3: impacts on the food web structure
- WP4: impacts on the functioning and vulnerability of the ecosystem



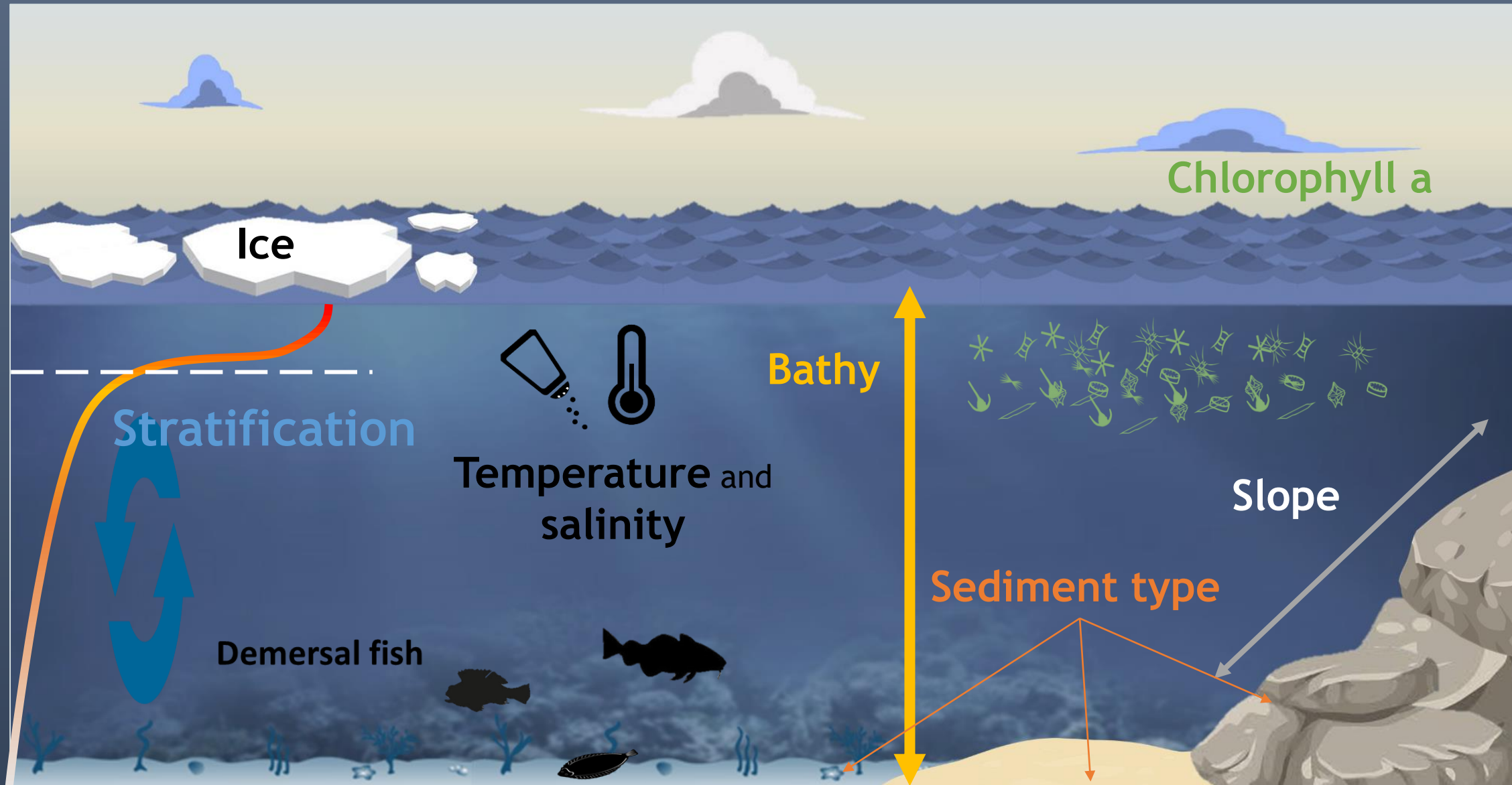
Collecting data for the Barents sea



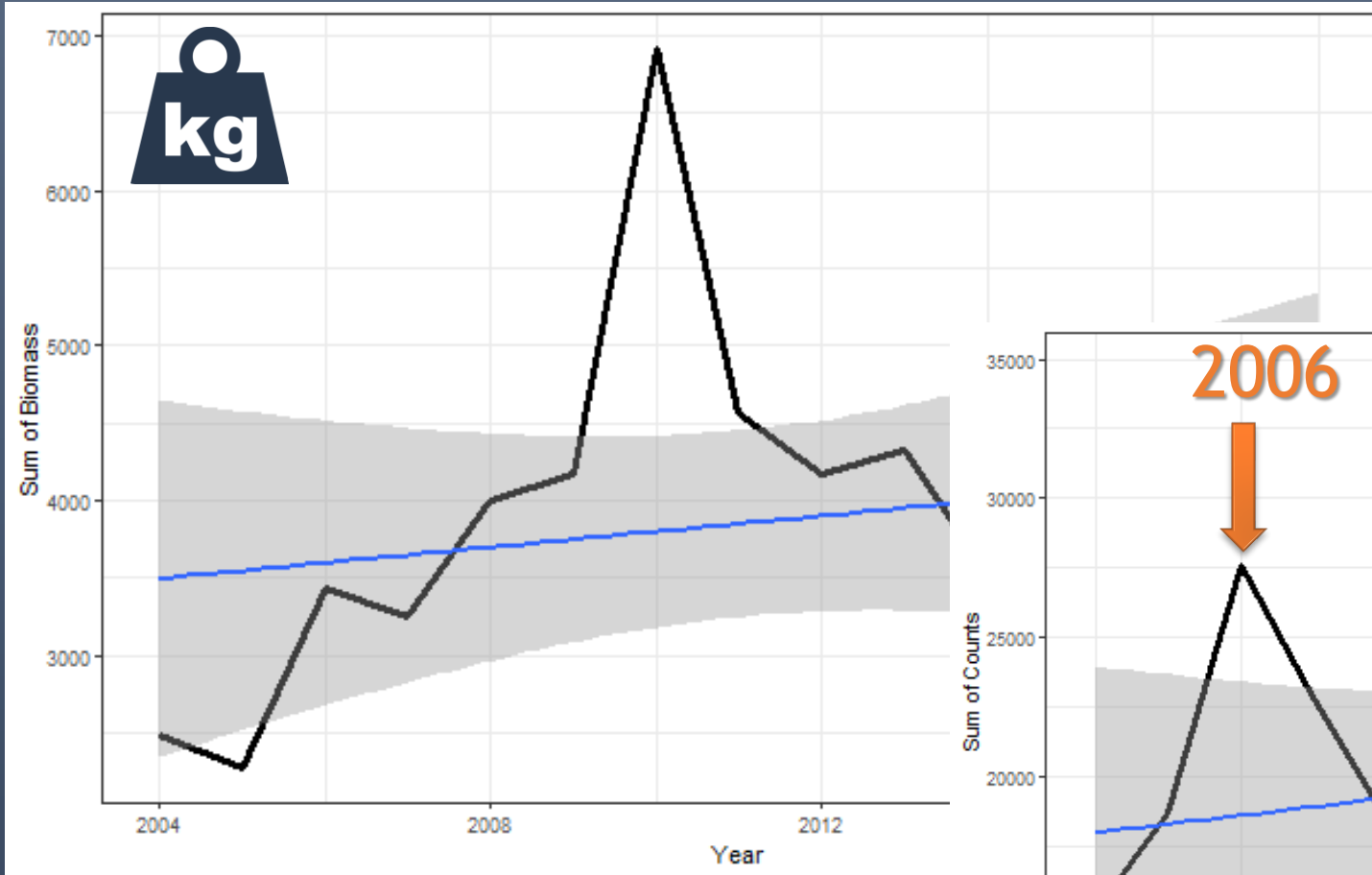
