Epibenthic invertebrates and pelagic-benthic coupling

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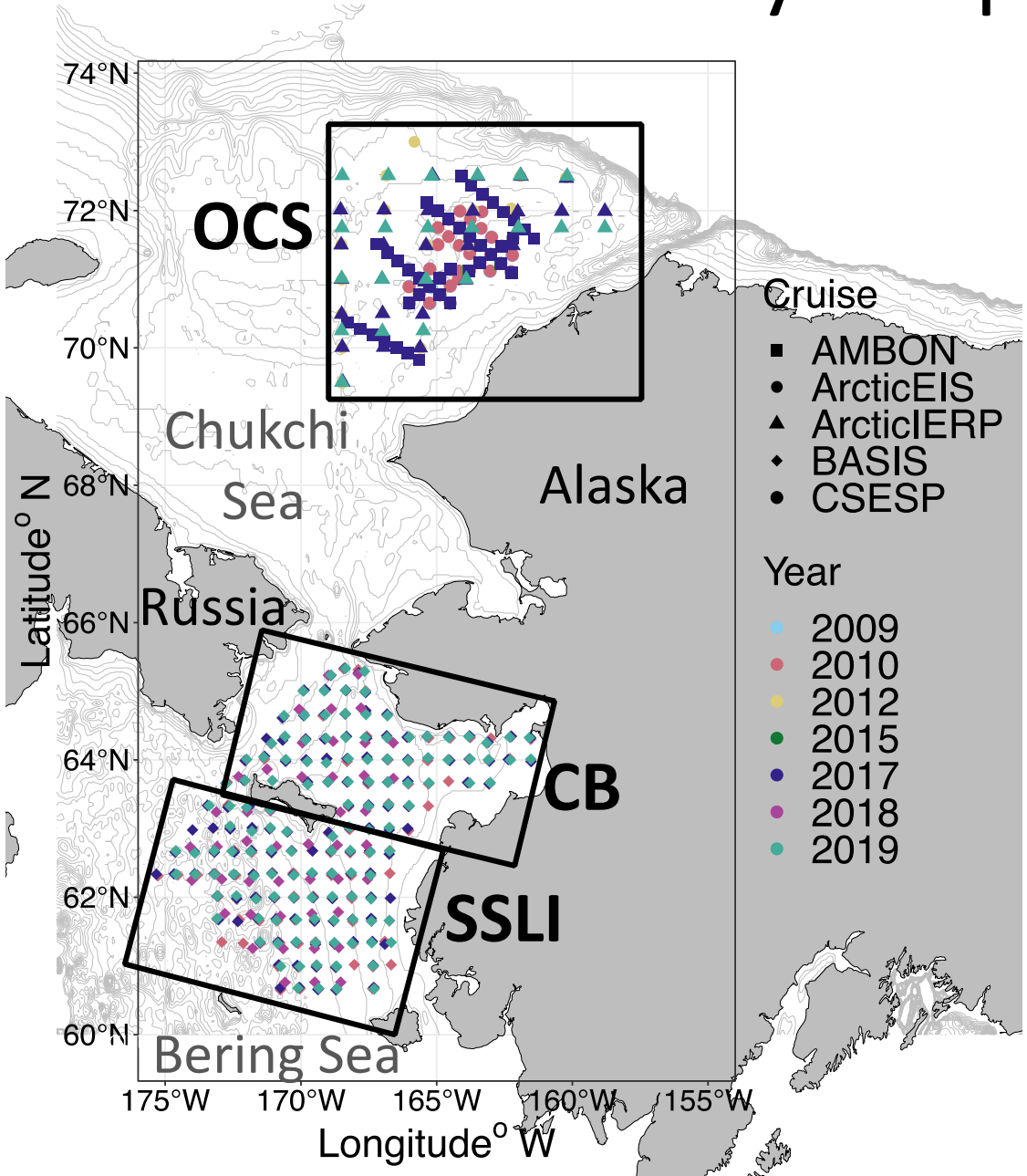
Topics

- Predicting functional change
- Thermal habitat projections: “Winners and Losers”
- Weakening of pelagic-benthic coupling: recent evidence and future work
- Gaps and monitoring needs

Functional diversity of epibenthos



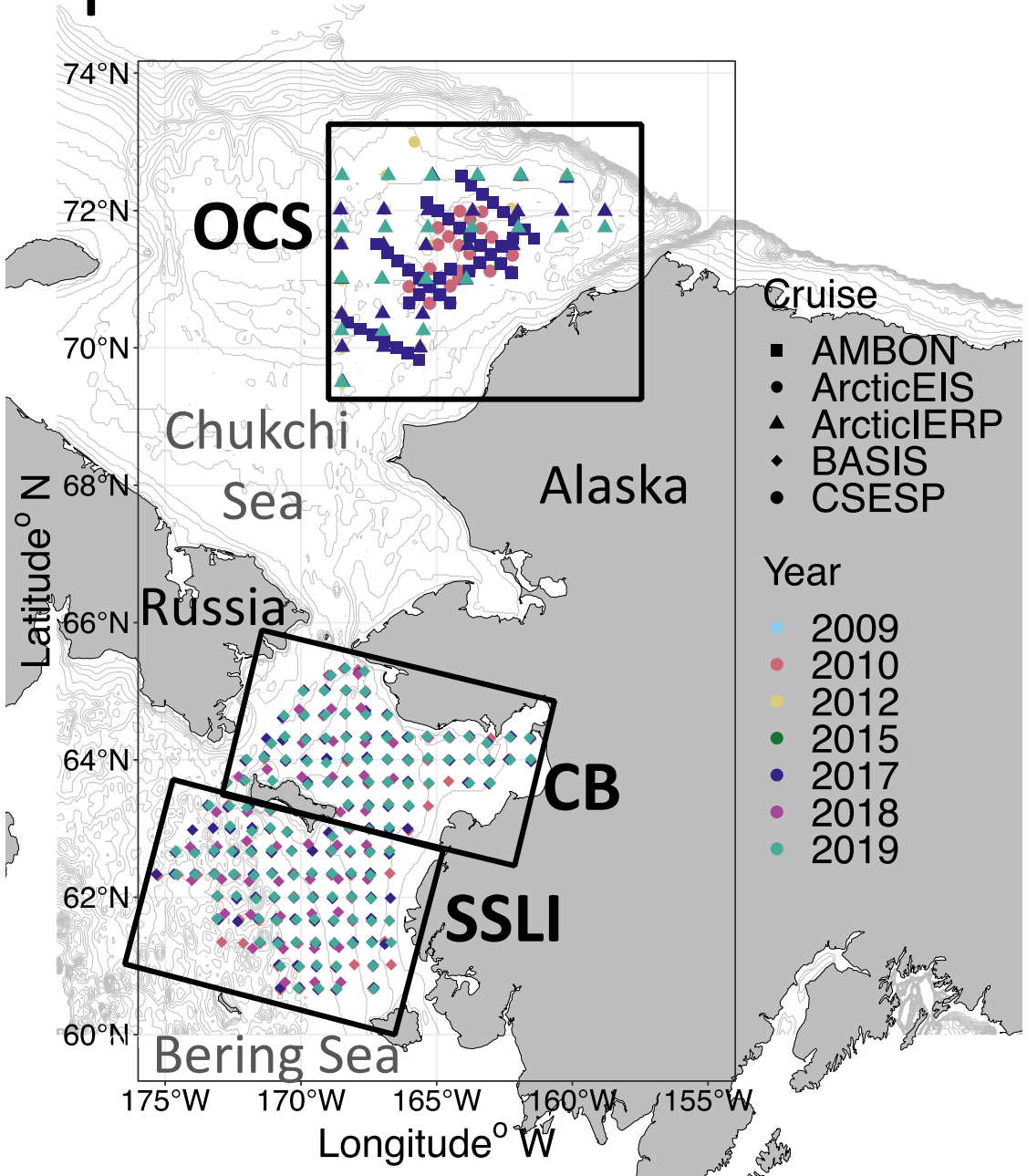
Taxonomic perspective:
Who is there?

Functional perspective:
What do species do?

