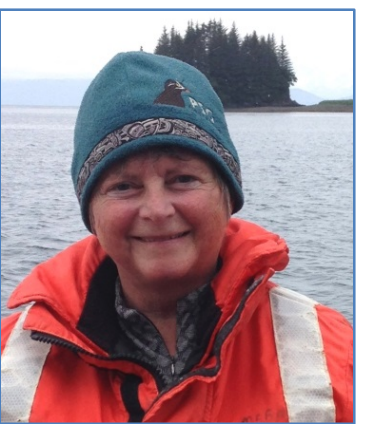


# Pacific Arctic seabird communities in a time of change

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## Introduction

Rapid changes are altering the northern Bering-Chukchi Sea ecosystem. We joined multiple vessel-based research projects to monitor seabirds in the Pacific Arctic, including within the “Distributed Biological Observatory (DBO)” (Fig. 1). We surveyed 144,920 km during 2007-2018 (Fig. 2). We summarize community composition, abundance, and trends information derived from these surveys. We have also begun to analyze relationships among seabird and prey communities and habitat associations. We will continue surveys at least through 2021.

## Methods

- Conduct surveys as part of vessel-based ecosystem projects, such as **AMBON** (Arctic Marine Biodiversity Observing Network), **ArcticIES** (Arctic Integrated Ecosystem Study), the **DBO**. Data from 2007-2015 during June 16 – Nov 19
- Visual obs., strip transect with distance ‘bins’ to 300m
- Single observer records in GPS-integrated laptop; Dlog3 software (A.G. Ford, Inc, Portland, OR)
- Calculate density (birds/km<sup>2</sup>) in ~3-km segments
- Examined species richness, abundance, distribution
- **Preliminary:** long-term trends, relationships to environmental drivers, and prey associations (zooplankton, fish)

