

## PICES-2017 Annual Meeting:

Environmental Changes in the North Pacific and  
Impacts on Biological Resources and Ecosystem Services  
Sep 22 – Oct 1, 2017 Vladivostok, Russia

## S11: FIS/POC Topic Session

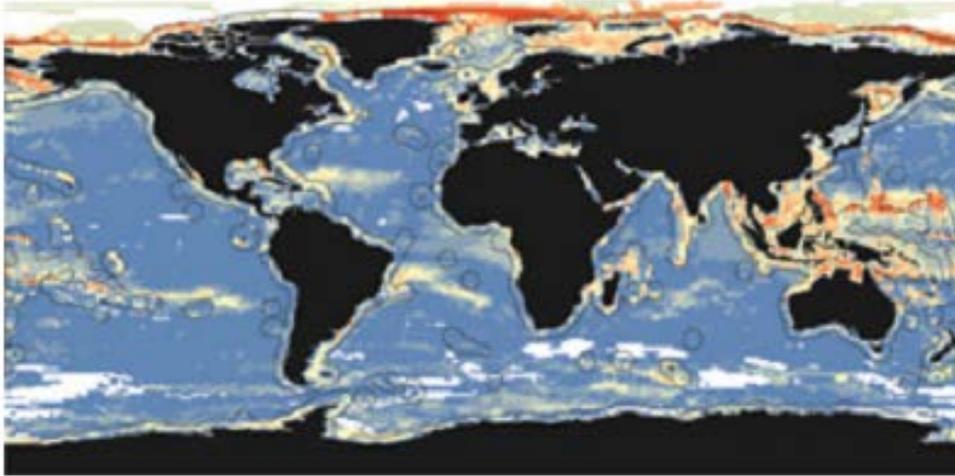
Environmental variability in Arctic and Subarctic  
ecosystems and impacts on fishery management  
strategies

# Assessing biodiversity patterns of fish resources in the Eastern Bering Sea

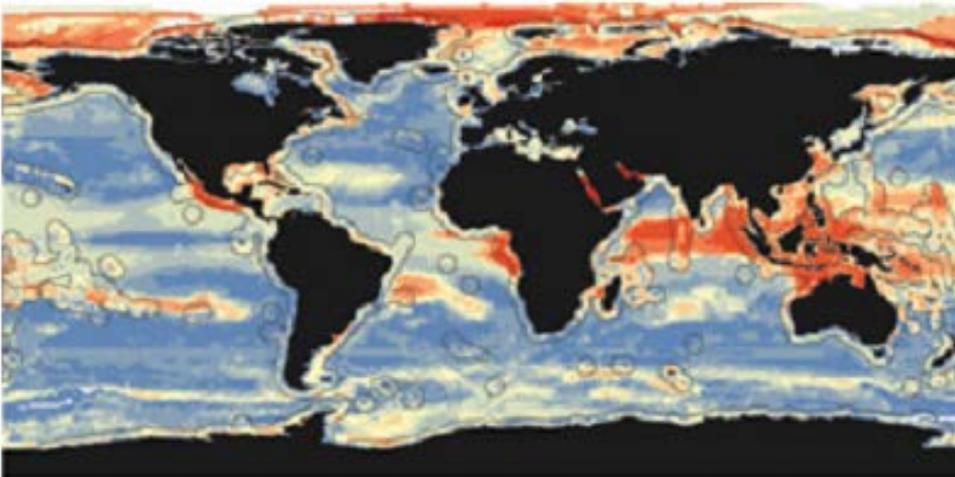
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Toru Hirawake and Franz J. Mueter

# Introduction

Present-day (2006)  $\beta$ -diversity



Future (2100)  $\beta$ -diversity



- Climate changes significantly impact biodiversity, through changes in species richness & community composition<sup>1,2</sup>
- Highest projected  $\beta$ -diversity changes at the equatorial, subarctic and Arctic Oceans<sup>1</sup>

# Introduction

## Beta diversity ( $\beta$ -diversity)<sup>3</sup>

“extent of change in community composition, in relation to a complex gradients of environment”