Functional diversity affects ecosystem functioning

Previous functional trait-environment relationships

Epibenthic functional change



1 model per region = 3 Joint species distribution models

2009-2014

2015-2019

} PAROMS

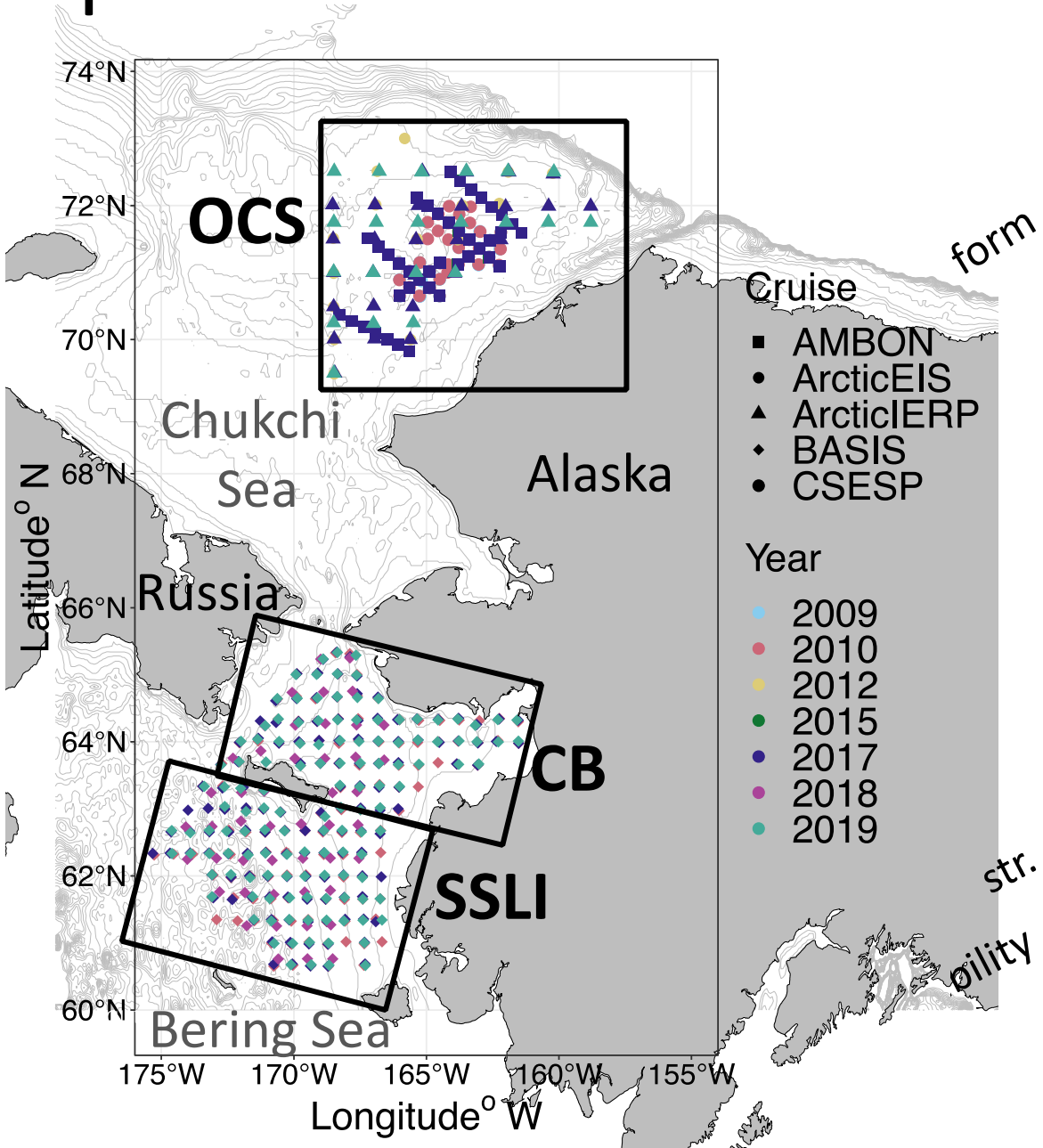
2040-2050

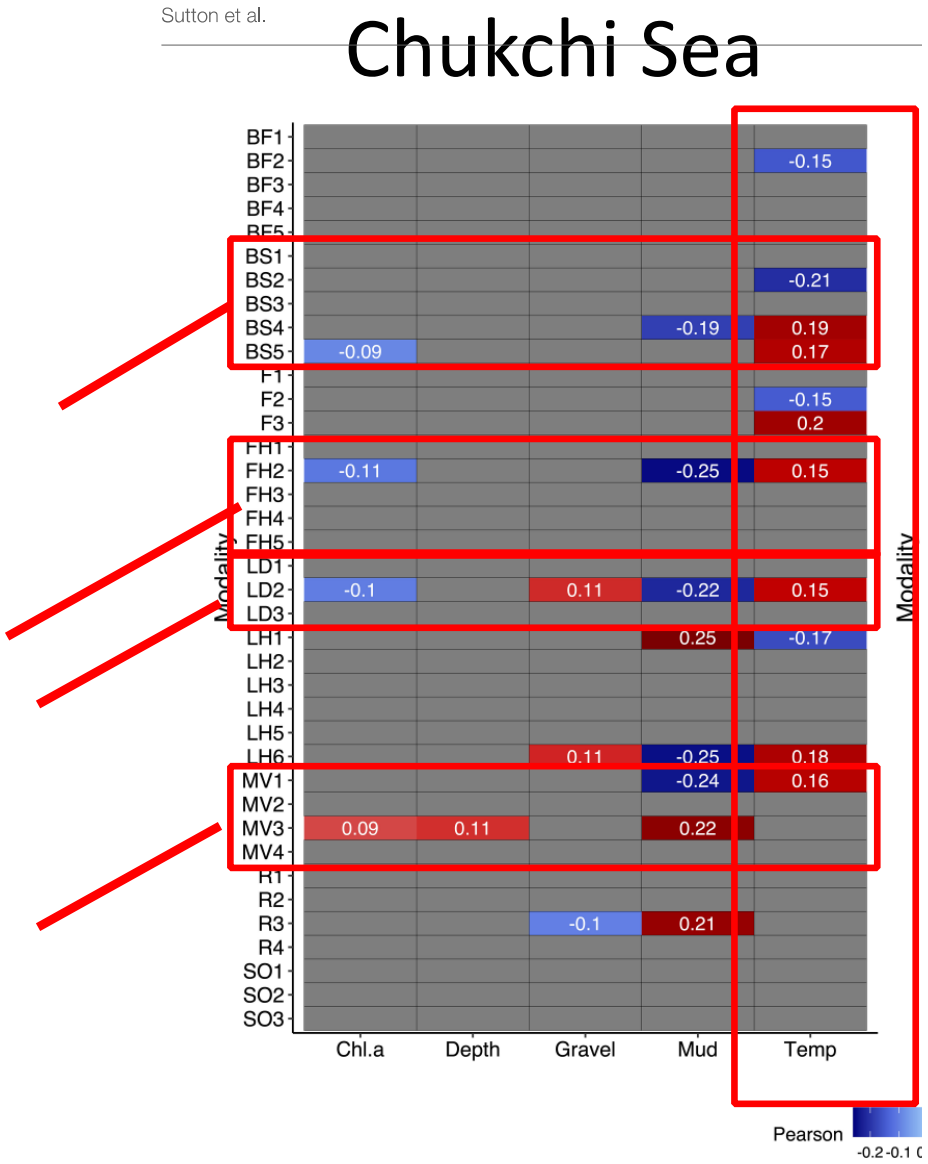
2090-2100

} IPCC "worst-case scenario"

Trait – environment relationships

Epibenthic functional change

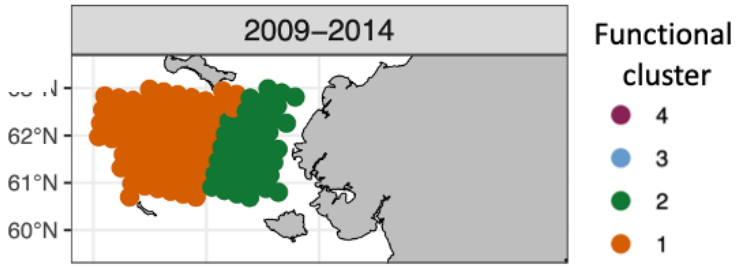




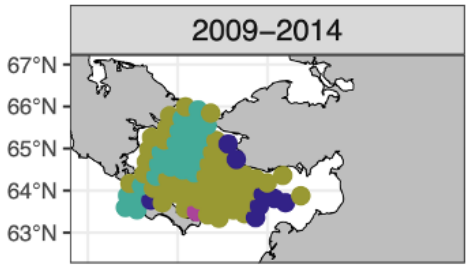
Sutton et al. 2021

Functional shift

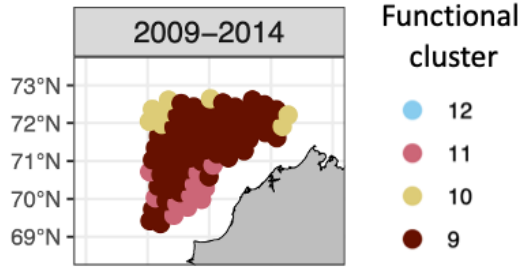
SSLI



CB



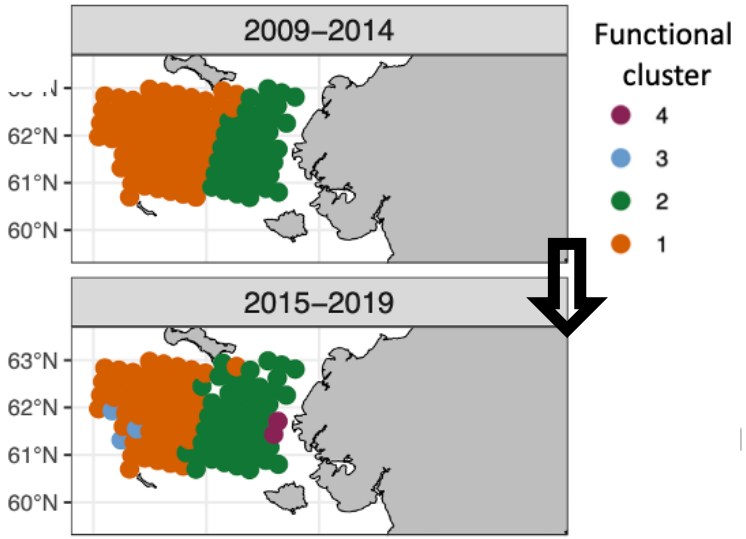
OCS



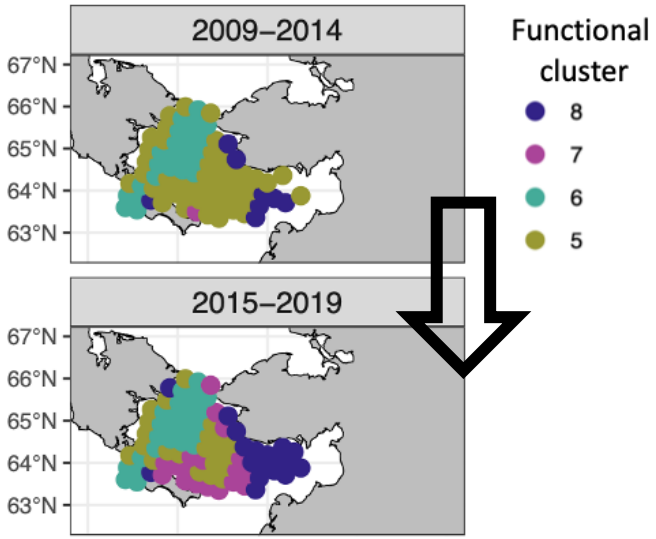
Sutton L, Hauri C, Pages R, Mueter F, Iken I. 2023. Predicting epibenthic functional distribution on changing Arctic shelves. *Ecological Applications*. Submitted.