## Abundance & Distribution

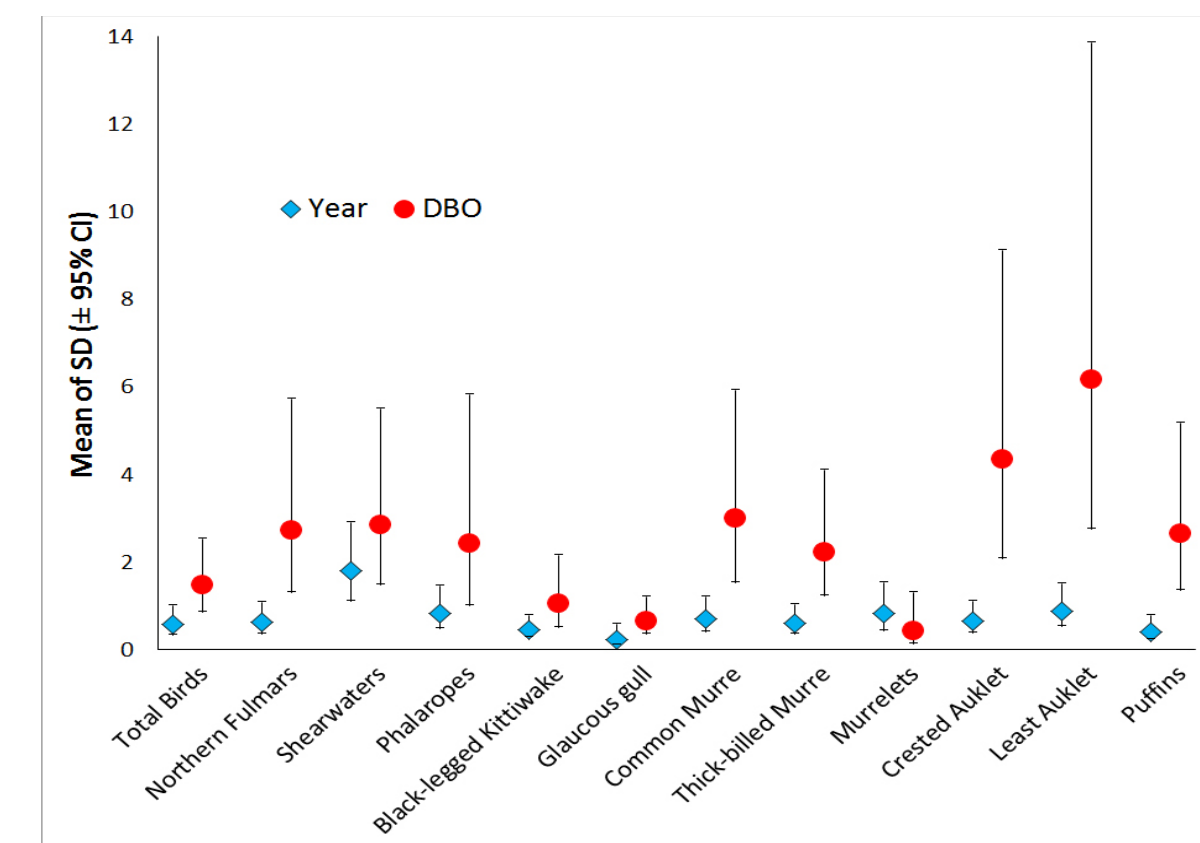


Fig. 3. DBO vs Year (2007-2015). SD of log expected density ( $\pm$  95% CI) for site and year, among 8 DBOs and 9 years. Location had less variance than Year.