- It is further partitioned into two components that account for dissimilarity patterns in community composition<sup>4</sup>



replacement of some species by others

nested loss of species from the richest to the poorest locality

combination of both replacement & species loss

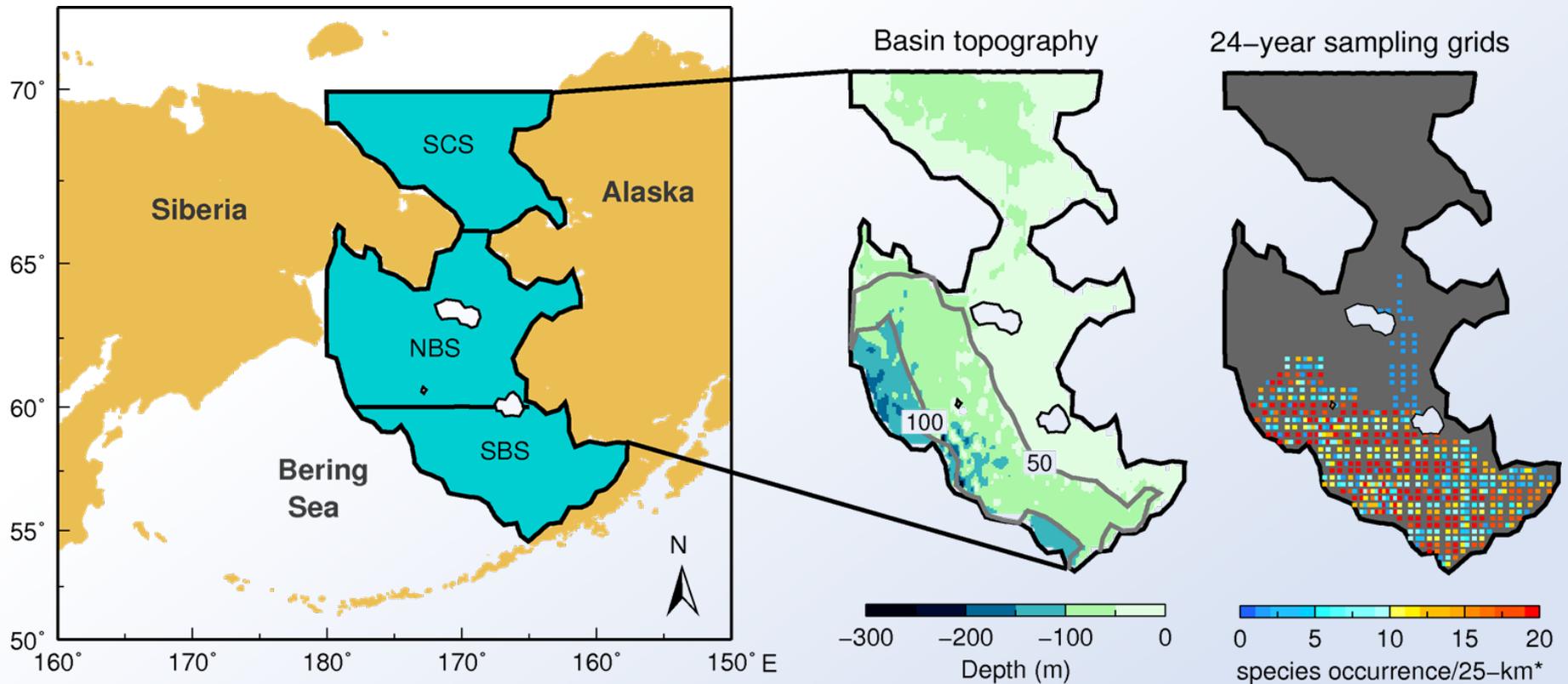
# Introduction: *Why examine regional $\beta$ -diversity?*