Collecting data for the Barents sea



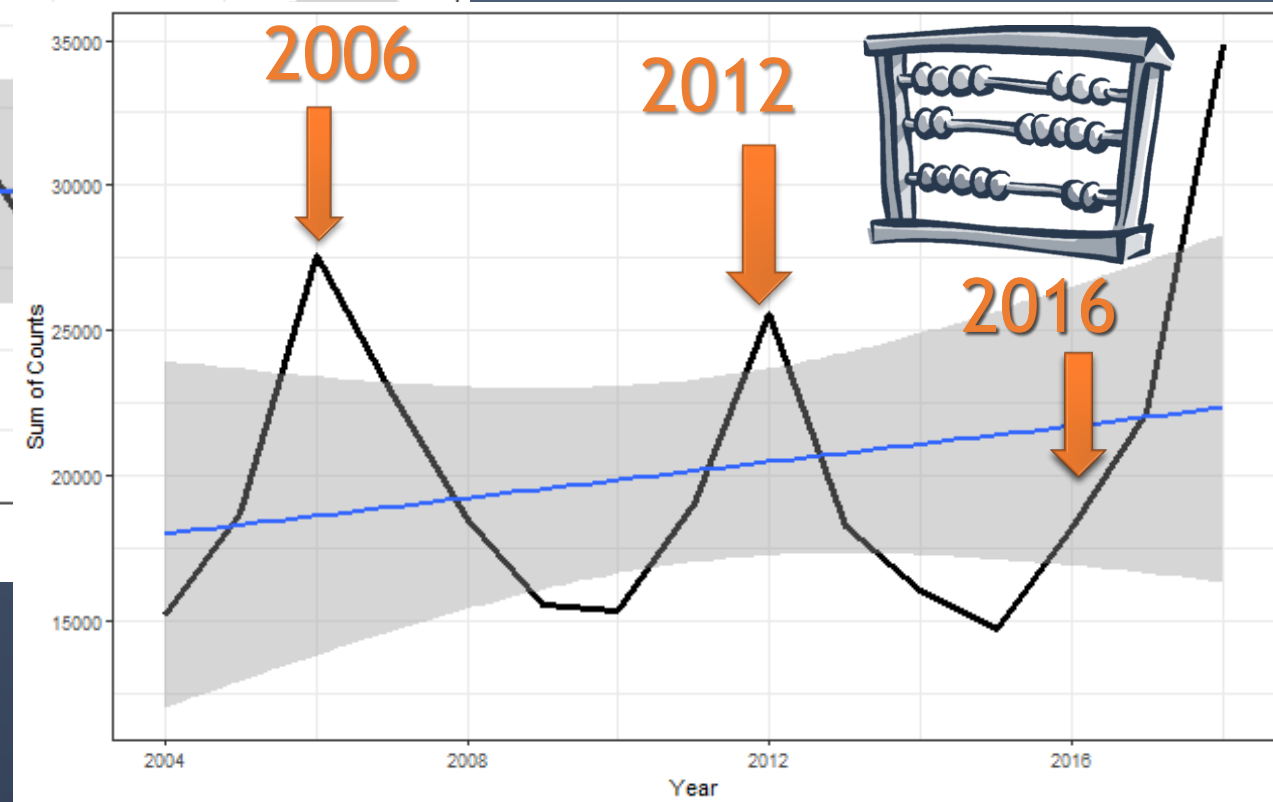
Collecting data for the Barents sea



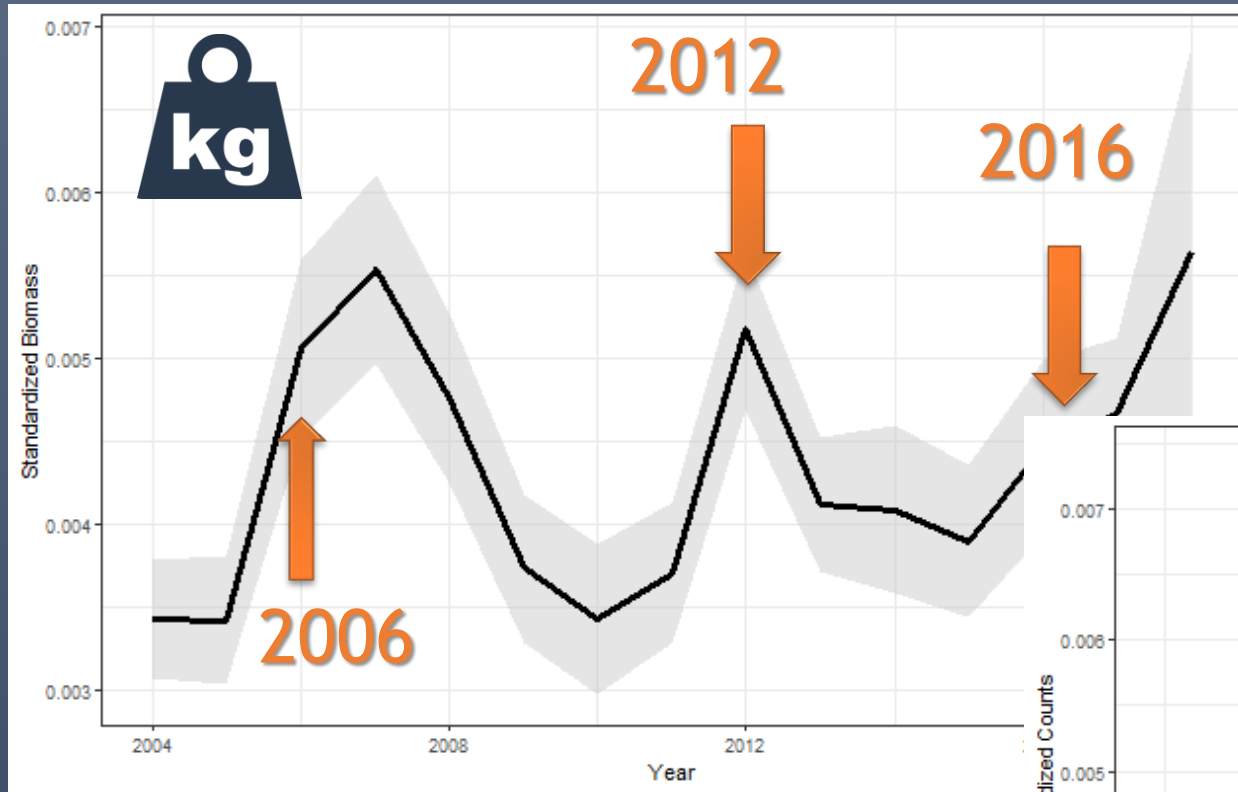
Temporal scale: press



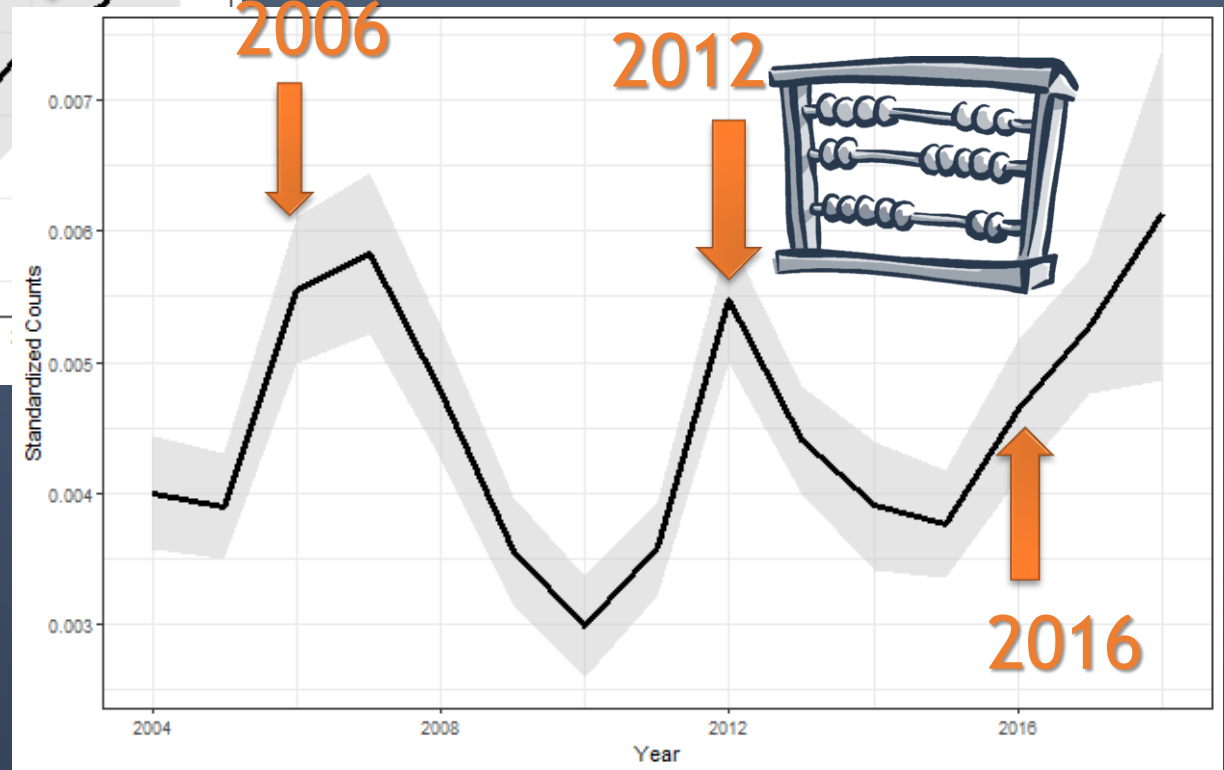
Mean() Sp_i



And pulses!