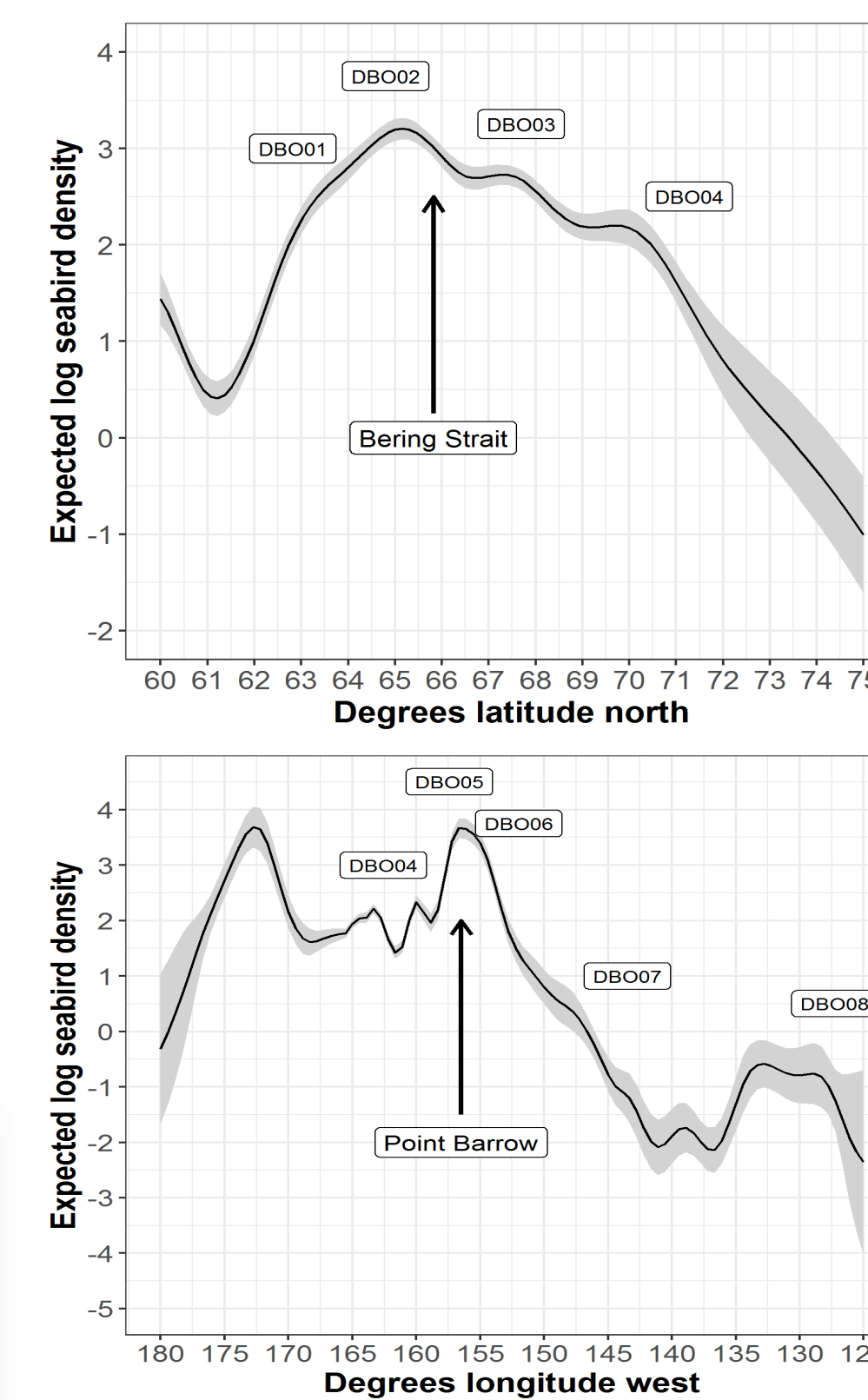


Fig. 4. Modeled total seabird density (log expected count/3-km segment  $\pm$  2 SE) by latitude (top) holding longitude constant at 168°W, and by longitude (bottom) holding latitude at 71°N. DBO locations shown by boxes.