Functional shift

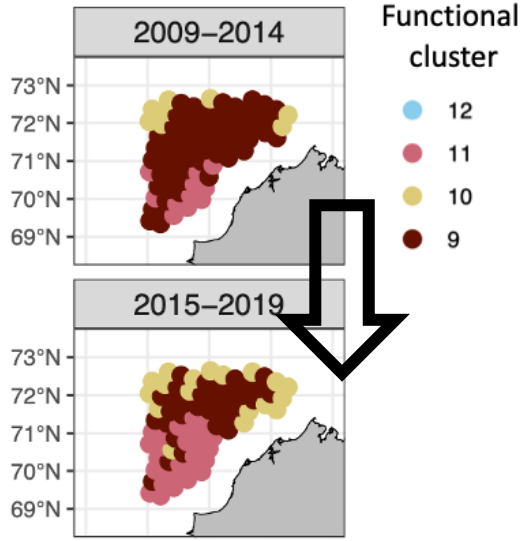
SSLI



CB



OCS



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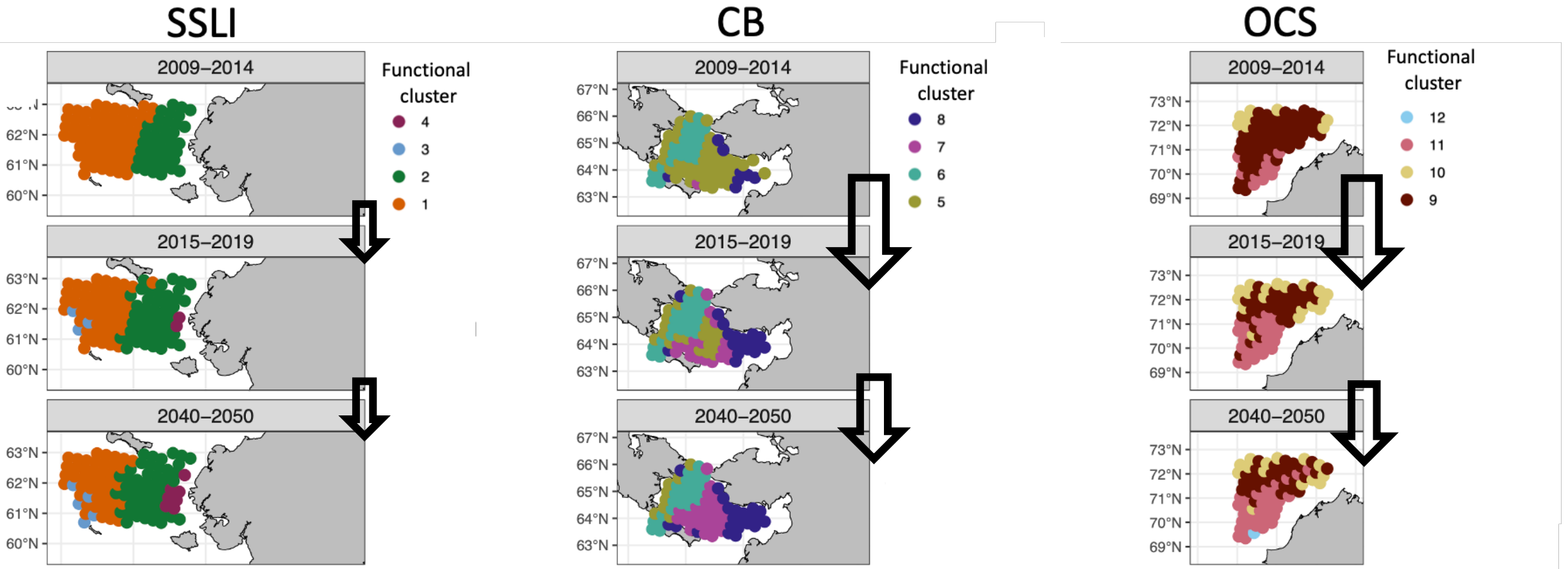
Functional shift



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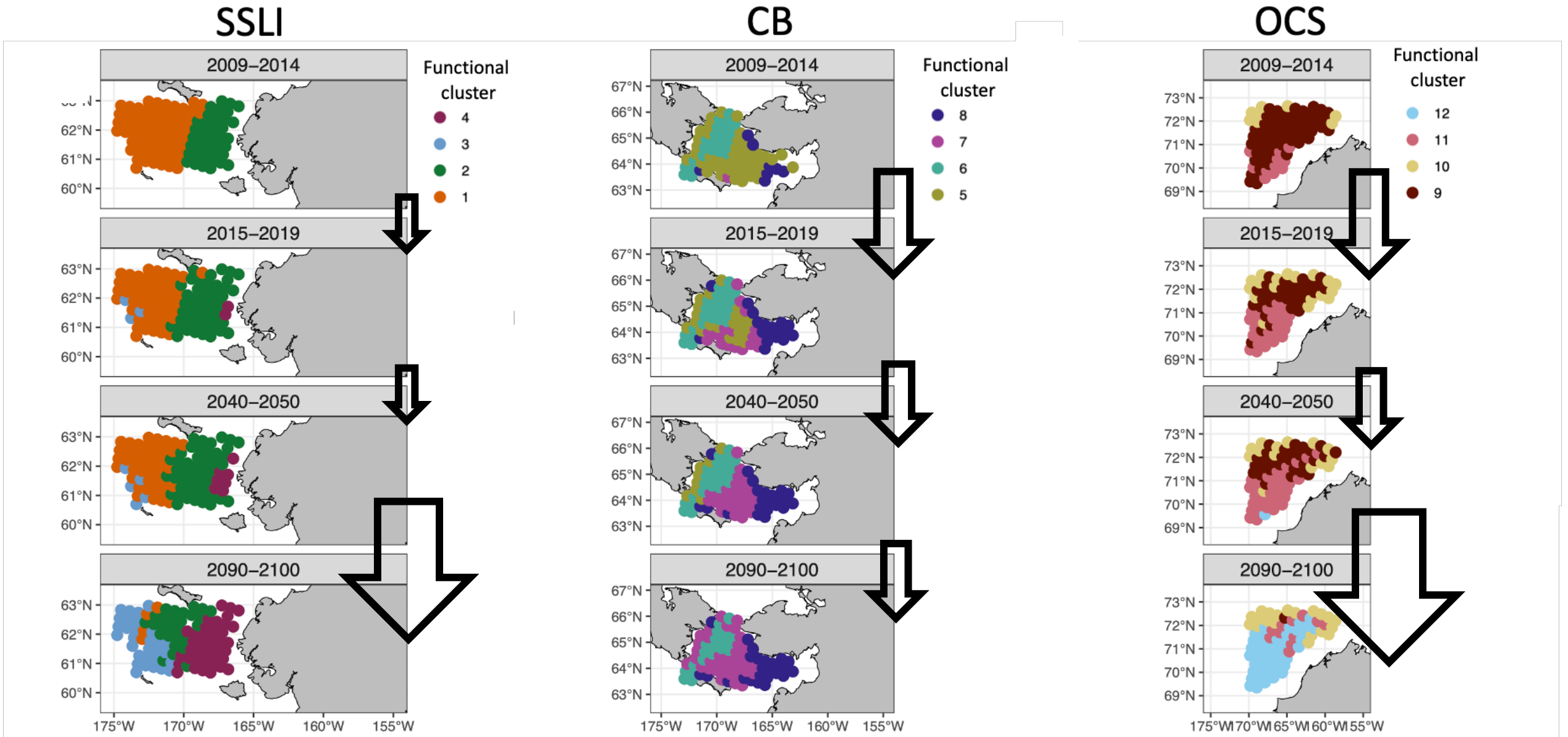

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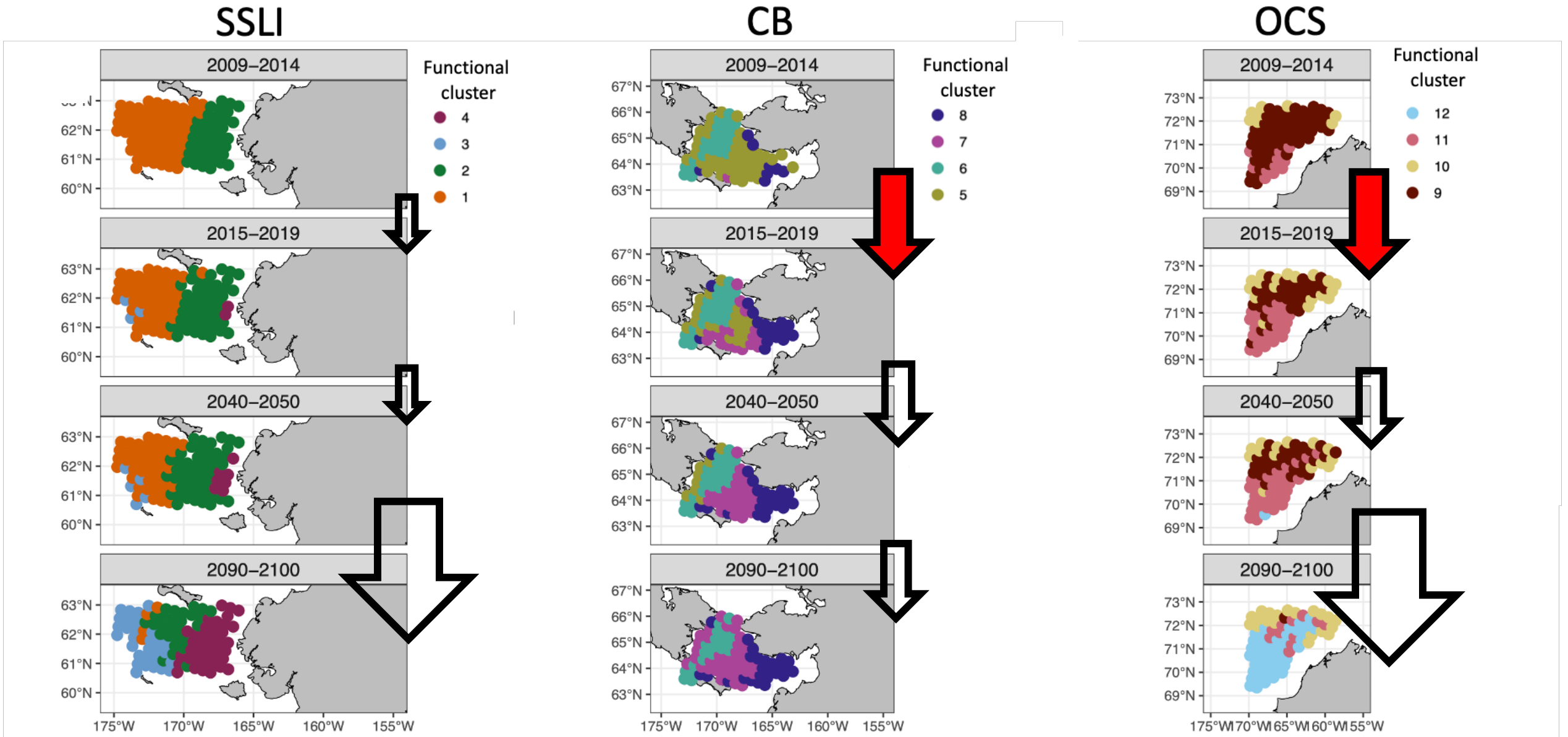
Functional shift