- ❑ **Unlike  $\alpha$ -diversity,  $\beta$ -diversity is less well-studied<sup>5</sup>**
  - Global patterns in beta diversity along large-scale gradients are less consistent; vary among ecosystems and assemblages of organisms<sup>6,7</sup>
  
- ❑ **Studies of beta diversity can inform management**
  - Heterogeneity in communities tends to reflect heterogeneity in habitat<sup>3</sup>
  - It can also indicate important spatial or temporal biogeographic transitions<sup>8</sup>

## General research questions

- How are the regional patterns of species richness and  $\beta$ -diversity distributed in space and across climate transitions?
- How are the components of total  $\beta$ -biodiversity (i.e. spatial turnover and nestedness) vary across transitions?

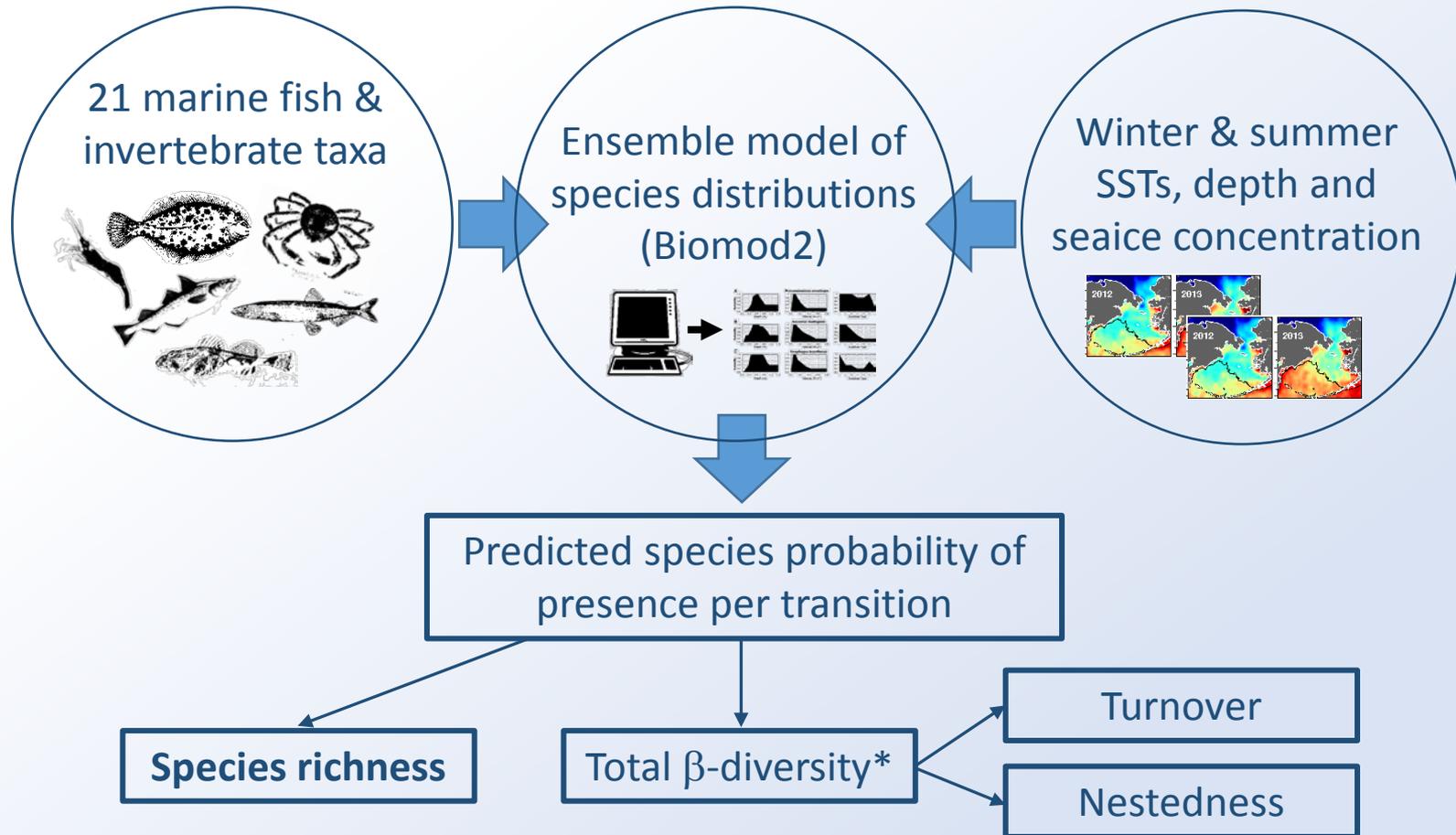
# Data & methods: *Study area & 24-year\* sampling grids*