## Seabird Communities

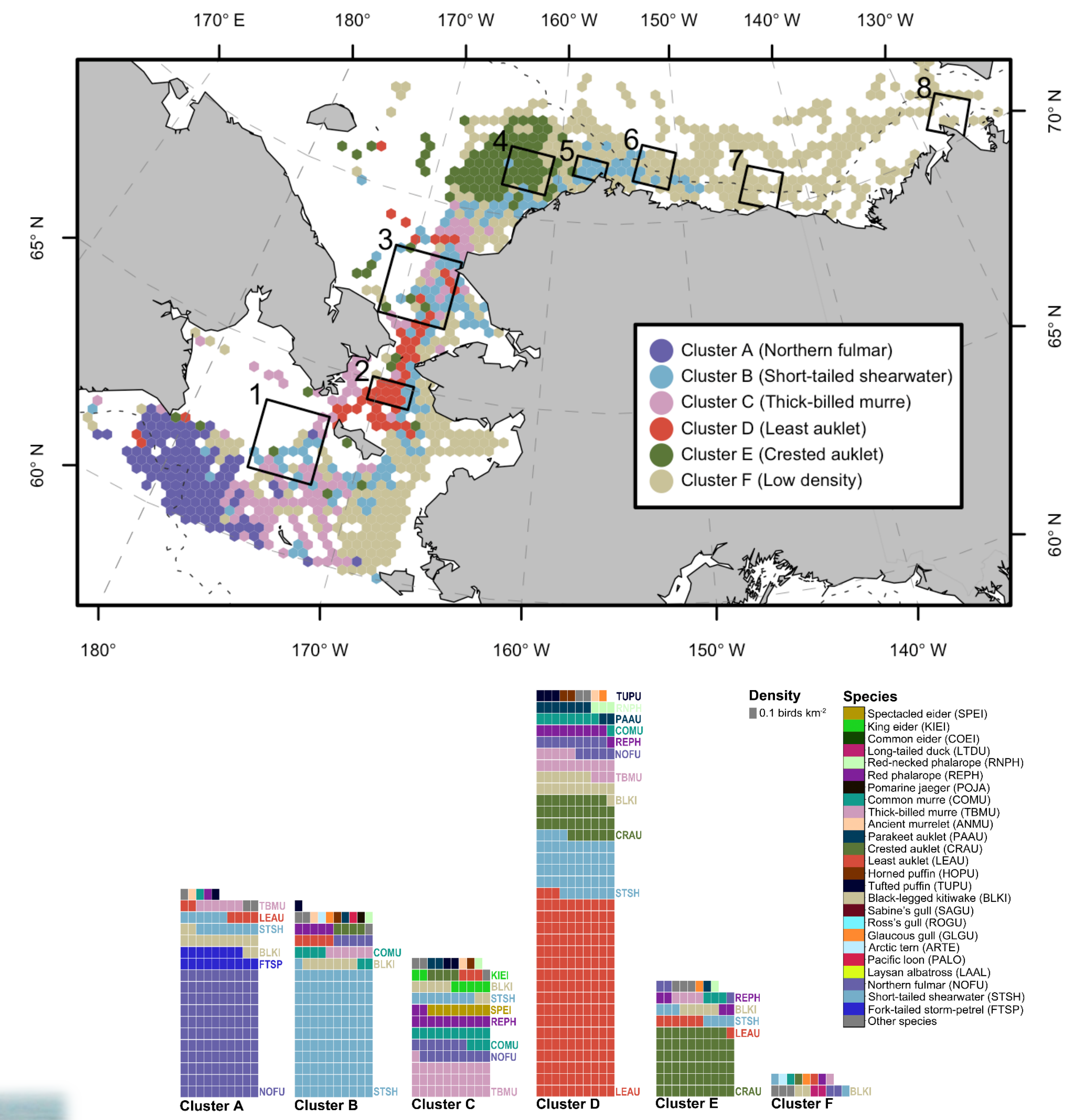


Fig. 7. Six communities identified by K-means Cluster Analysis, mapped to 30-km hexagonal grid (top). Colors show distribution of community types, referred to by their most abundant species. Full species composition of each cluster is in waffle graph (below).