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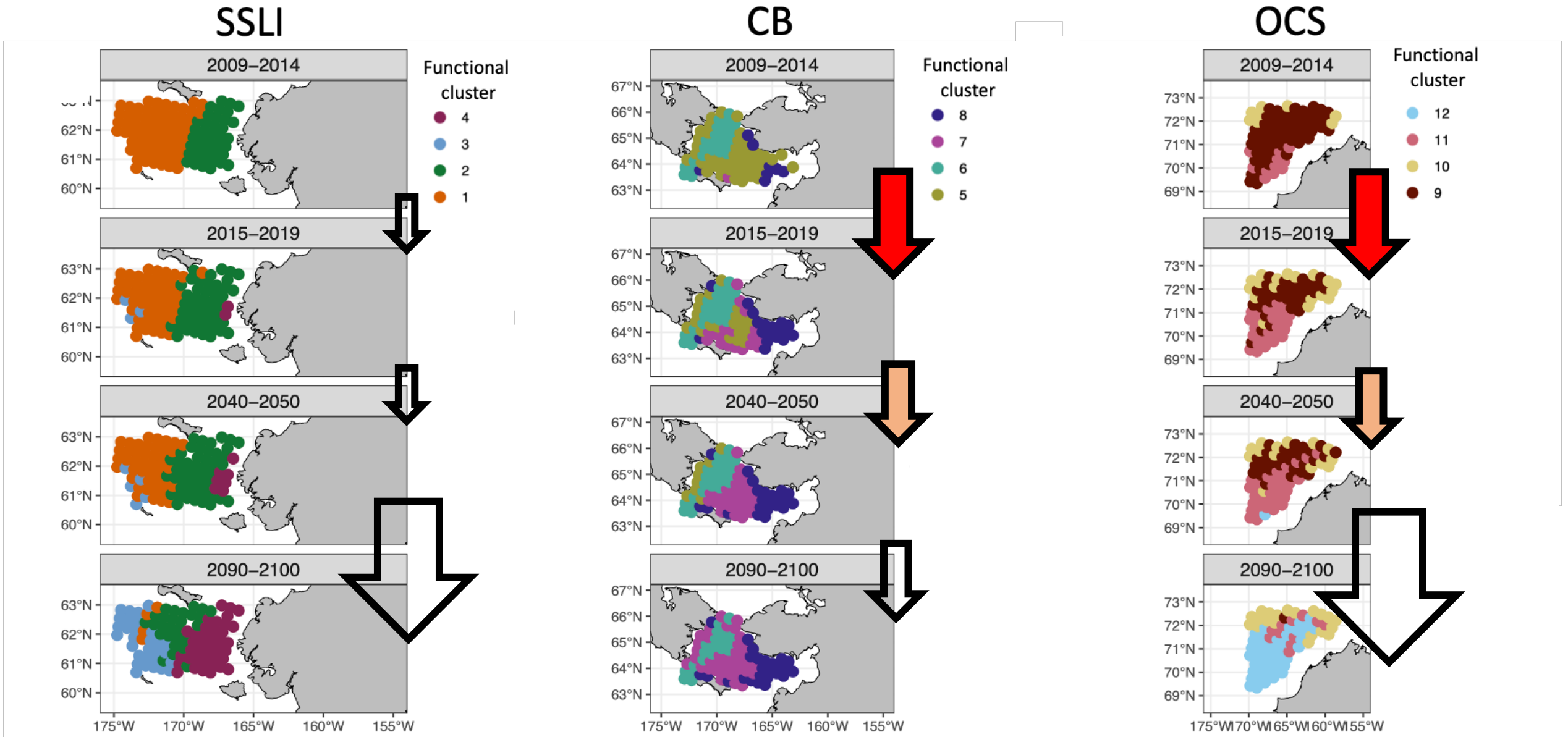

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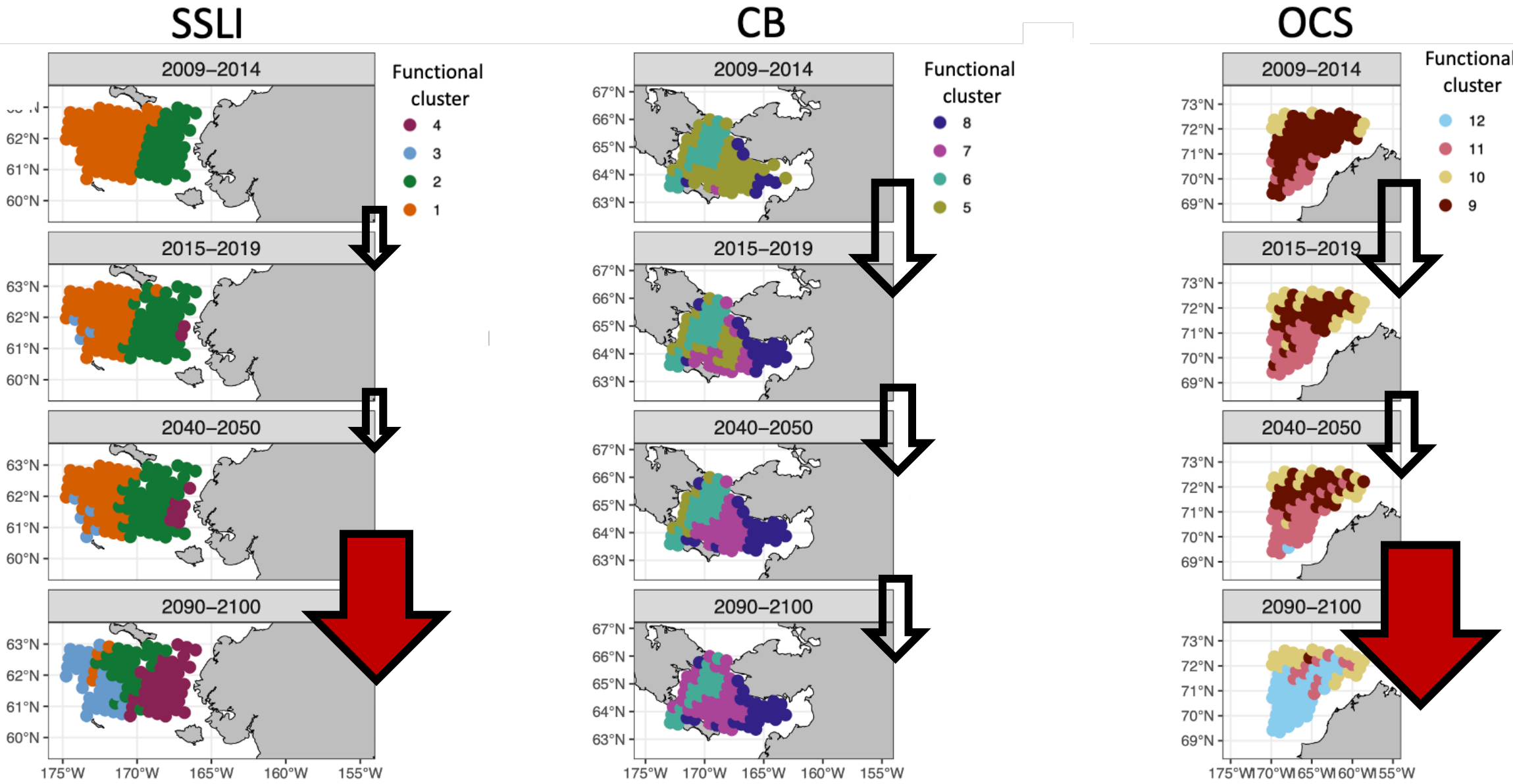
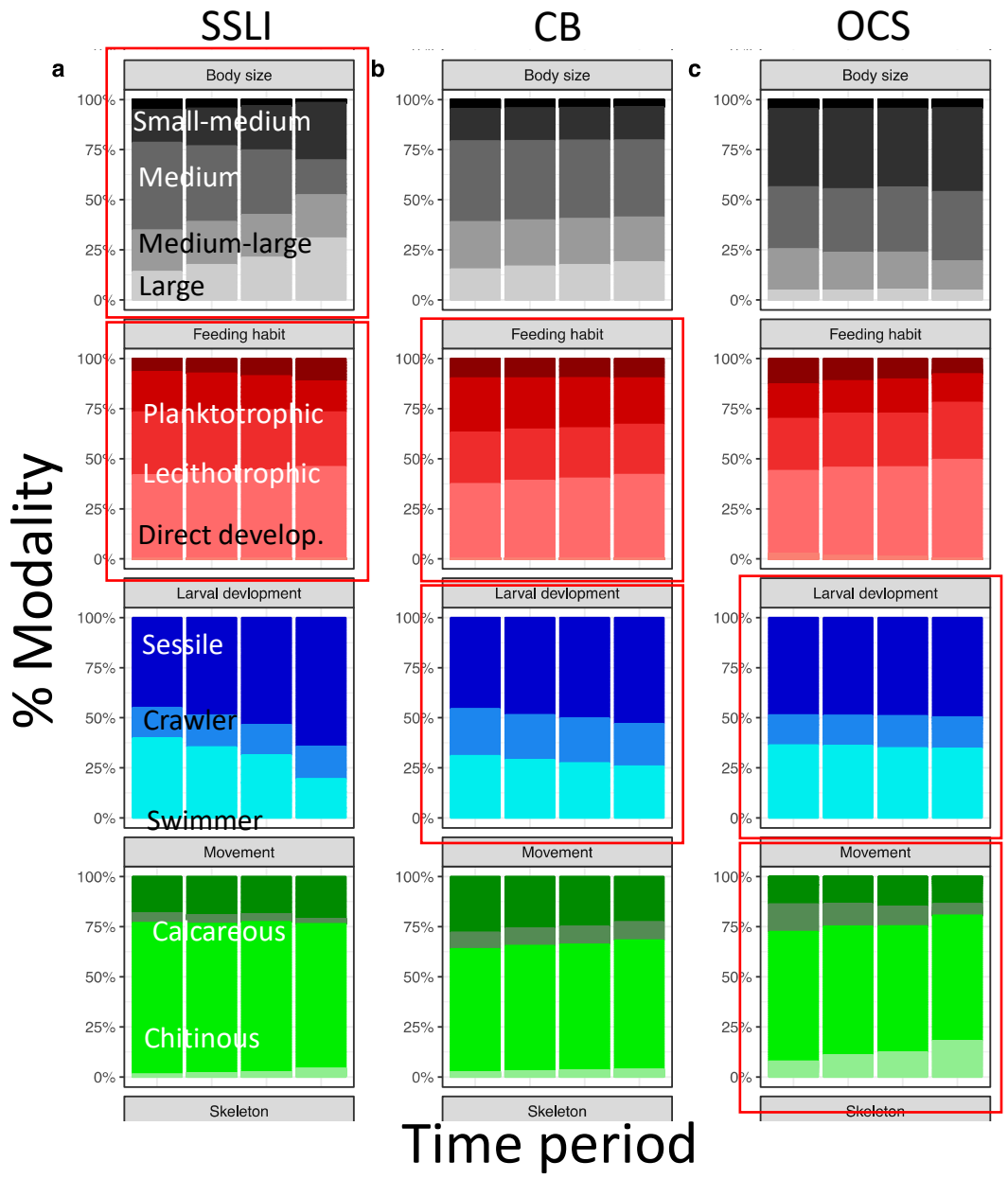
Functional shift