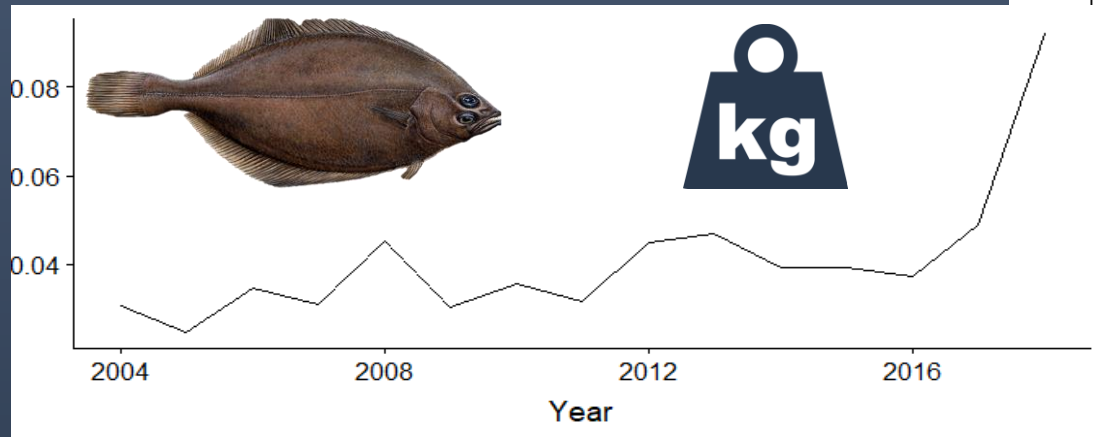
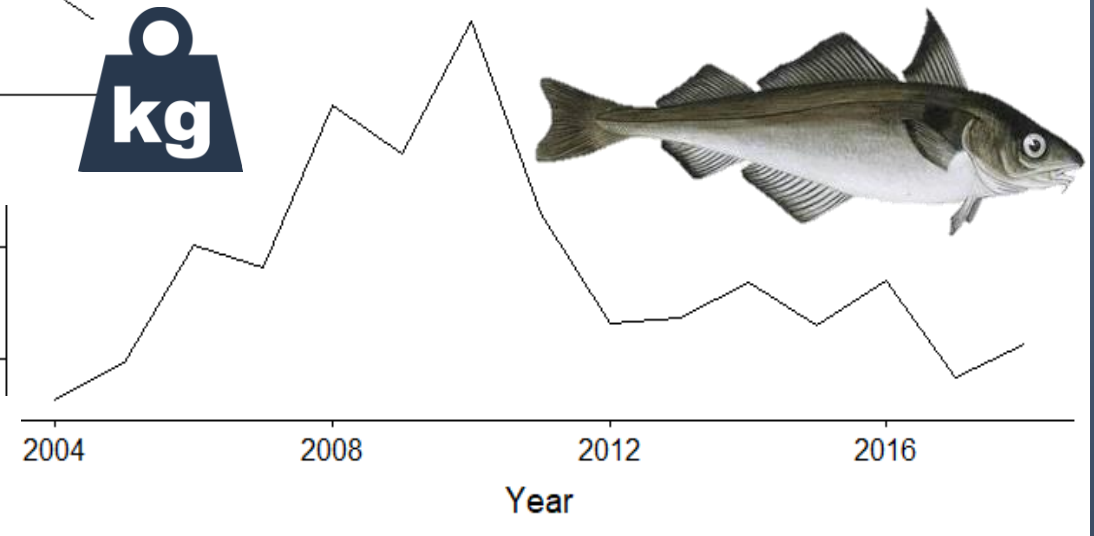
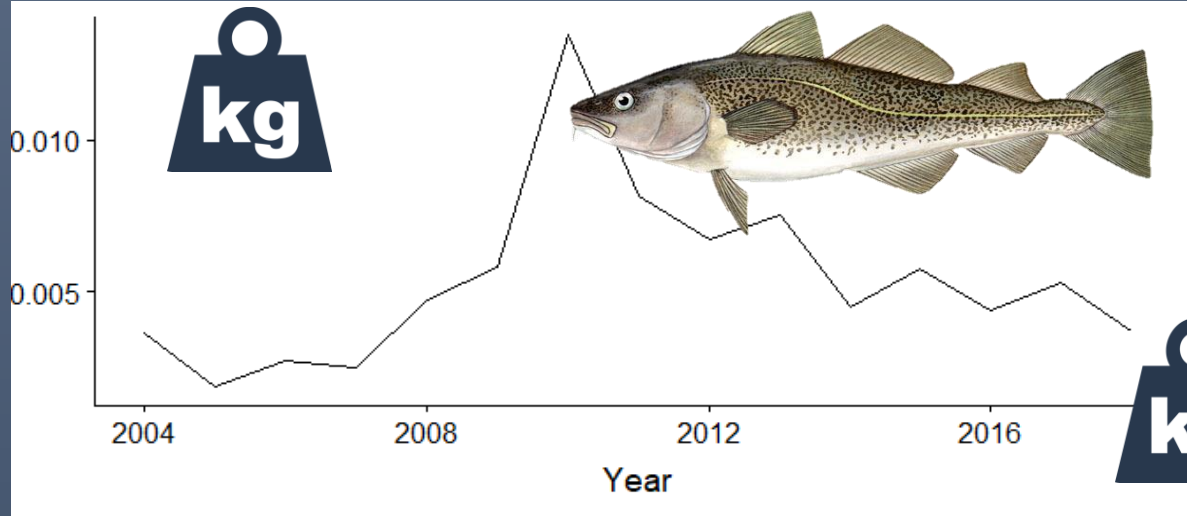


Mean($\frac{Sp_i, yr_j}{\text{Max}(Sp_i)}$)



What are the species pulsing?

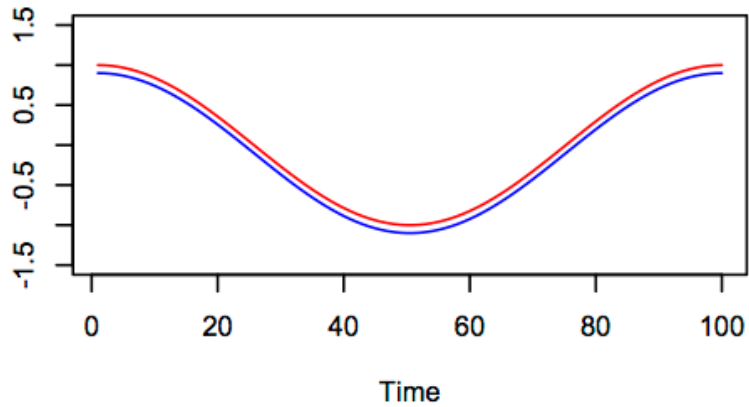
Looking at the species level is hard...



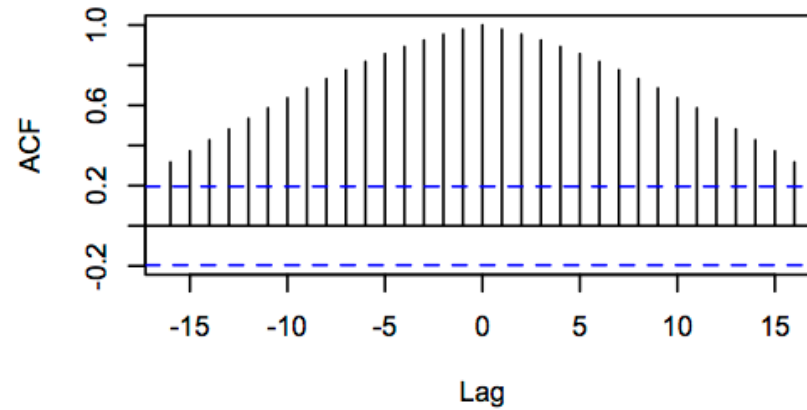
Detect synchronicity with CC



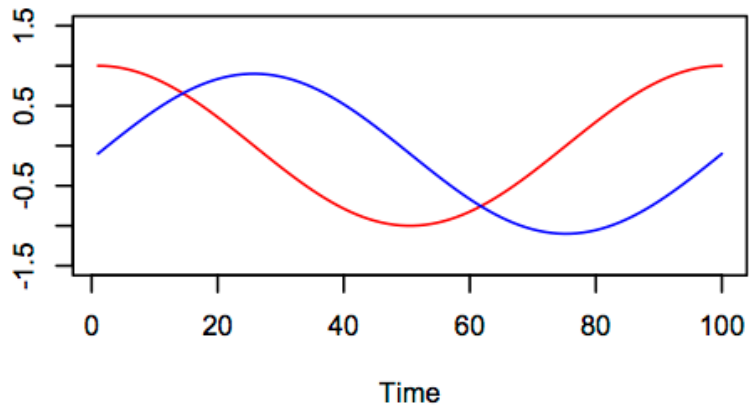
Pure Sinusoids In Phase (n=100)



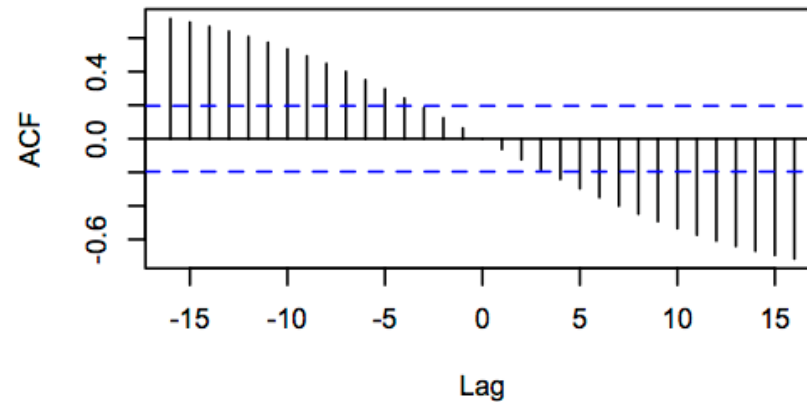
c1 & c2



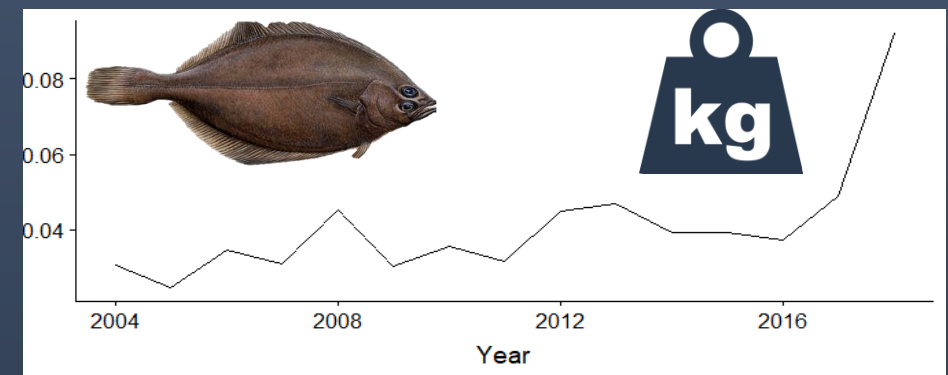
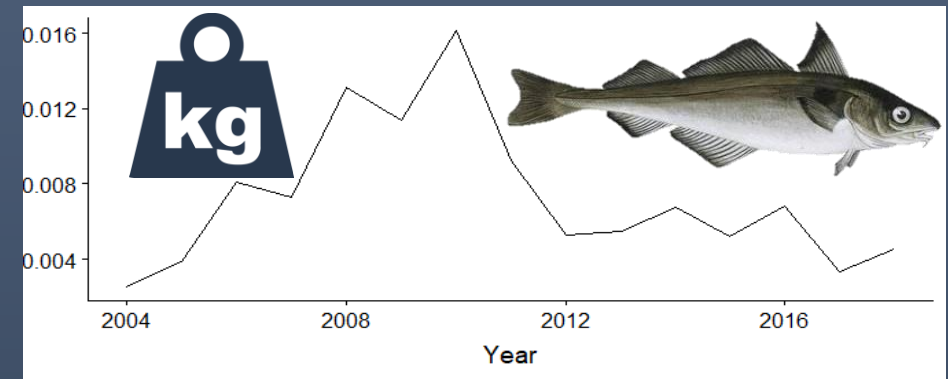
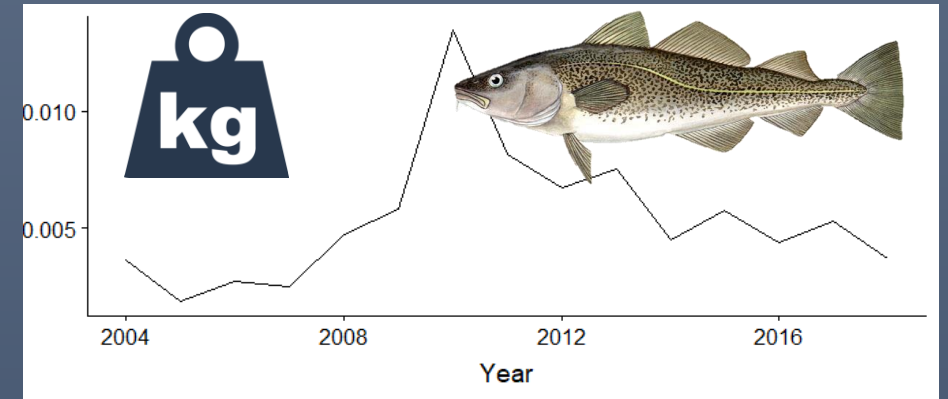
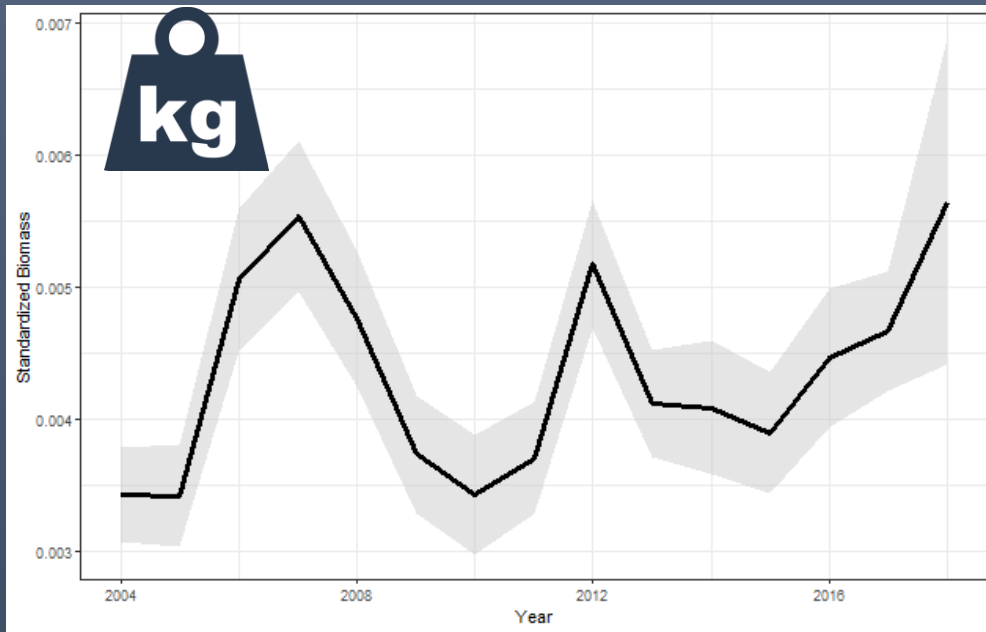
Sinusoids Phase Shifted (n=100)