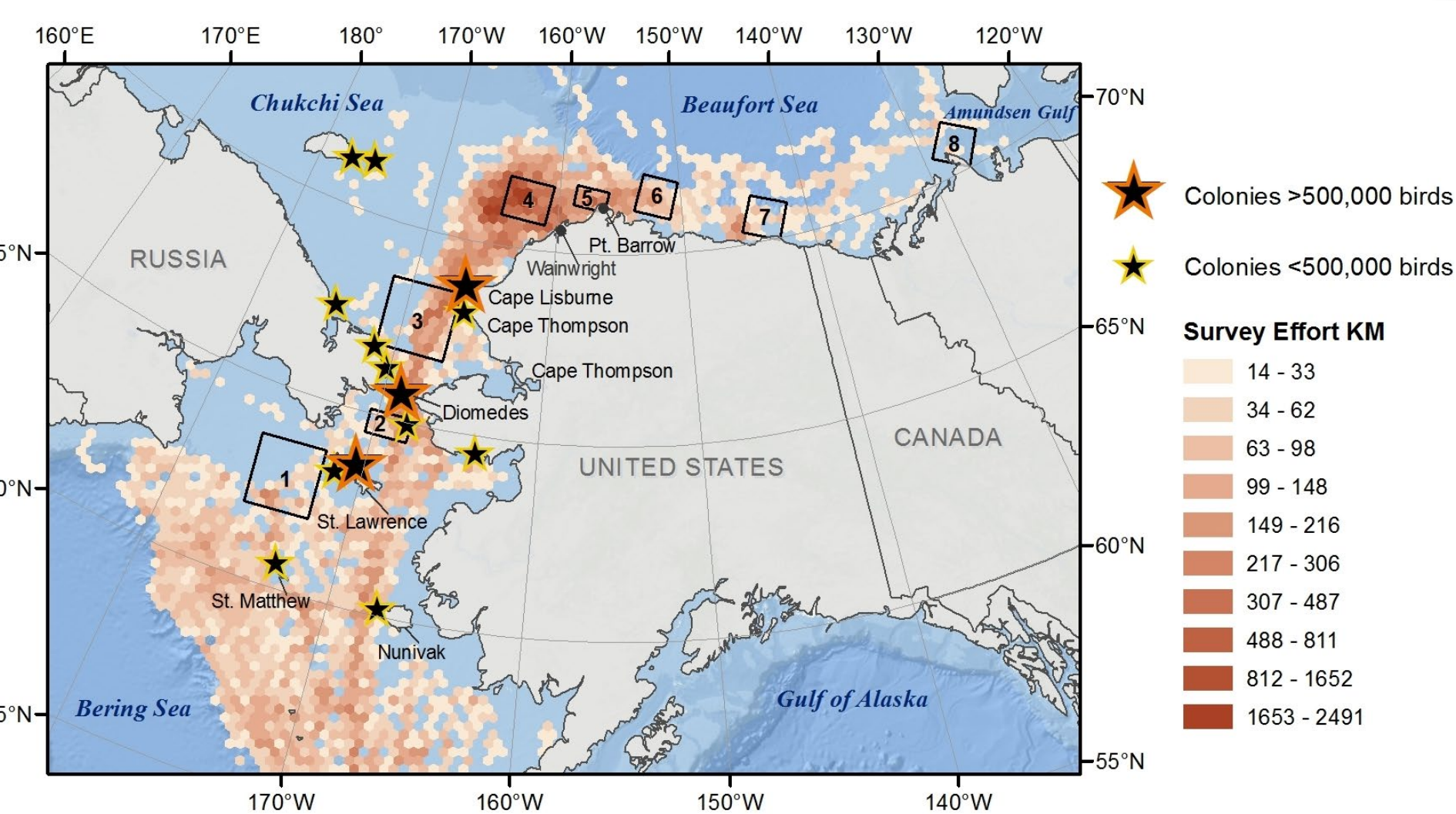


Fig. 1. Study area showing DBOs (open black boxes), major seabird colonies (stars), and km of survey effort (orange cells), 2007-2015 (used for most analyses shown).