Sutton L, Hauri C, Pages R, Mueter F, Iken I. 2023. Predicting epibenthic functional distribution on changing Arctic shelves. *Ecological Applications*. Submitted.

Trends in functional traits



Temporal changes varied by region

SSLI: Body size / larval development

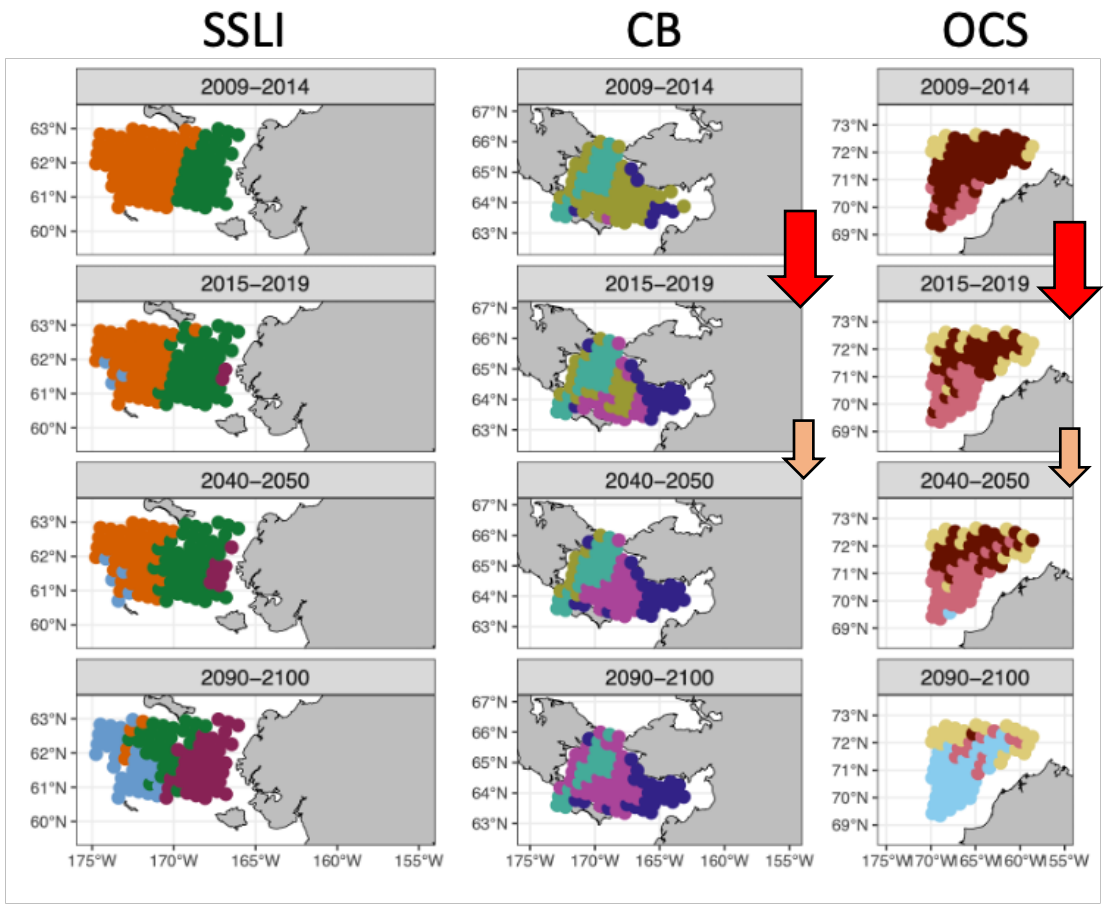
CB: Movement / larval development

OCS: Movement / skeleton

Functional response to changing Arctic

Take-aways

Functional change may have already occurred in the most northern regions; new normal?



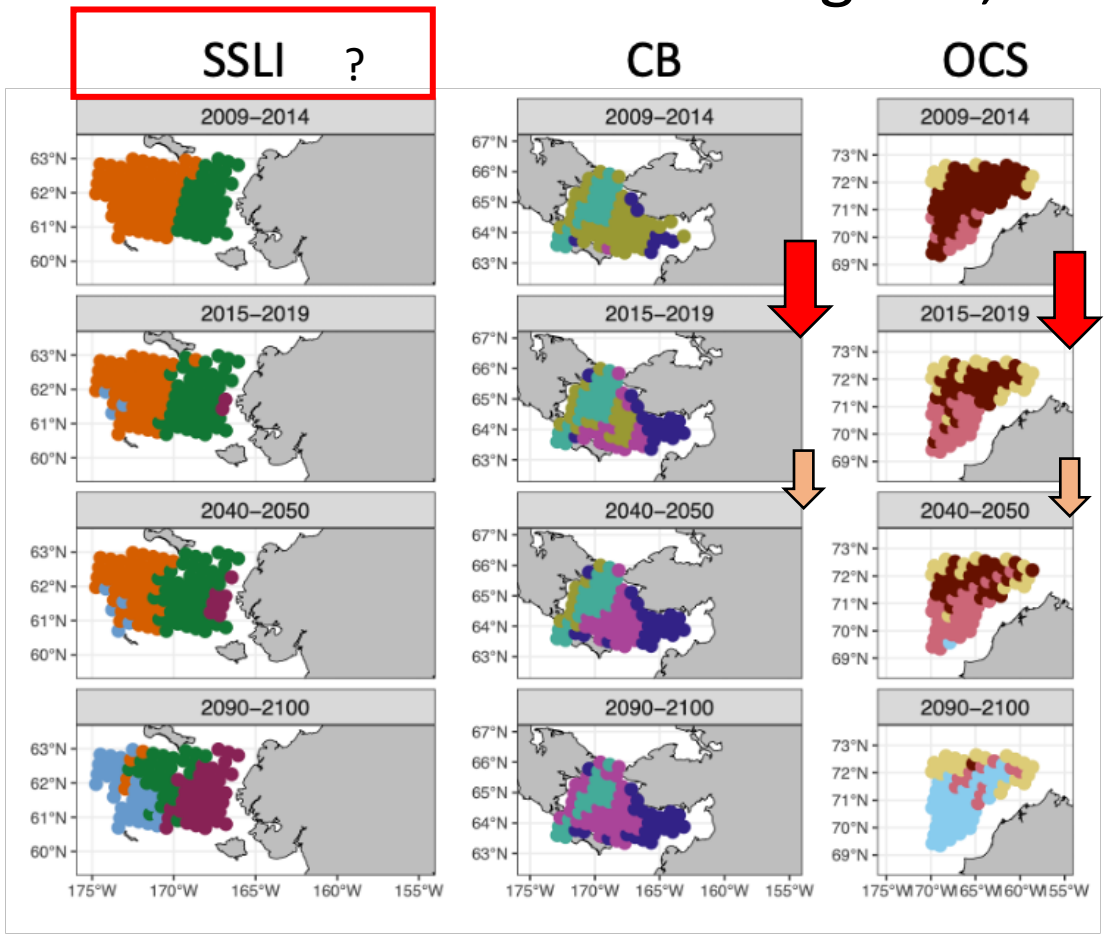
Take-aways

Functional change may have already occurred in the most northern regions; new normal?

Functional change in SSLI prior to 2009?