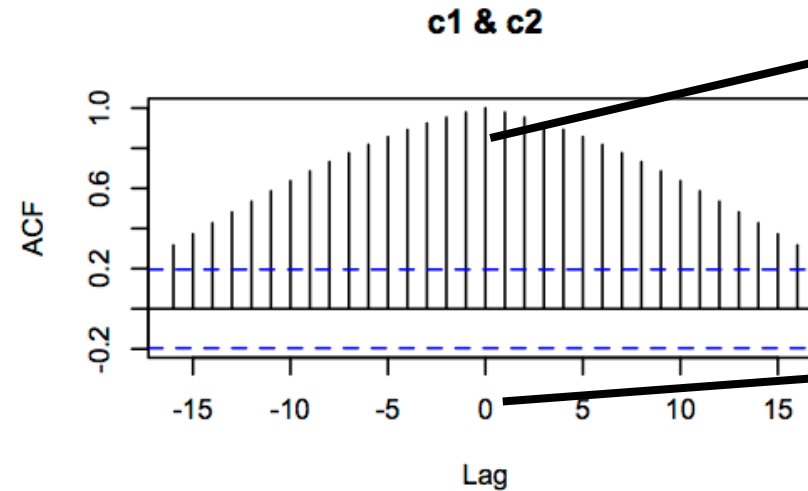
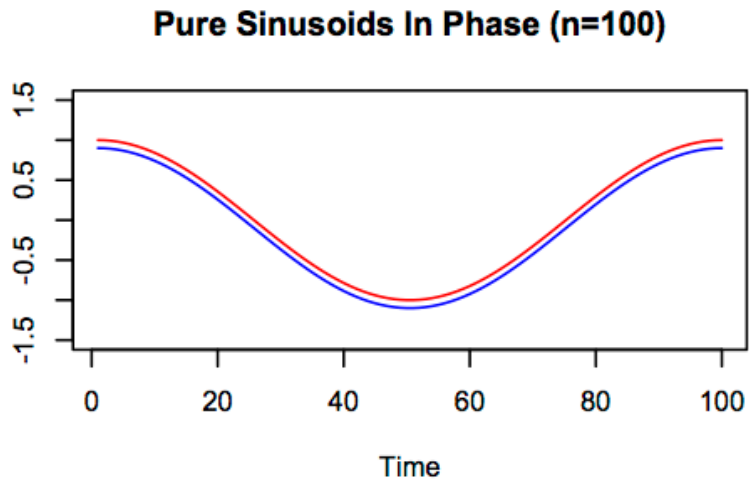
c1 & s1



Applying CC to the Barents sea

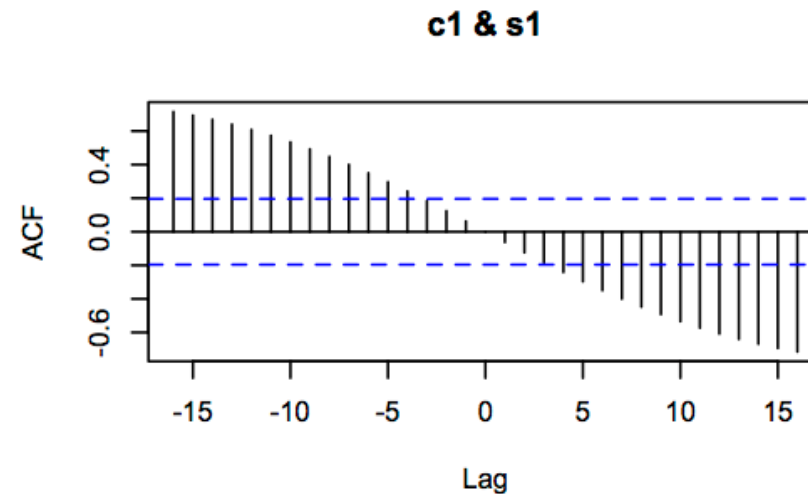
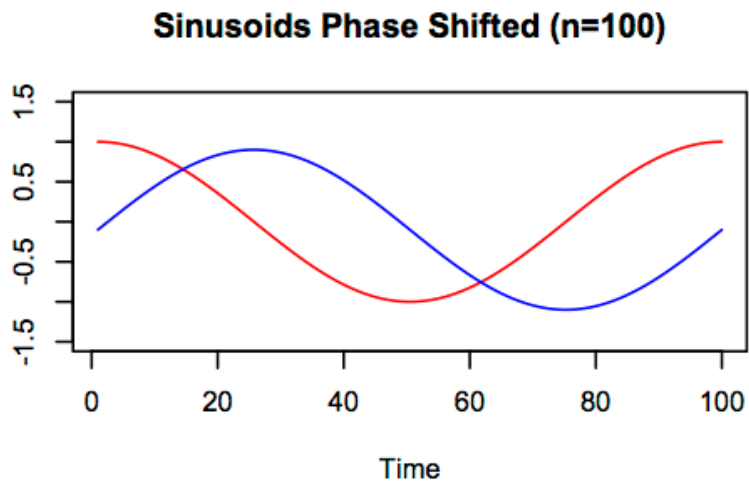