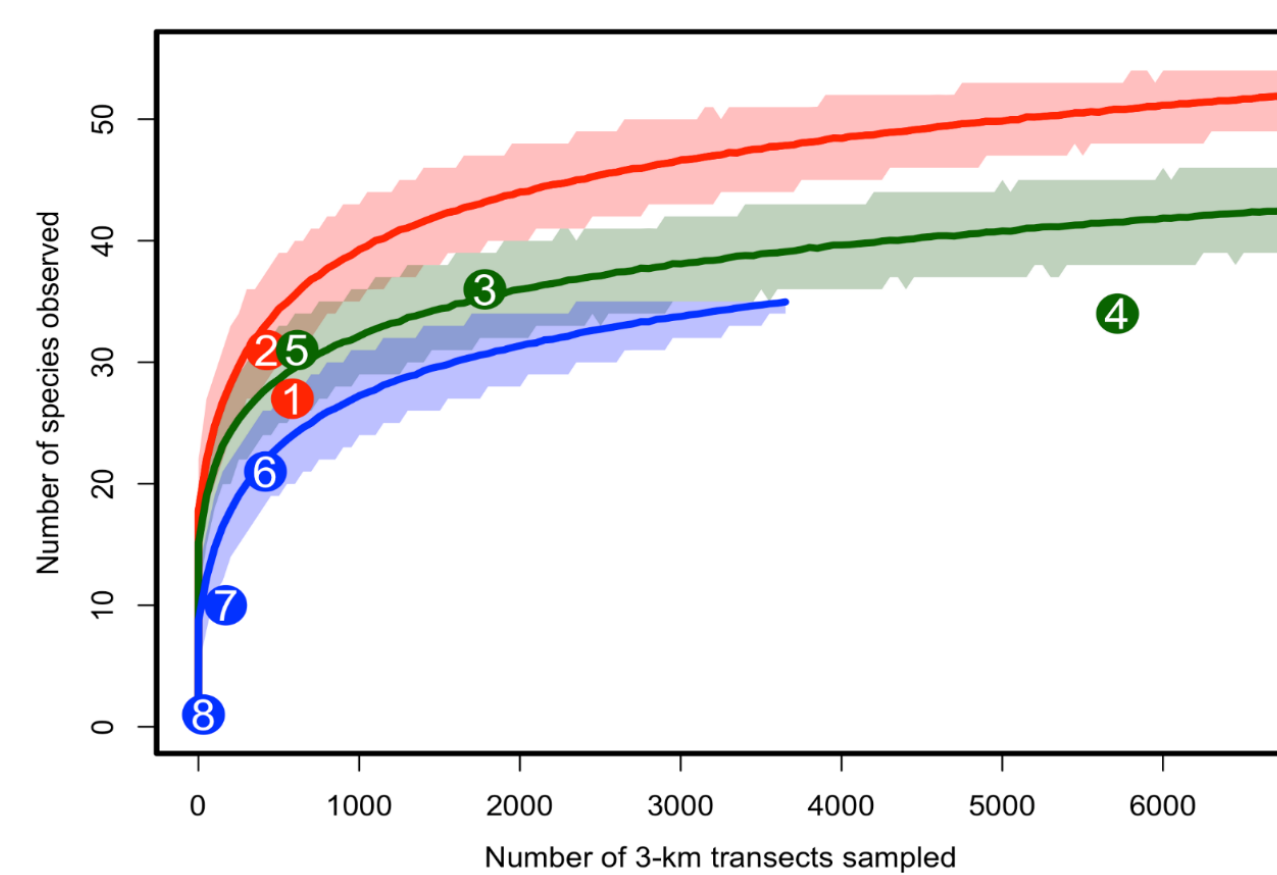


Fig. 2. Predicted species richness N. Bering (red), Chukchi (green), Beaufort (blue). Observed species richness for Distributed Biological Observatory sites (DBOs) in colored circles. Predicted values generated by random selection of 3-km transects.