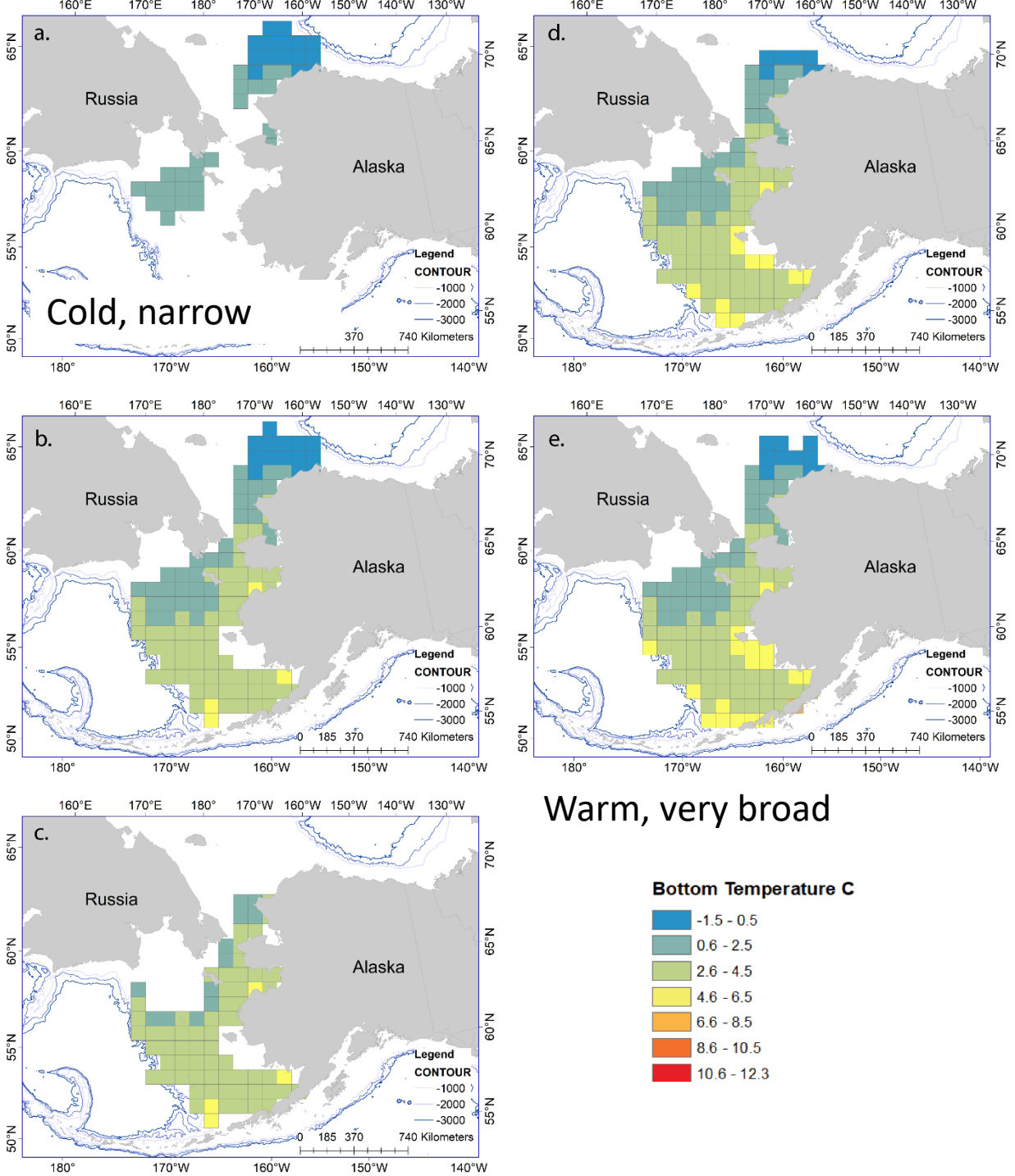
Change in modalities point to functional response to borealization

Predict which attributes of species are advantageous in changing Arctic



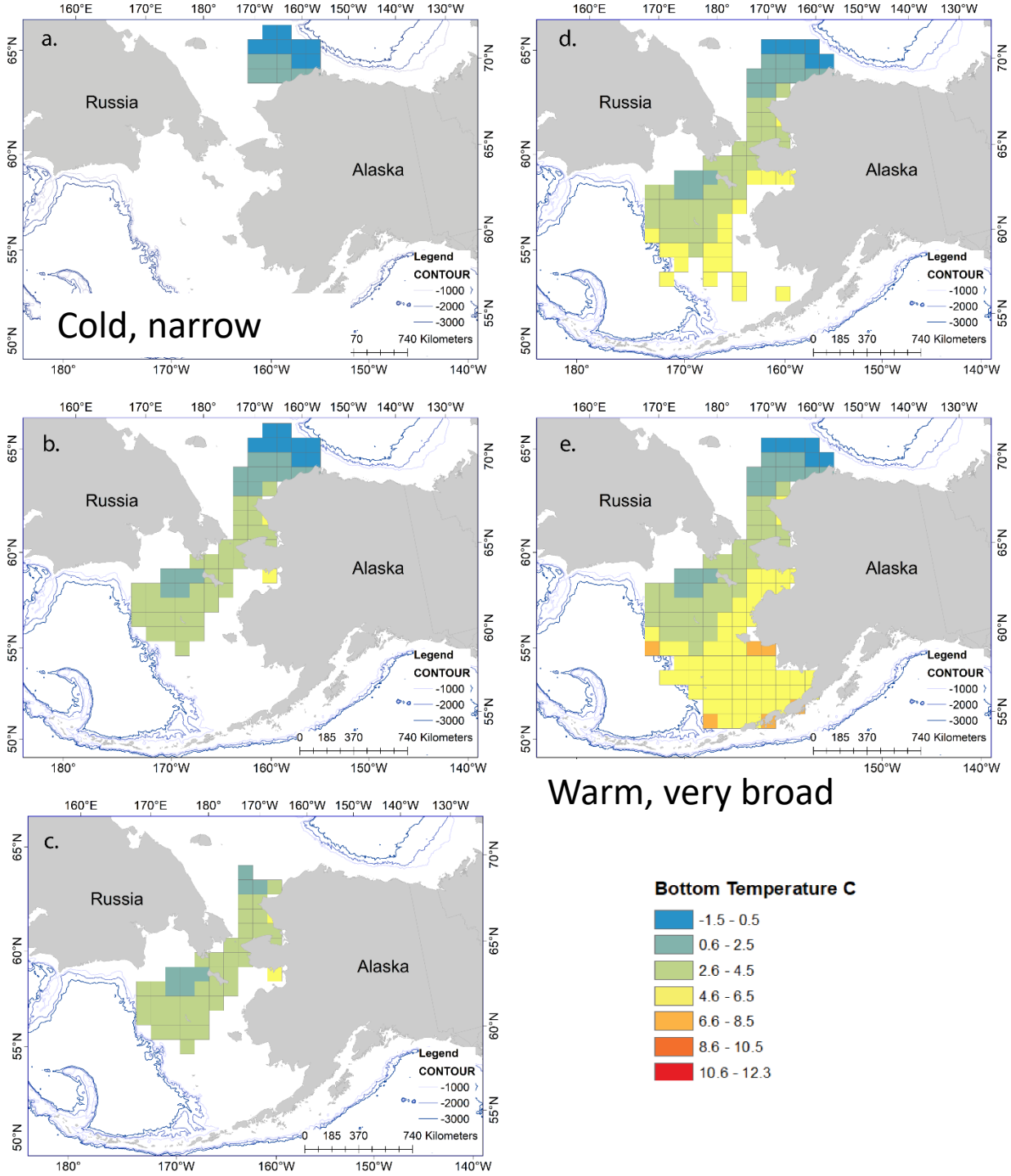
Present

- Thermal habitat
- Epibenthic invertebrates clustered by median temperature and range
- Modeled bottom temperature

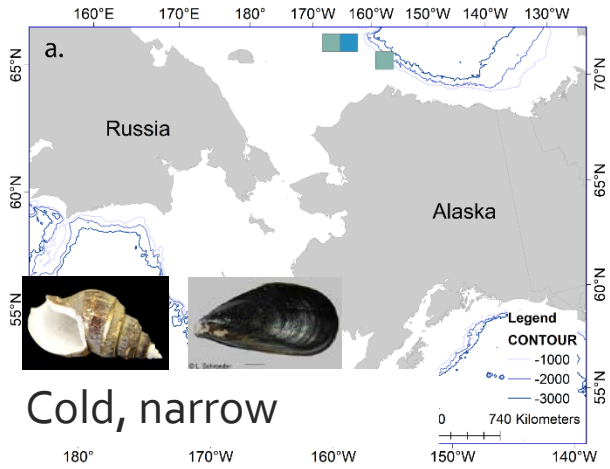


Logerwell, E.A., Wang, M., Jörgensen, L.L., Rand, K., 2022. Winners and losers in a warming Arctic: Potential habitat gain and loss for epibenthic invertebrates of the Chukchi and Bering Seas, 2008–2100. Deep Sea Res. Part II Top. Stud. Oceanogr. 206, 105210. https://doi.org/10.1016/j.dsr2.2022.105210

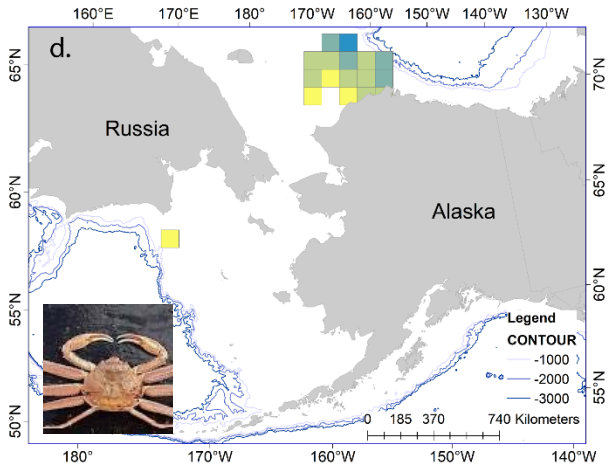
Mid-century

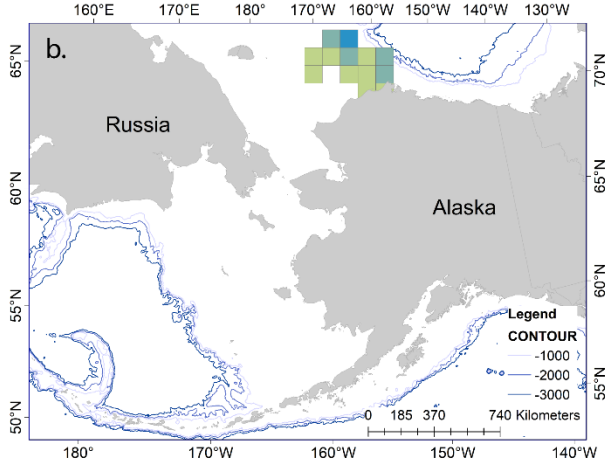

a.
d.
b.
e.
c.
Russia
Alaska
Legend
CONTOUR
-1000
-2000
-3000
740 Kilometers
Cold, narrow
Warm, very broad
Bottom Temperature C
-1.5 - 0.5
0.6 - 2.5
2.6 - 4.5
4.6 - 6.5
6.6 - 8.5
8.6 - 10.5
10.6 - 12.3