\* Pollock occurrences per 25-km grid (June-July, 1993-2016)

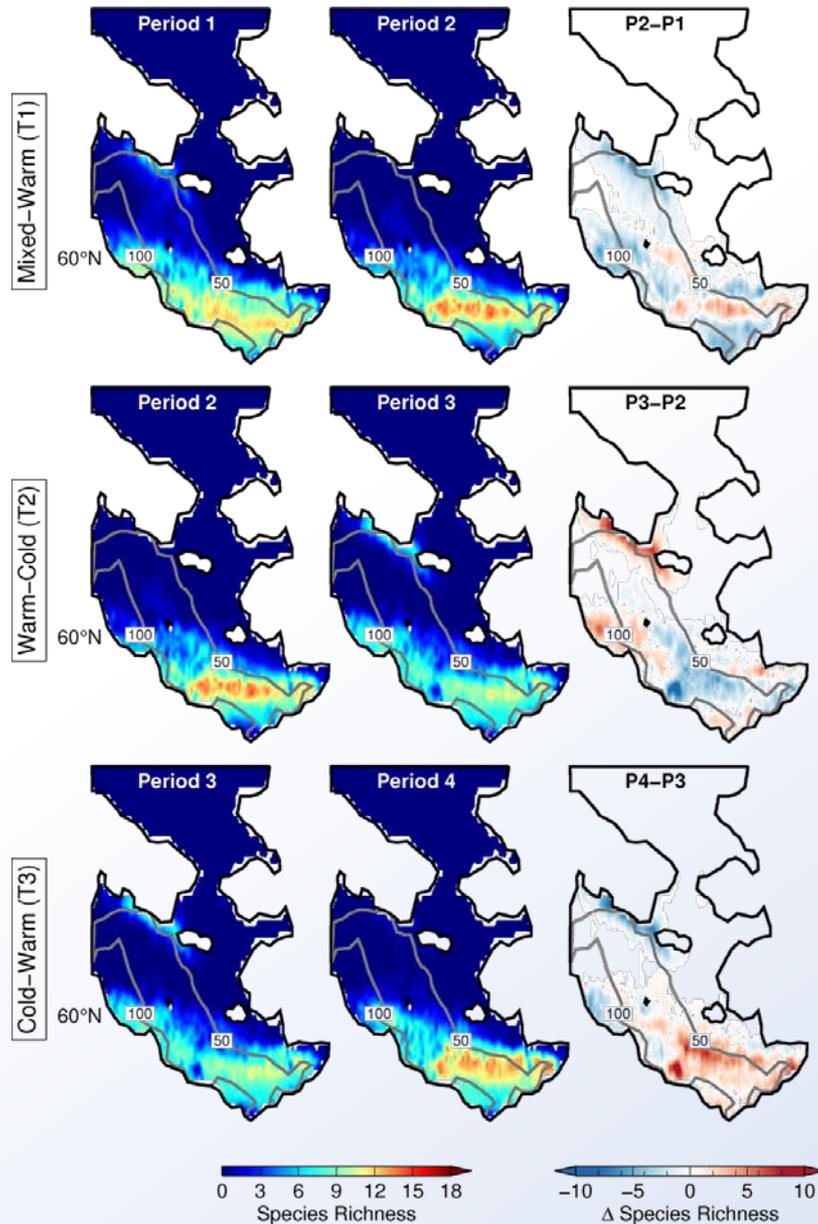
# Data & methods

Transition 1 (Mixed-Warm)		Transition 2 (Warm-Cold)		Transition 3 (Cold-Warm)	
1993-2000		2001-2005		2006-2013	
Period 1		Period 2		Period 3	
				2014-2016	
				Period 4	