## Trends & Associations

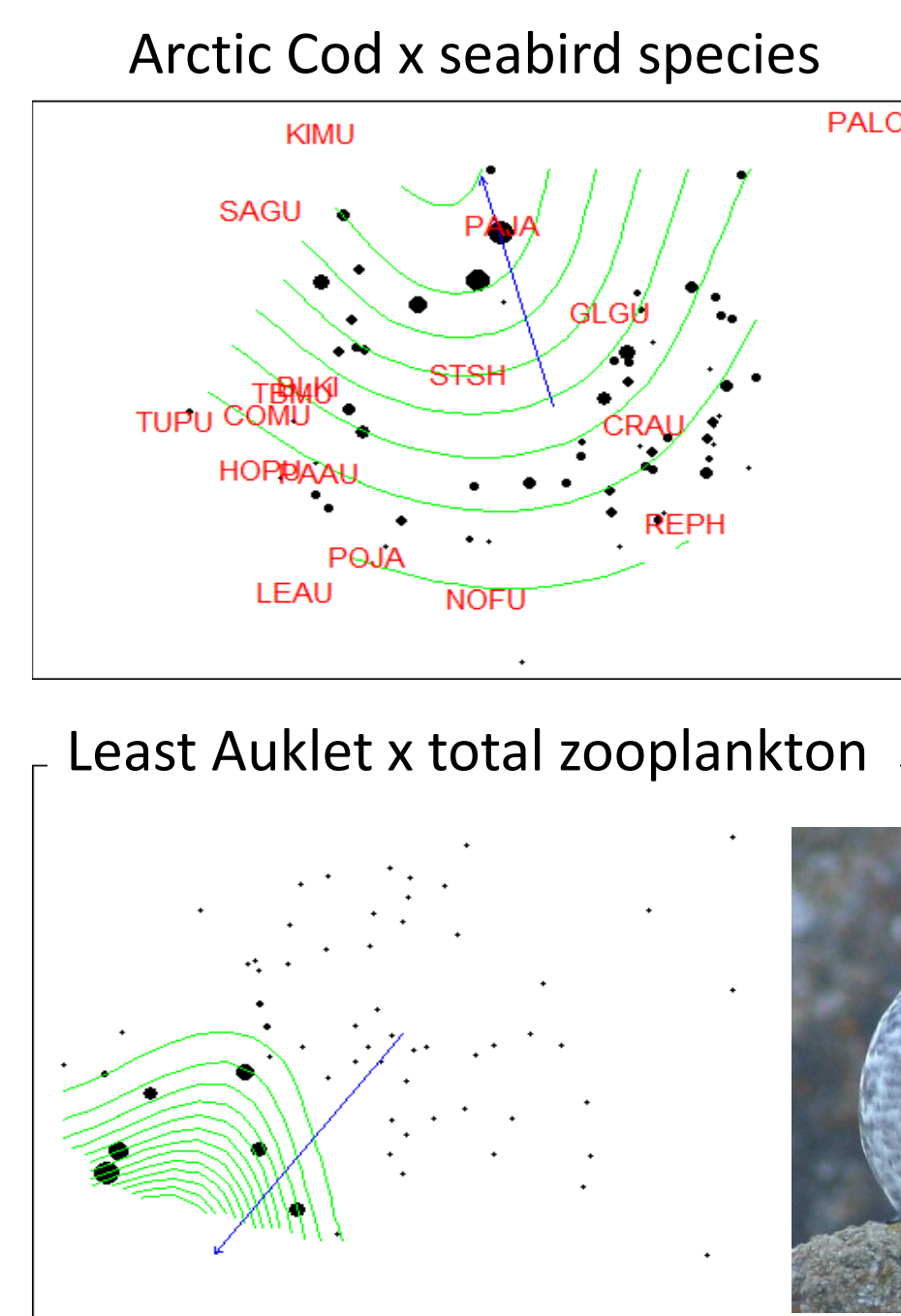


Fig. 5. Preliminary analysis of cross community indicators; data from AMBON (Chukchi Sea) in 2015. Mantel correlations among communities, & a species' abundance from community A, associated with best NMDS ordination of community B (top, Arctic cod x bird species). Strongest correlation was for planktivorous Least Auklet x zooplankton (bottom;  $R^2$  0.85,  $P$  < 0.000).

