Project information

Keywords

Seabirds, phenology, ocean climate

Project title

Timing of reproduction in seabirds: large-scale comparisons, and links to population dynamics, climate and lower trophic levels (SEATIME)

Year

2017

Project leader

Contact leader: Zofia Burr, University Centre in Svalbard; University Centre in Svalbard leader: Øystein Varpe; Norwegian Polar Institute leader: Sébastien Descamps

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)

67,43ºN &11,87ºE and 70,37ºN & 31,13ºE

Participants

Norwegian Polar Institute: Sébastien Descamps
University Centre in Svalbard: Øystein Varpe and Zofia Burr
NINA, Tromsø: Tone Reiertsen and Kjell Einar Erikstad
UiT The Arctic University of Norway: Rob Barrett
Akvaplan-niva: Øystein Varpe
NINA, Trondheim: Tycho Anker-Nilssen and Børge Moe
IMR, Bergen: Mari Myksvoll and Frode Vikebø
Uni Research Climate, Bjerknes Centre for Climate Research: Michel d. S. Mesquita

Flagship

Fjord and Coast

Funding Source

Fjord and Coast Flagship in the FRAM Centre

Summary of Results

The aim of this project is to address ecological responses to changes in environmental conditions through the study of timing of seabird reproduction. Results from this work include analyses of seabird breeding timing at two spatial scales: (1) a comparatively smaller spatial-scale comparison of two mainland Norwegian colonies, and (2) a complementary pan-Arctic scale.

For the Norwegian colonies, we have compiled long-term data sets on phenology and breeding success for two study species: puffins (*Fratercula arctica*) on Hornøya and Hernyken, Røst and kittiwakes (*Rissa tridactyla*) on Hornøya. We quantified inter-annual variability and tested for changes temporal trends in breeding timing and in environmental covariates. Relevant environmental variables that represent marine and terrestrial conditions were gathered from available online data sources or from project partners who have environmental data available for use: average April-May air temperatures from local weather stations, average April-May sea surface temperatures from the Hadley Centre Meteorological Office's HadISST data set, average December-March inflow of Atlantic Water through the Fugløya-Bjørnøya section, and average December-March speed of coastal current near Hernyken, Røst. There were no significant advancements or delays in breeding timing for puffins or kittiwakes at either colony.

We used statistical model selection using environmental predictors (local air temperature local sea surface temperature for both colonies, and measures of Winter Atlantic Water inflow to the Barents Sea for Hornøya only and the Winter Norwegian Coastal Current for Hernyken only) and our seabird hatching timing data series as responses. Based on AICc, the best model for puffins breeding timing at Hornøya was air temperature (potentially as a proxy for snow melt and therefore burrow access). For kittiwakes at the same colony, the best predictor was Atlantic Water inflow. This result highlights the difference in mechanisms; the former is a terrestrial limitation to breeding timing and an abiotic mechanism that is highly related to climate change, while the latter is a large-scale oceanographic mechanism with implications for lower trophic-level (therefore prey) dynamics. For puffins breeding on Hernyken, the results for breeding timing were less clear. While there is co-variability in air and sea surface temperatures between the two colonies, puffin breeding timing is not related between the two colonies. For kittiwakes on Hornøya, breeding success was related to breeding timing, such that in years of earlier breeding the average number of chicks per nest was higher; however, we found no relationship for puffin breeding success and timing at either Hornøya or Røst.

A pan-Arctic database on seabird breeding timing has also been created through this project. We have extracted over 2,400 seabird hatching dates for approximately 30 species from literature and other data sets, and have extracted corresponding environmental covariates. Main results include that the spring onset (based on SST dynamics) has advanced more rapidly in the Pacific (-0.29 day.year^{-1}) than in the Atlantic (-0.12day.year^{-1}) even if the difference is not significant. When looking at seabird breeding timing by foraging behavior type, we found surface feeders breed on average 10 days earlier in 2016 than in 1982 but only in the Pacific and divers have not changed their breeding schedule at all in either region.This database is a unique tool that can be used to investigate changes in Arctic seabird populations in response to the warming of their environment, and highlights spatial and life-history variability in response to environmental conditions, notably SST.