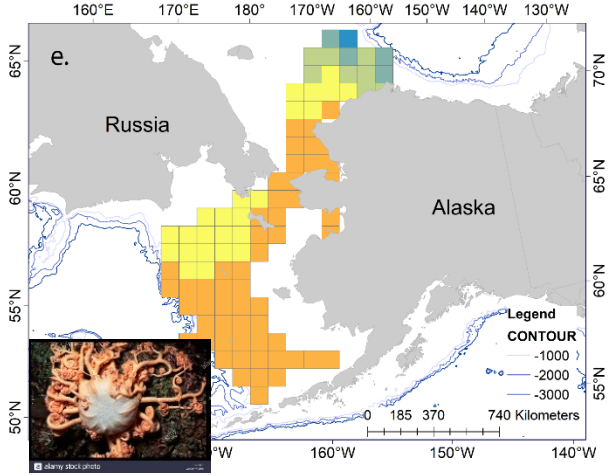
End-of-century



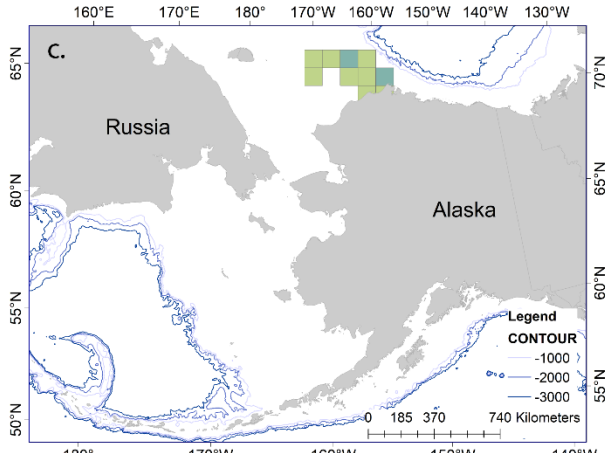
Cold, narrow







Warm, very broad

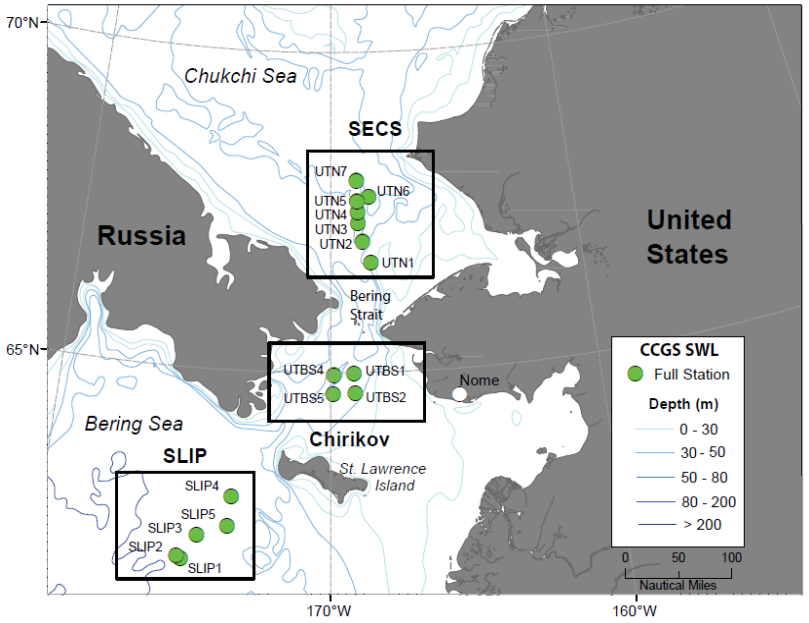


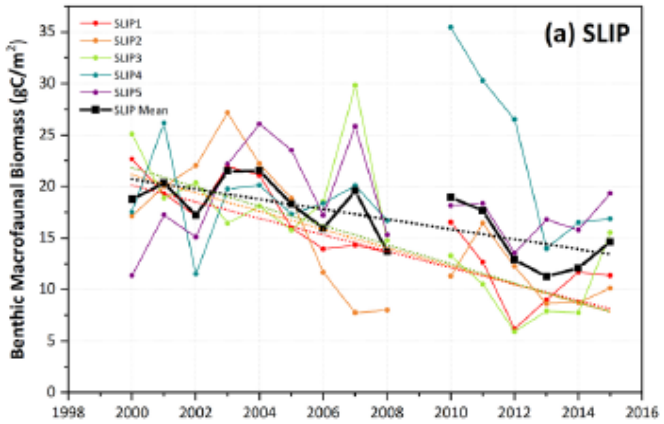
Bottom Temperature C

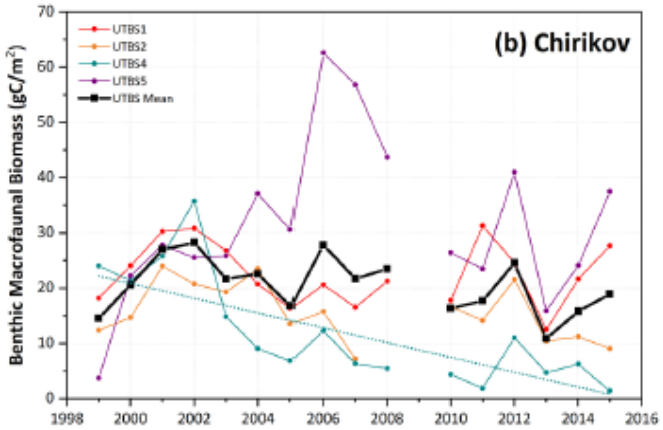
- -1.5 - 0.5
- 0.6 - 2.5
- 2.6 - 4.5
- 4.6 - 6.5
- 6.6 - 8.5
- 8.6 - 10.5
- 10.6 - 12.3

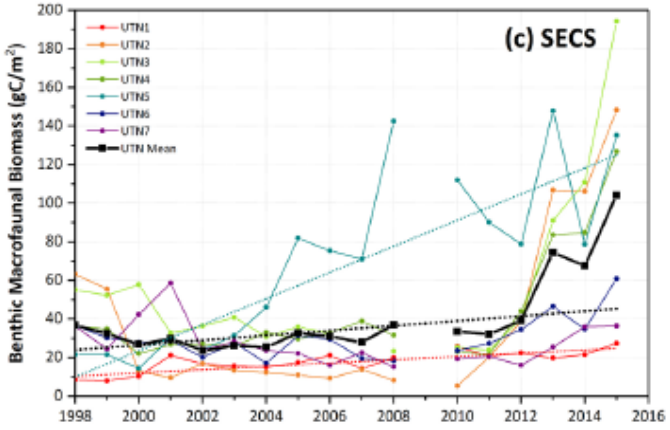
Weakening of pelagic-benthic coupling: recent evidence and future work