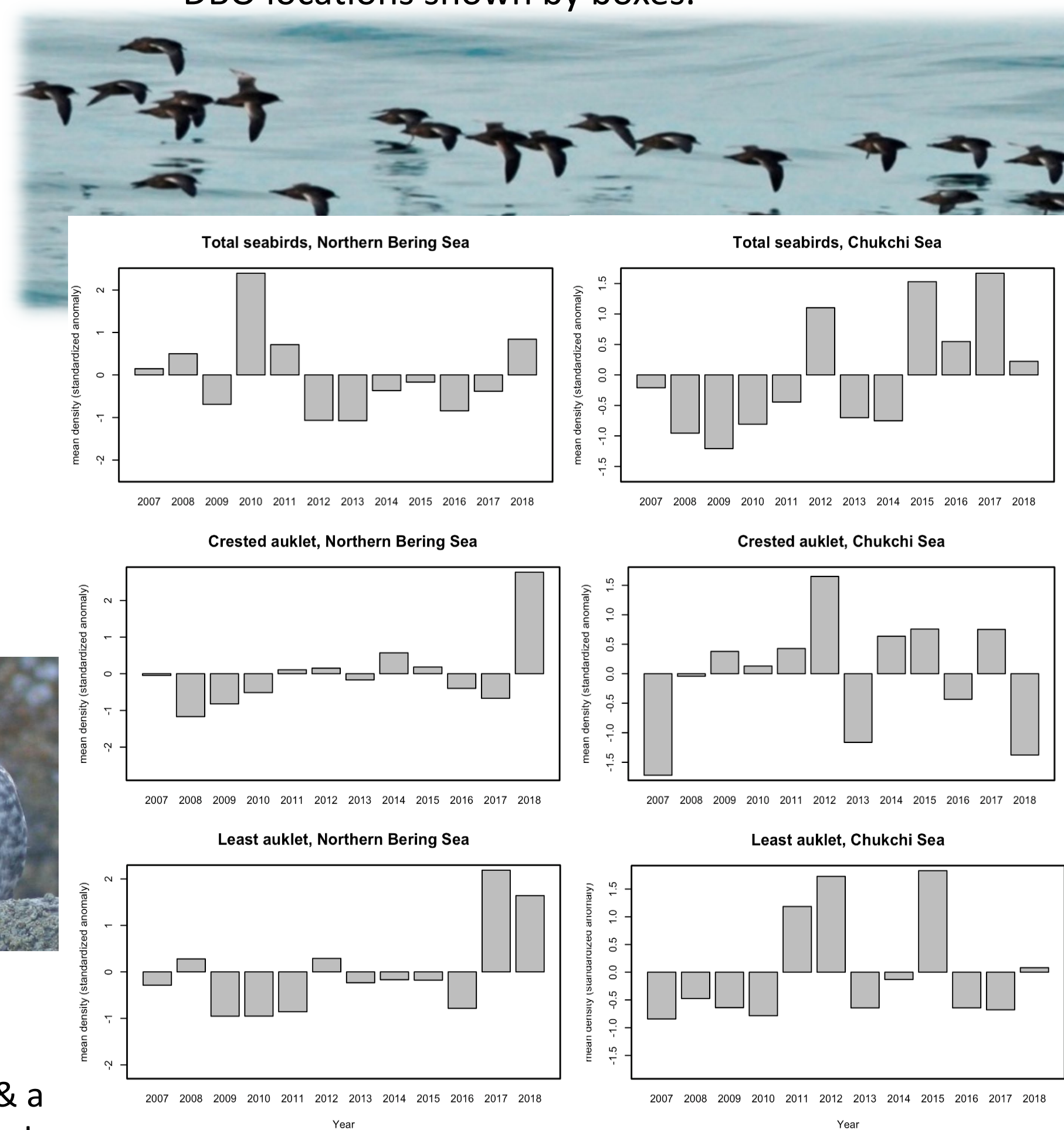


Fig. 6. Standardized anomalies of mean density, from 2007-2018, for total birds (top) and two auklet species (2 bottom rows) in the northern Bering and Chukchi seas.

## Results & Discussion

- Strong location (DBO) effect; also latitudinal & longitudinal gradients in seabird abundance.
- Bering Strait & Point Barrow/Barrow Canyon have high seabird densities; potential high-risk from traffic.
- In Chukchi Sea, planktivorous seabirds correlated with prey, but piscivorous seabirds did not – possibly due to colony effects on latter.
- Six seabird communities identified, with five having one predominate species and one (more nearshore and in Beaufort Sea) with very low density of mixed species.
- Evidence of shift from N. Bering into Chukchi for many species since 2007, but in 2017 & 2018 (anomalously warm), auklets didn't go to Chukchi after breeding, but appeared to stay in N. Bering.
- DBOs reflect regional seabird community, and it is cost effective to collaborate with long term projects (e.g. AMBON, AIERP, ASGARD, DBO)

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