Applying CC to the Barents sea

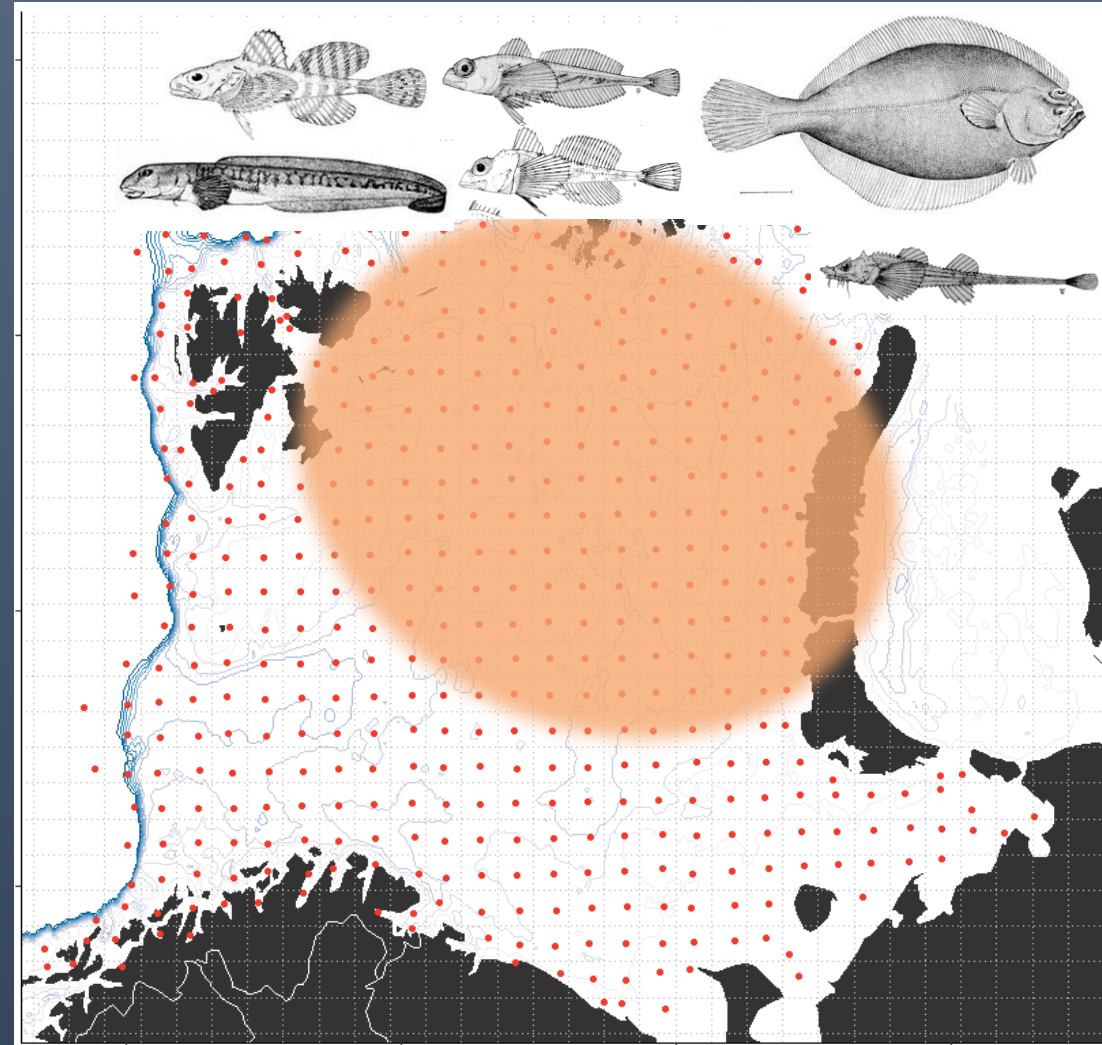
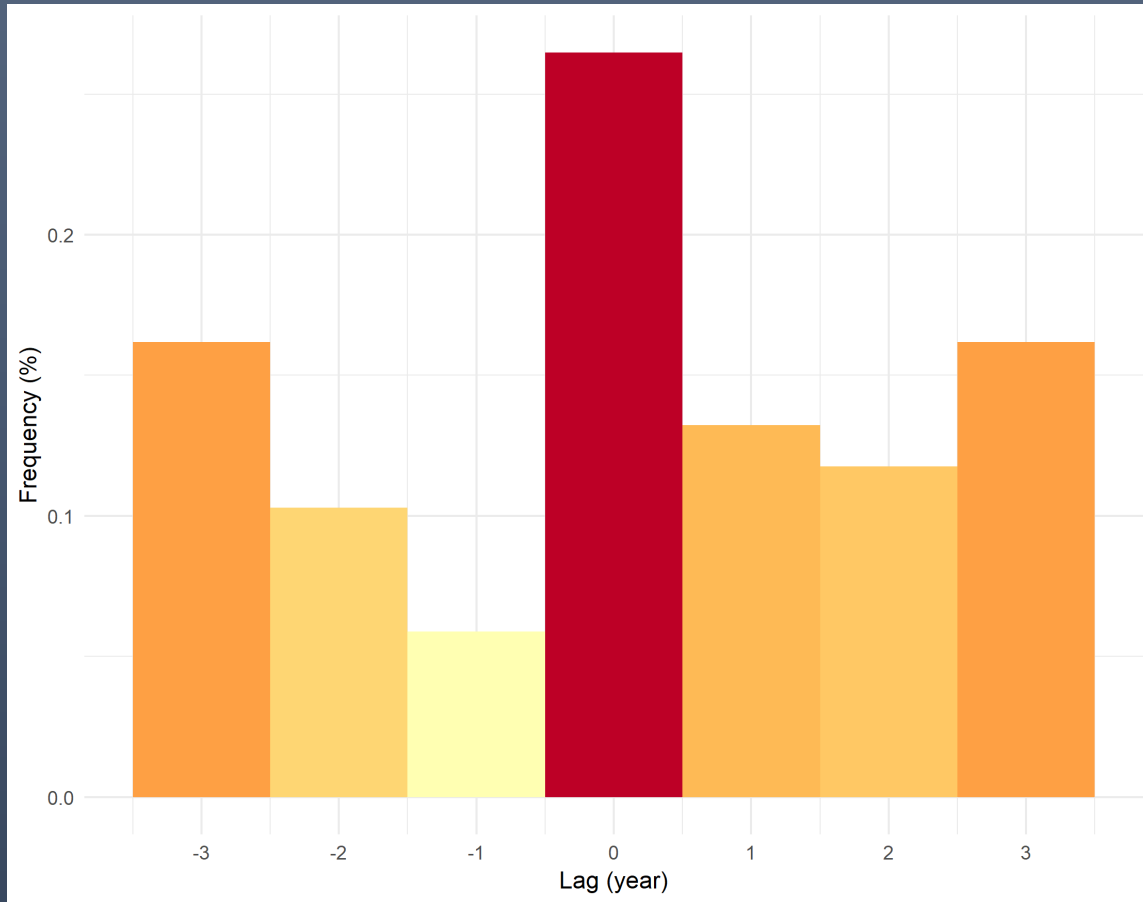


Maximum significant correlation

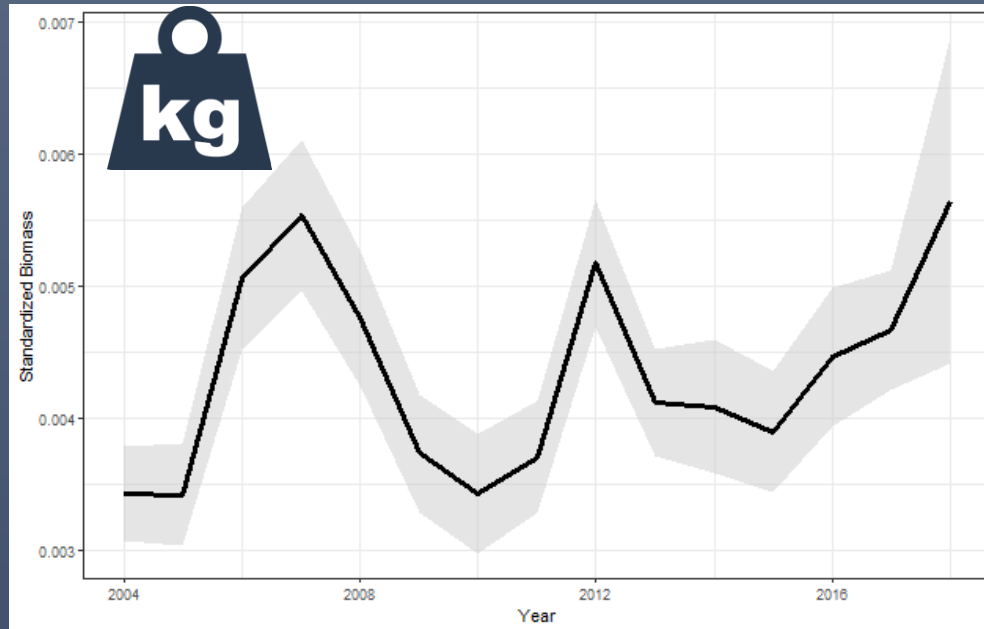
Lag



What are the species pulsing?



Why are they pulsing?