\*Sorensen index of Dissimilarity – betapart package (Baselga & Orme 2012)

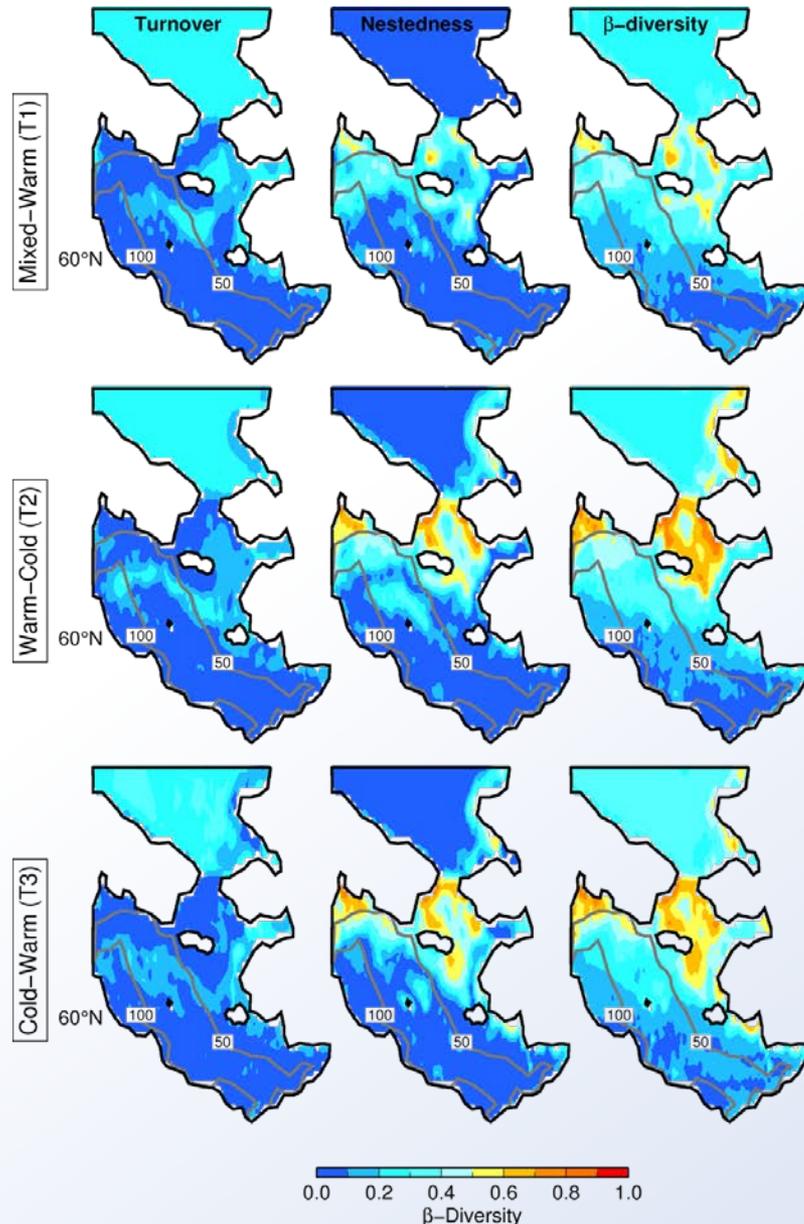
# Results & Discussion: *Spatio-temporal patterns of richness\**



Spatio-temporal distribution of species richness showed clear regional patterns

- ❑ High species richness were located in Southern Bering Sea (SBS; 52-60N)
- ❑ Warm years showed higher richness in SBS than cold and mixed periods (moderately high in NBS; 60-70N)