Infauna biomass



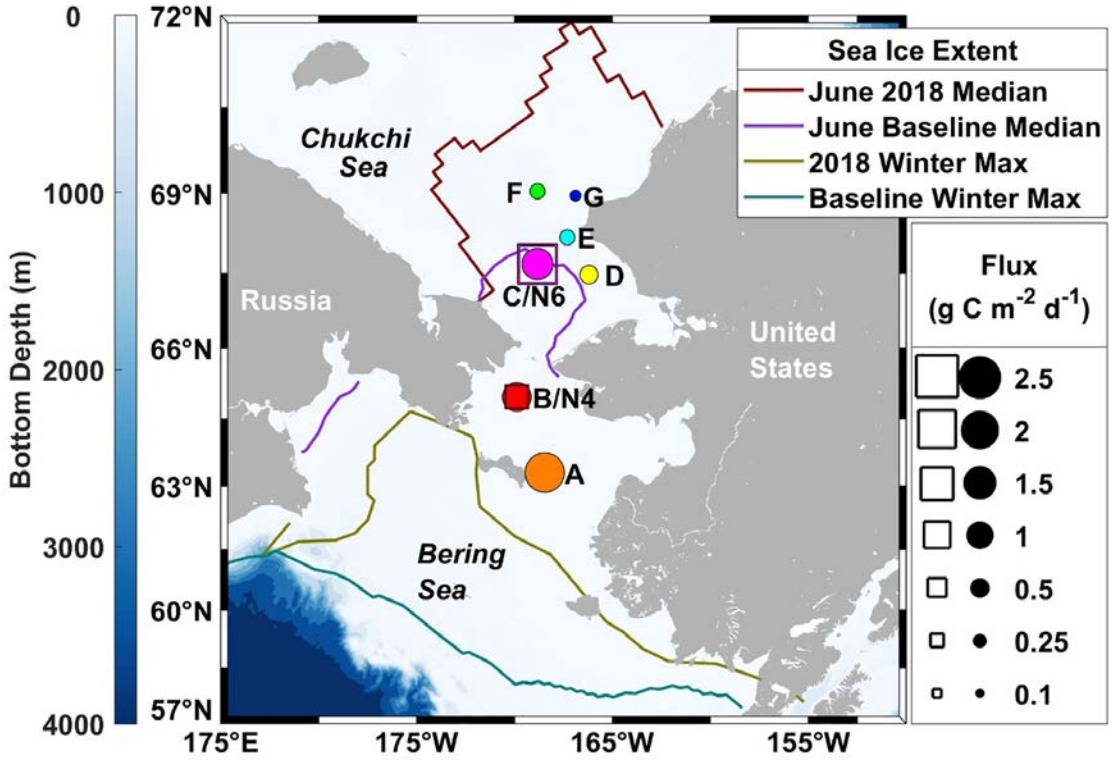


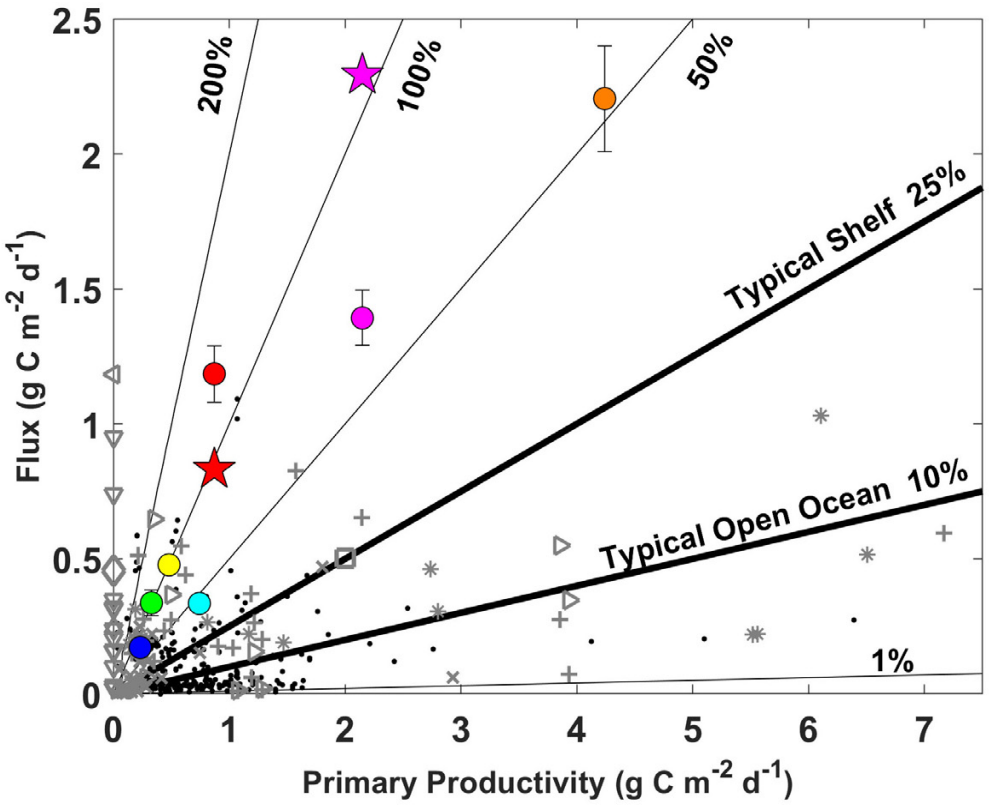


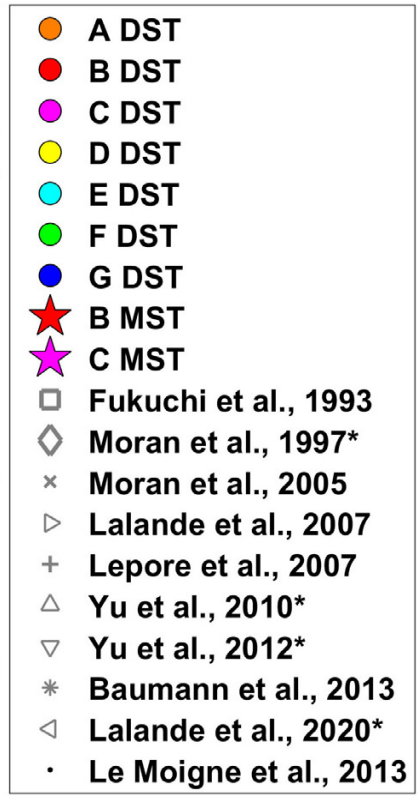


Grebmeier, J.M., Frey, K.E., Cooper, L.W., Kędra, M., 2018. Trends in benthic macrofaunal populations, seasonal sea ice persistence, and bottom water temperatures in the bering strait region. Oceanography 31, 136–151. https://doi.org/10.5670/oceanog.2018.224

Pelagic-benthic flux during a warm year, 2018







O'Daly, S.H., Danielson, S.L., Hardy, S.M., Hopcroft, R.R., Lalande, C., Stockwell, D.A., McDonnell, A.M.P., 2020. Extraordinary Carbon Fluxes on the Shallow Pacific Arctic Shelf During a Remarkably Warm and Low Sea Ice Period. Front. Mar. Sci. 7, 1–17. https://doi.org/10.3389/fmars.2020.548931

Benthic-pelagic de-coupling: Ecosystem re-assembly in the Northern Bering and Chukchi seas

Institutional Principle Investigators (alphabetical order):

Lee Cooper and Jackie Grebmeier (University of Maryland Center for Environmental Science)

Katrin Iken (University of Alaska Fairbanks)

Elizabeth Logerwell* and James Thorson (NOAA Alaska Fisheries Science Center)

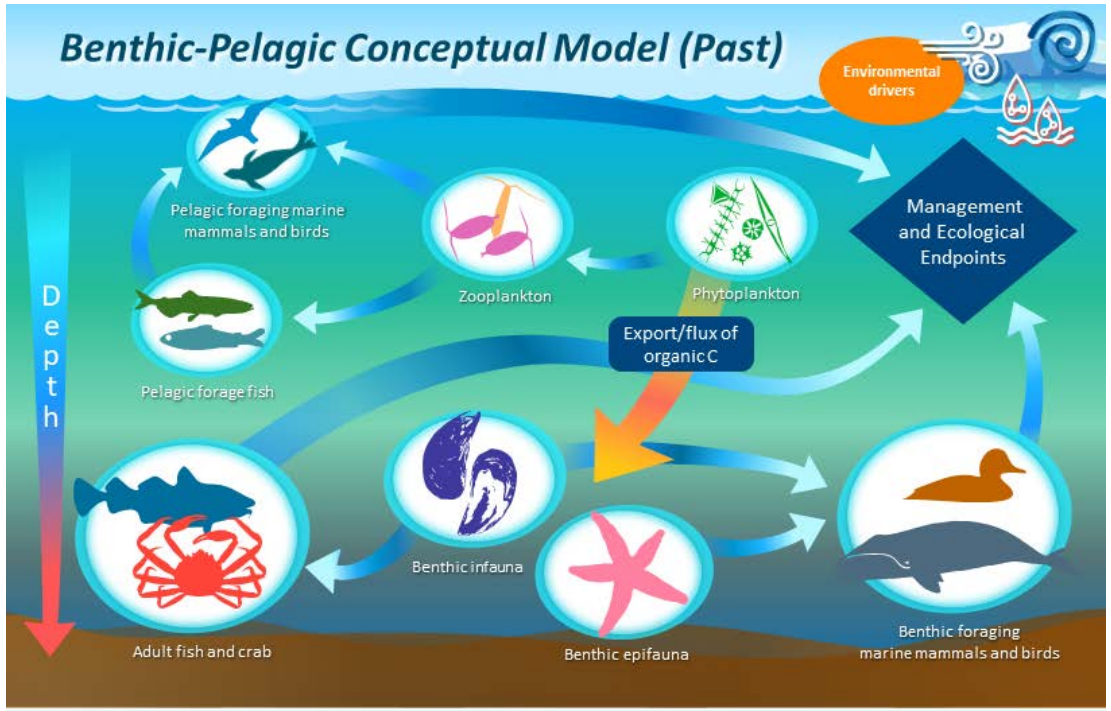
Mike Lomas (Bigelow Laboratory for Ocean Sciences)

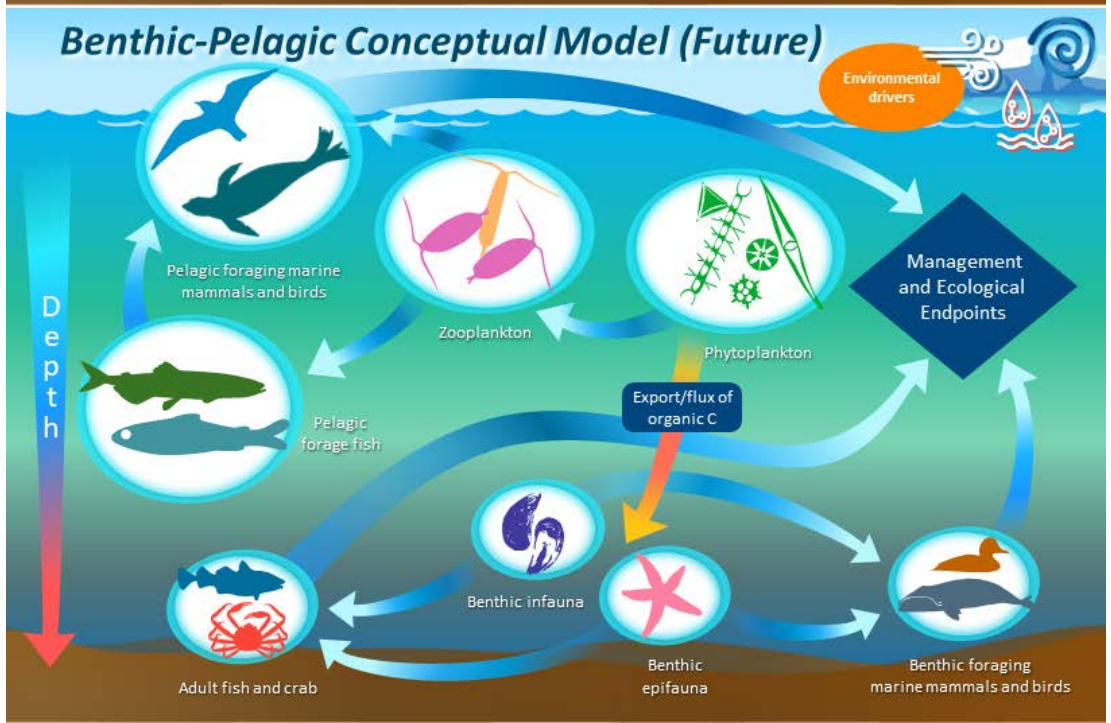
Ryan McCabe (NOAA Pacific Marine Environmental Laboratory)

Calvin Mordy (University of Washington)

Astrid Schnetzer (North Carolina State University)

**Lead PI*





Model predictions will be used to address three ecological and management endpoints:

- Survey optimization (e.g., evaluating sampling scenarios that could efficiently reduce uncertainty in future expeditions);
- Marine spatial information (e.g., identifying changes in resource densities for key subsistence populations in the historical hunting areas of Alaska Native communities); and
- Ecological outcomes (e.g., identifying whether benthic and/or pelagic biogeographic provinces are shifting).

Gaps and monitoring needs

- Monitoring
  - Benthic infauna and epifauna community, highest taxonomic resolution, taxonomic expertise, eDNA
  - Pelagic-benthic flux
  - Northern Bering – Chukchi Sea
- Gaps
  - Model more environmental drivers, e.g., pH
  - Temperature tolerances from laboratory studies
  - Ecosystem impacts of changing community composition and distribution “winners and losers”