Environmental variables

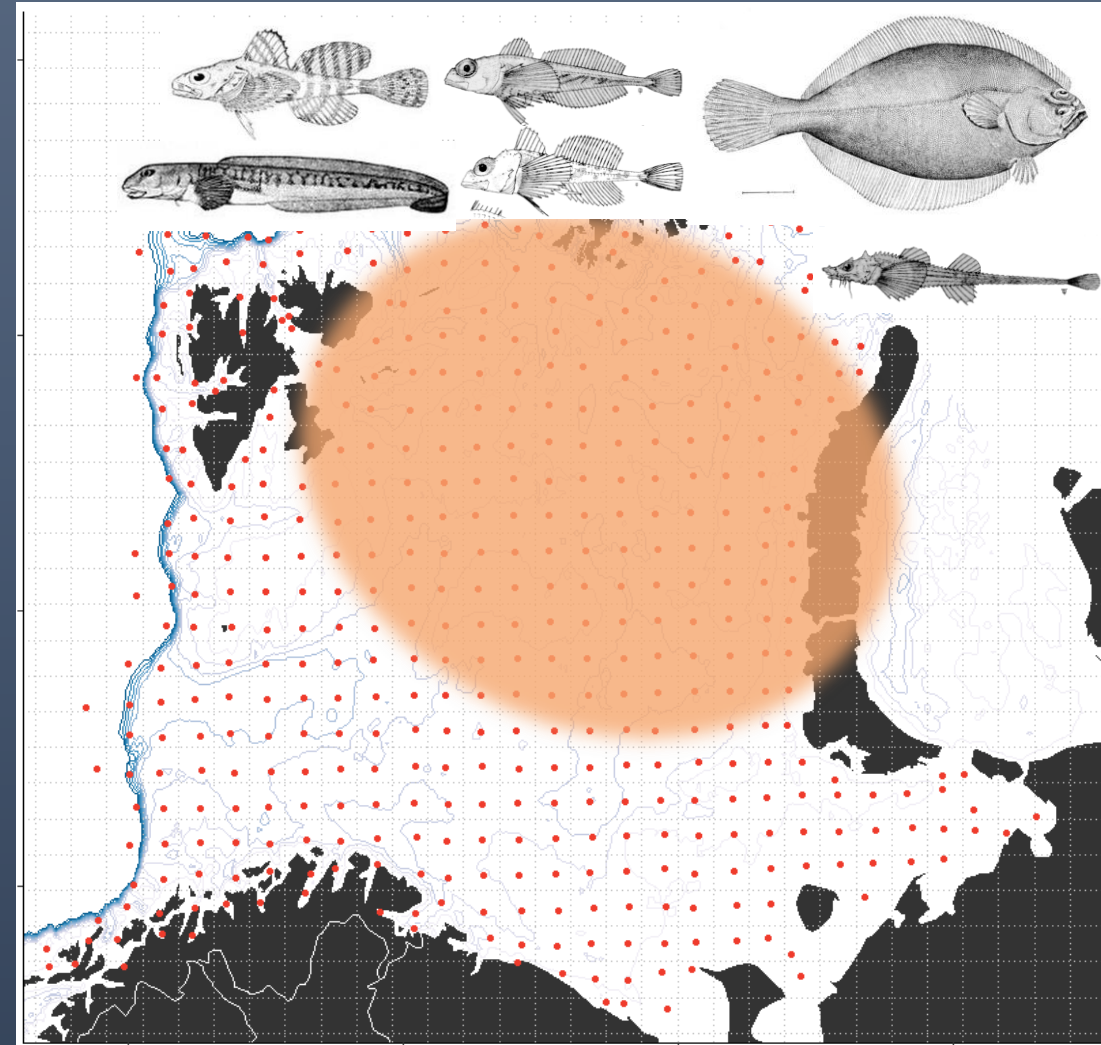
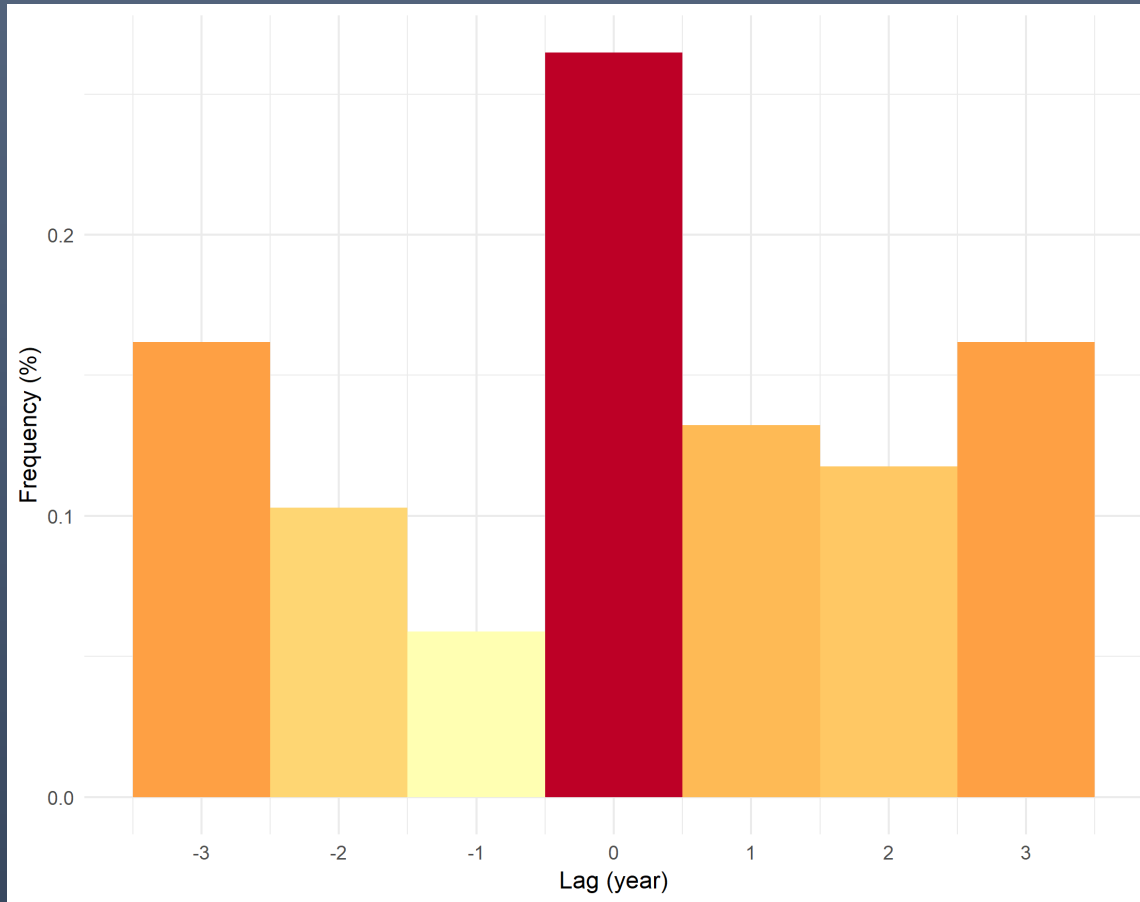
ARTICLES nature climate change
<https://doi.org/10.1038/s41558-018-0205-y>

Arctic warming hotspot in the northern Barents Sea linked to declining sea-ice import

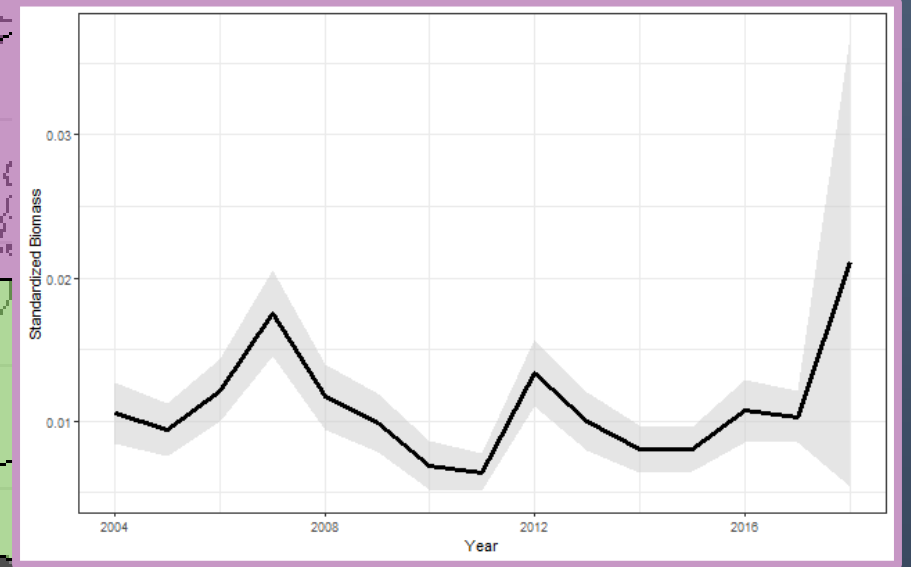
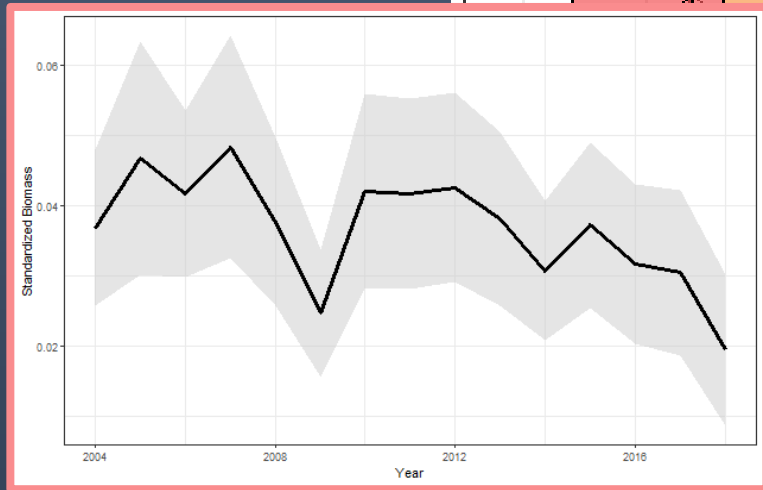
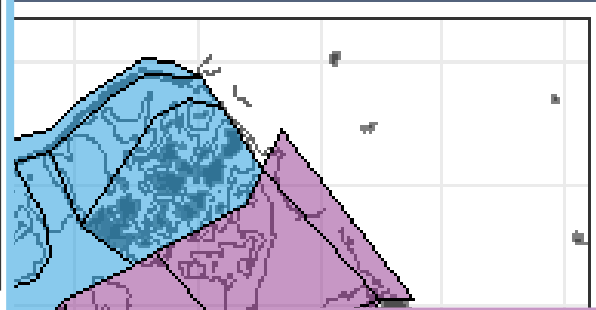
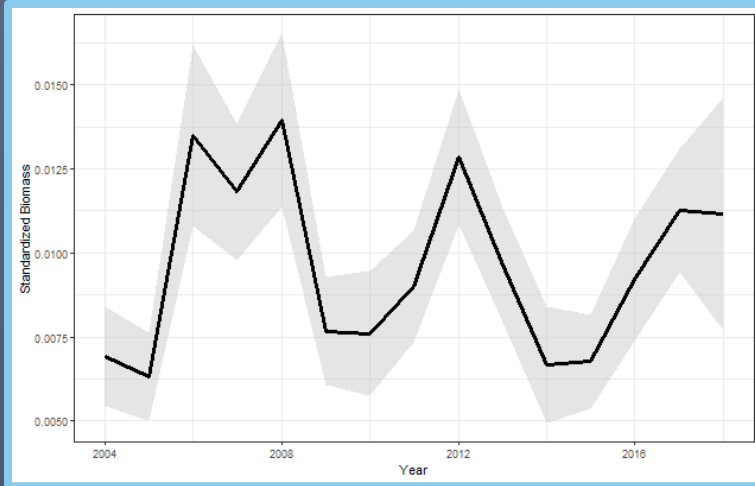
Sigrid Lind^{1,2*}, Randi B. Ingvaldsen¹ and Tore Furevik²



What are the species pulsing?



The spatial pattern is not uniform...



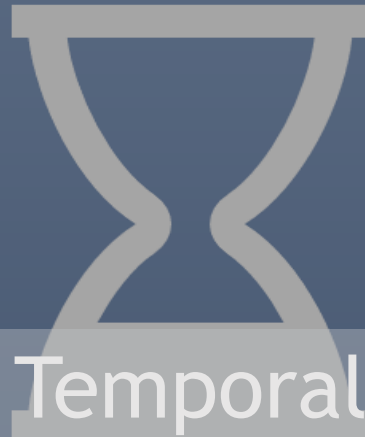
What scales to study an ecosystem?