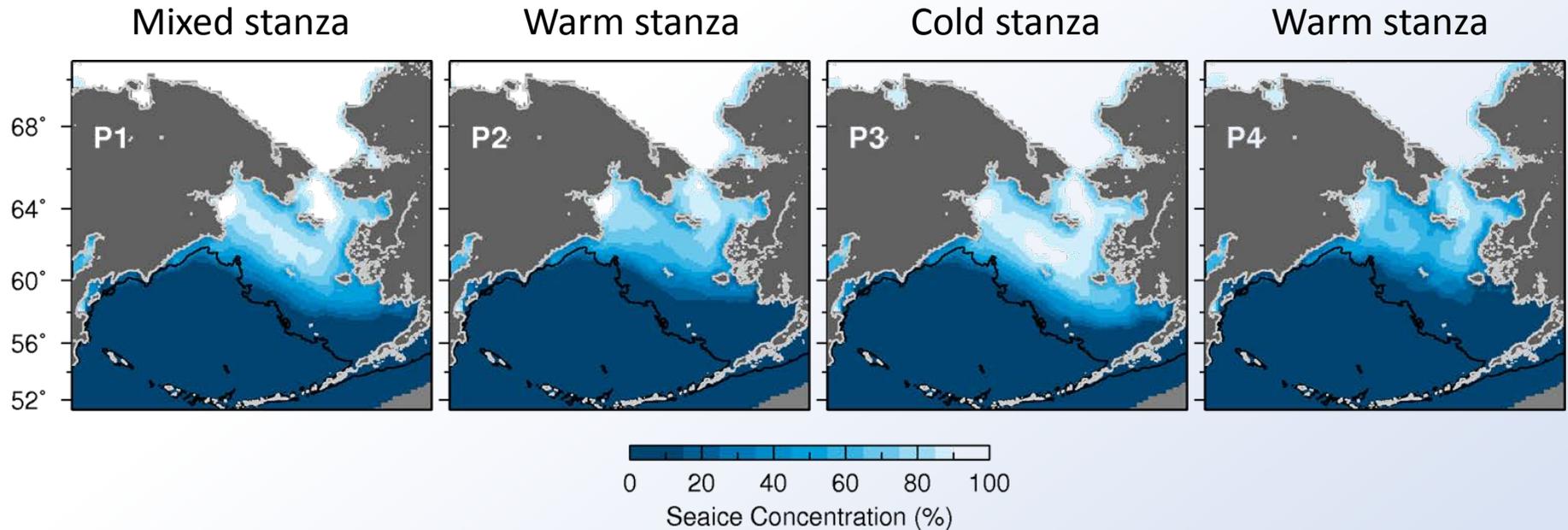
# Results & Discussion: *Spatio-temporal patterns of $\beta$ -diversity*



$\beta$ -diversity and its components showed contrasting patterns relative to species richness

- ❑ High  $\beta$ -diversity were located in Northern Bering Sea (60-70N)
- ❑ Nestedness component dominates  $\beta$ -diversity patterns across all transition
- ❑ Emerging pattern of homogenization in species assemblages under warm climatic stanzas<sup>1,9</sup>

# Results & Discussion: *Extent of winter seaice concentration: potential driver of $\beta$ -diversity patterns*



- ❑ Spatial extent of winter seaice showed retreat and advance during distinct climatic stanzas
  - Determines the latitudinal extent of cold pool in summer<sup>11</sup> ~ more extensive seaice extent, more southerly protrusion of cold pool and vice versa ~ preclude the meridional expansion of marine species in the EBS

# Summary

- Strong yet contrasting latitudinal gradients in both species richness & beta-diversity<sup>9,10</sup>
- Beta-diversity patterns across the 3 transitions were dominated by nestedness over turnover
  - Changes in spatial extent of oceanographic barrier (i.e. cold pool) to species poleward movement<sup>11</sup>
  - Intensification of warming signals during the last decades, modifying productivity conditions in the basin<sup>11,12</sup>
  - Warm climatic stanzas resulted to homogenization of species assemblages in the EBS

**Thank you for your attention**