Spatial

- Short term response of the community at large scale
- Community response change with spatial scale

→ One scale = one part of the story



Temporal

- Press and pulse trigger different type of response from the taxa
- Different scales to be studied according to the question asked



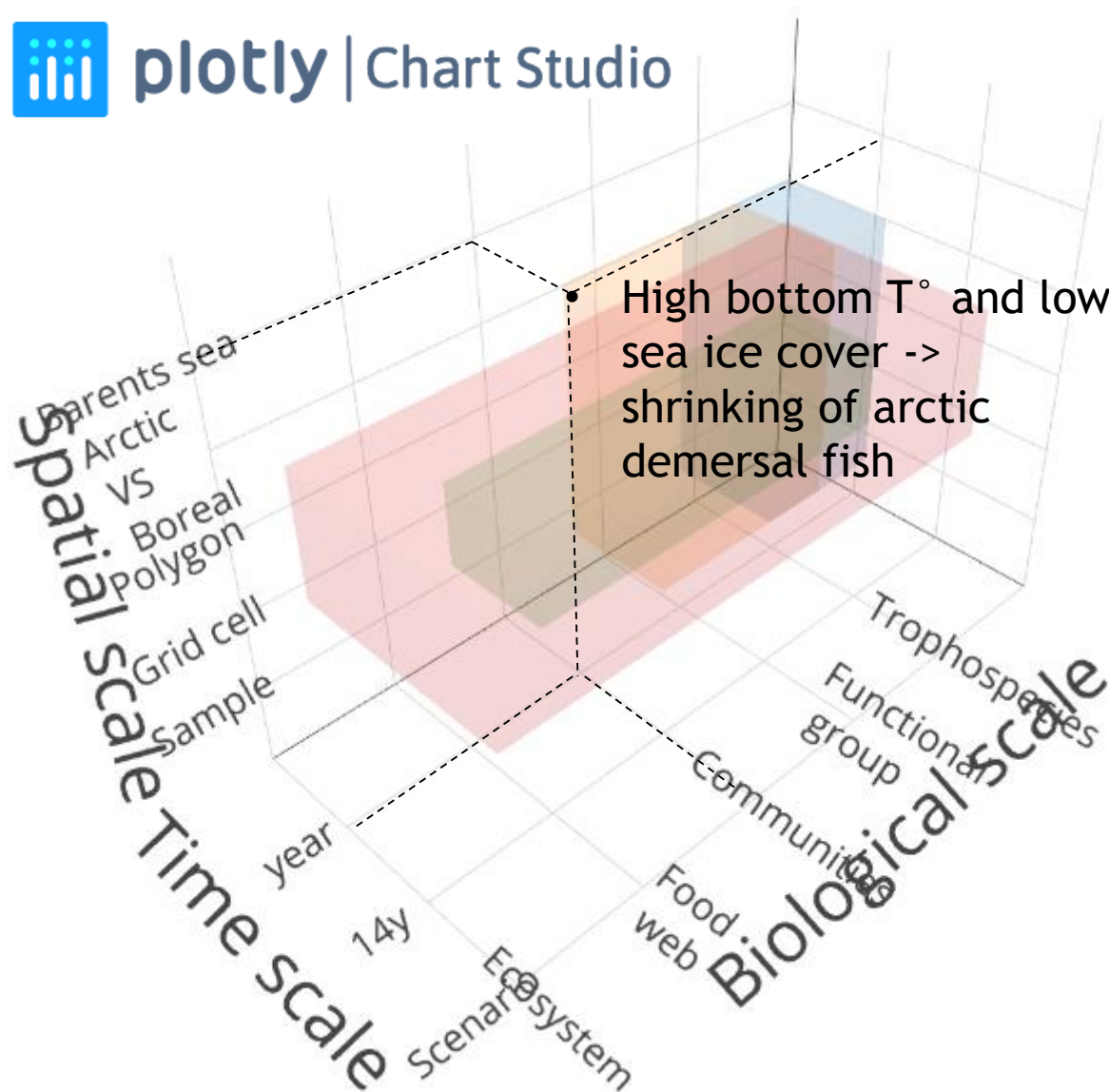
Taxonomic

- The species scale is noisy... but useful!
- The community scale indicates broad patterns
- Most of the ecosystem seems to follow the same patterns

→ Compromise between noise and uncertainty

Making sense of different scales

 plotly | Chart Studio

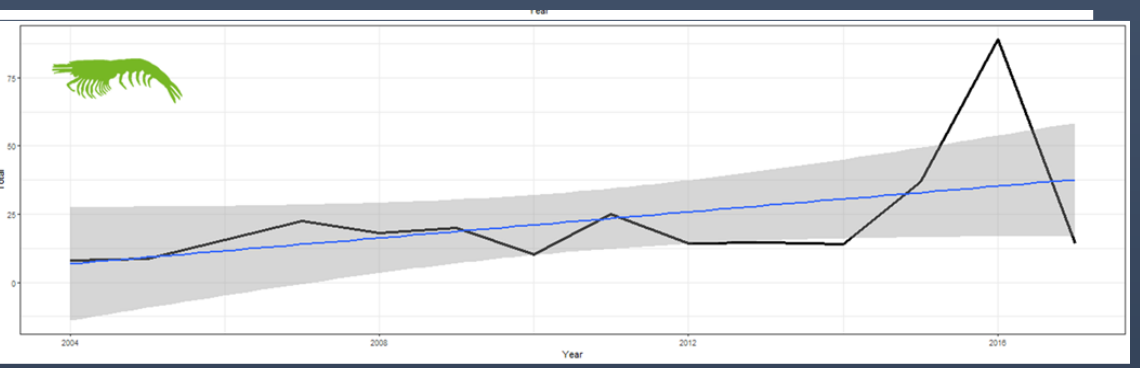
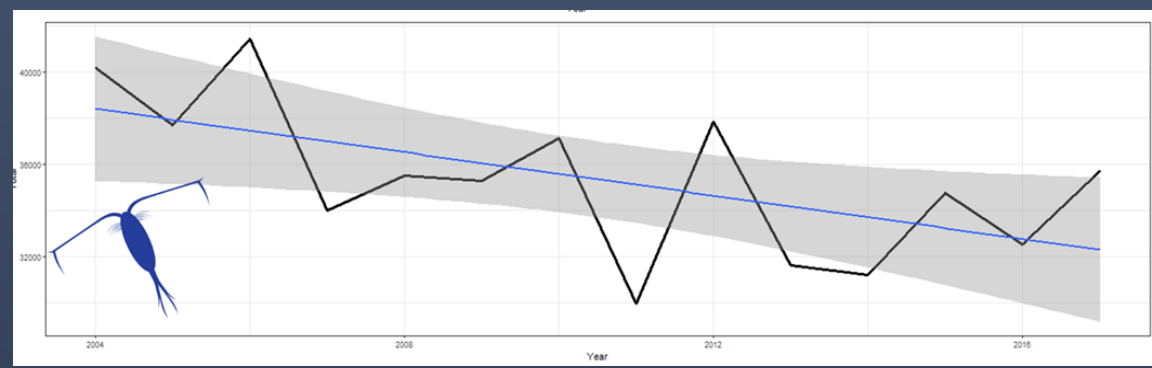
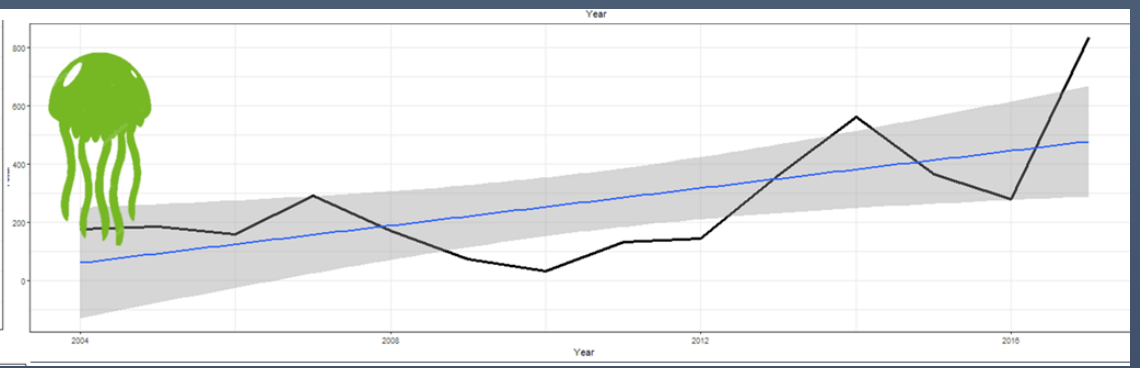
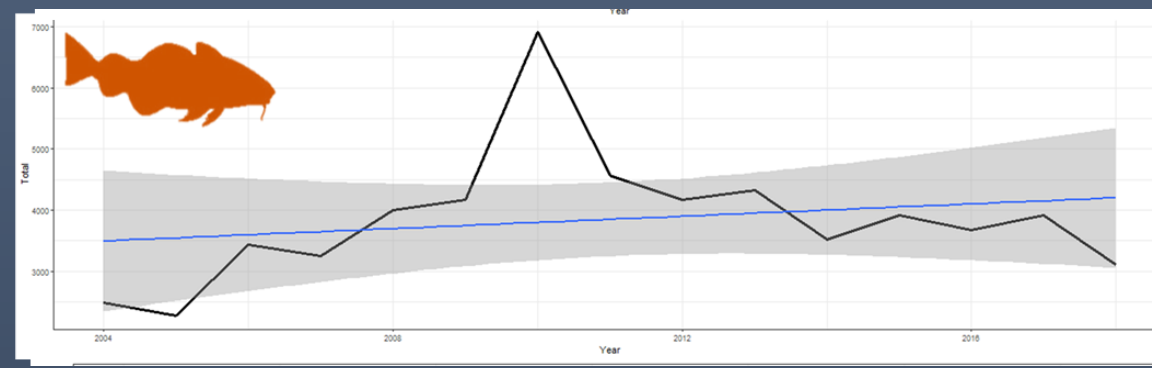
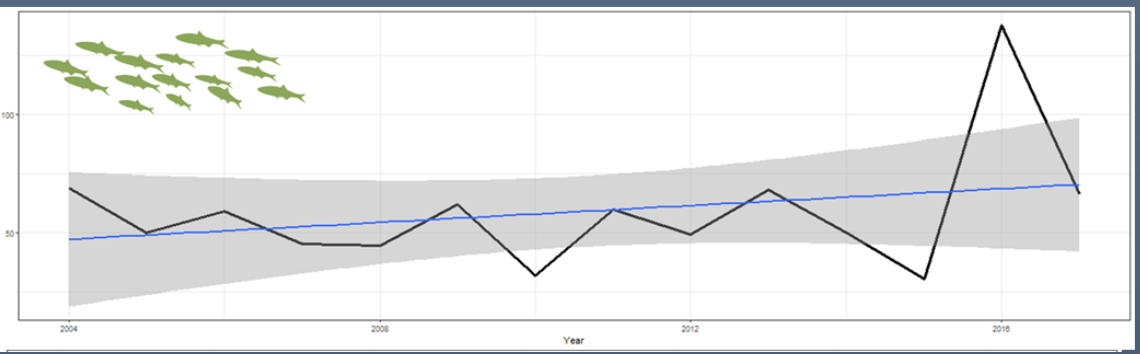
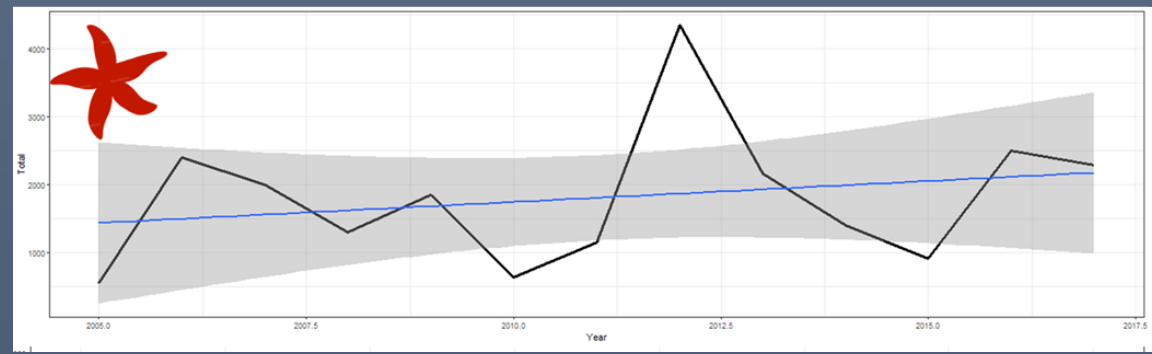


- Identify the different scales
- Identify the « jurisdiction » of each package
- Plot processes and hypotheses at the scale they occur
- *Identify gaps*

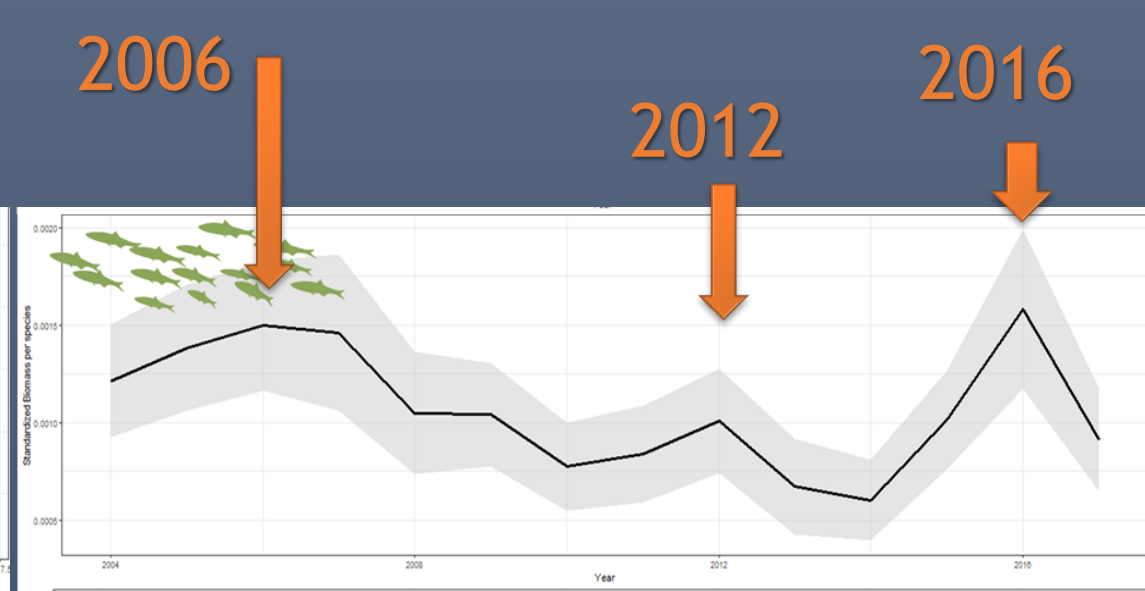
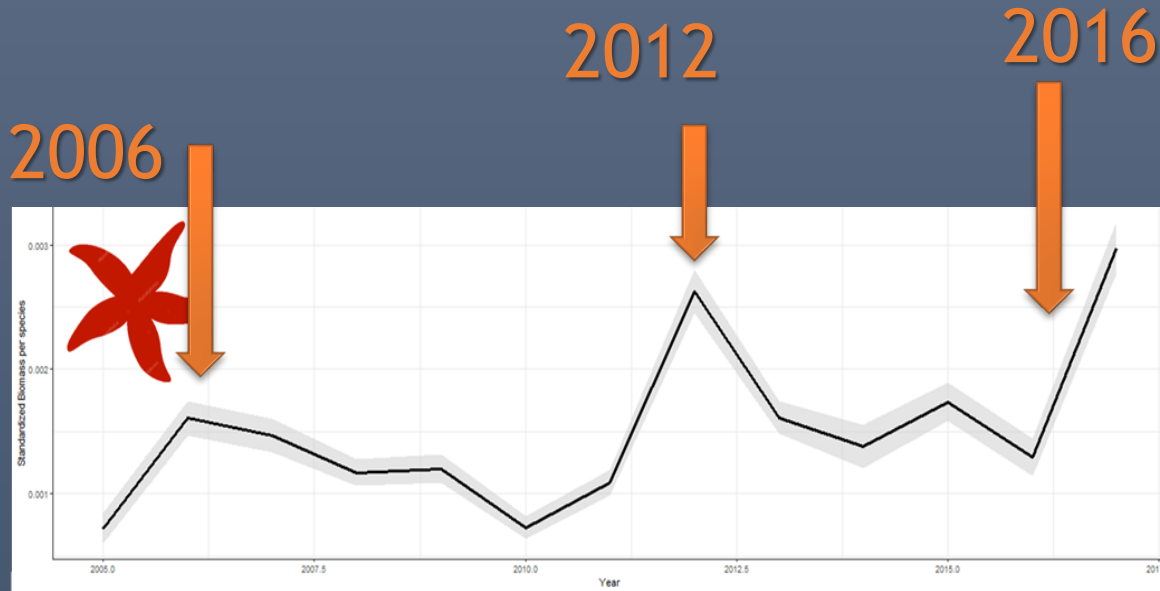


Thank you

What about the rest of the ecosystem?



What about the rest of the ecosystem?



What events in the Barents sea ?

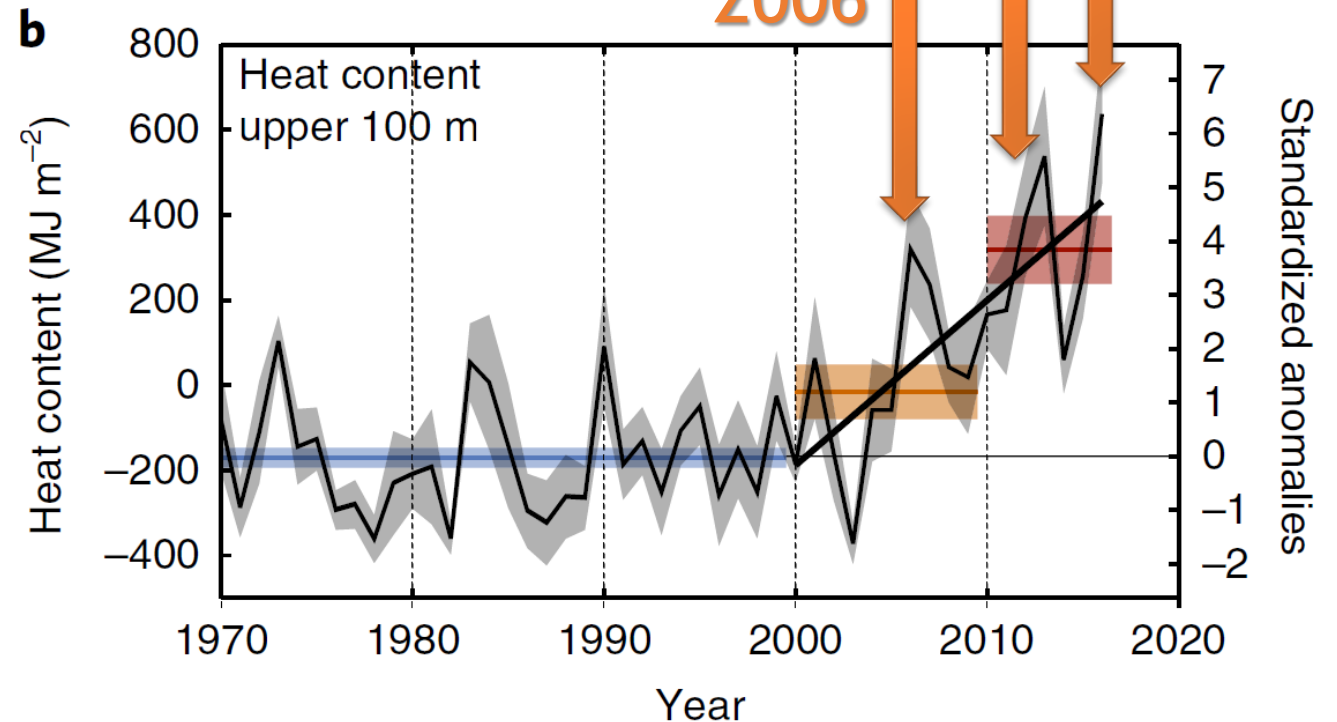
ARTICLES

<https://doi.org/10.1038/s41558-018-0205-y>

nature
climate change

Arctic warming hotspot in the Barents Sea linked to declining sea-ice

Sigrid Lind^{1,2*}, Randi B. Ingvaldsen¹ and Tore Furevik²



What is the answer of the Barents sea ecosystem to those events?