Through this project, we have also identified gaps in knowledge about mechanisms for seabird breeding timing and in the understanding of timing of important biological phenomena in lower trophic levels in the Norwegian and Barents Seas. We therefore submitted a research proposal to the Norwegian Research Council (September 2017) aimed at filling these gaps in knowledge.

Master and PhD-students involved in the project

Two master's students have been involved in this project and based at UNIS. One student, Svenja Halfter, finished her thesis titled 'Long-term phenology of marine plankton in the North Atlantic and Arctic Ocean' in May 2017. A second student, Elinor Tessin, is currently working on her master's thesis titled 'Spatial variability in timing of pelagic primary production in the Nordic Seas: drivers and relationships with latitude' with expected completion in Spring 2018.

For the Management

We quantify when seabird hatching timing occurs within the annual cycle at several locations, and examine how this ecological event is changing over time. Further, we improve upon the understanding of the mechanisms that drive seabird breeding timing, which provides insight into how biological systems are coupled to physical environmental conditions. In addition, it is essential to know when important events that have implications for populations are happening in order to plan appropriately or react correctly in the case of an unforeseen event, such as an oil spill. We also provide the first results at such a spatial (circumpolar) and temporal (1982-2016) scale about the phenological response of top/meso predators to changes in spring onset. We further highlight that there are spatial and life-history variability in these responses to climate change, which should be considered when making management decisions.

Published Results/Planned Publications

Two articles directly resulting from this project are in well-developed draft format and will be submitted either by the end of 2017/early 2018 on the following:

1) Seabird breeding phenology in the Norwegian and Barents Seas: spatial and species comparisons in relation to environmental conditions

2) Are Arctic seabirds breeding earlier as a response to Arctic warming?

Communicated Results

Communication in 2017:

Conference presentations:

1. Varpe Ø. Society for Integrative and Comparative Biology annual meeting. Evolutionary Impacts of Seasonality Symposium. New Orleans. January 2017. Title of presentation: Life History Adaptations to seasonality.
2. Burr et al. Pacific Seabird Group Annual Meeting. Tacoma, Washingtom. February 2017. Poster title: Timing of Reproduction in Seabirds: Large-scale Comparisons and Links to Population Dynamics, Climate and Lower Trophic Levels.
3. Varpe Ø. 23rd European Meeting of PhD Students in Evolutionary Biology. Sept 2017. Krasiczyn Castle, Poland. Plenary speaker and mentor. Title of presentation: Life History Adaptations to seasonality.

Invited lectures:

1. Burr Z. Hjort Centre Seminar Series. May 2017. Presentation title: Seabird breeding timing: a response to local or large-scale processes?

Teaching/outreach:

1. Project content used as teaching material during University Centre in Svalbard Bachelor Course *AB-204, Arctic Ecology and Population Biology*, Fall 2017 taught by Øystein Varpe with guest lecture by Zofia Burr.
2. Phenology and seabird exhibit at UNIS Open Day, November 2017

Interdisciplinary Cooperation

This project has connected several disciplines through building a group of biologists, oceanographers and a climatologist to ask questions about what environmental factors might influence how seabirds schedule breeding timing, with opportunities to provide insight on other ecosystem components through linking biological and physical conditions. We represent 8 institutions, including climate institutes outside of the Fram Centre, such as the Bjerknes Centre for Climate Research and Uni Research Climate, and through this collaboration have included mechanistic physical-biological coupling perspectives and ocean climate data in our analyses that would otherwise have been challenging.

Budget in accordance to results

The budget has been used as planned for the following:

- 175,000 NOK on salary at UNIS for Zofia Burr. She has taken care of administrative aspects of the project, analyzed data, lead the preparation of one manuscript, and contributed significantly to the research proposal submitted to the Norwegian Research Council.
- 75,000 NOK has been spent on researcher travels and conferences/meetings and salary related to this.
- 100,000 NOK for salary at NP for development on Arctic seabird phenology

Could results from the project be subject for any commercial utilization

No

Conclusions

This study links an annual biological event to physical environmental conditions, thus highlighting potential responses to global climate change. We have shown results for temporal trends in breeding timing that identify regional and life-history differences, and we have identified substantial inter-annual variability in breeding timing for which we provide some mechanistic explanations. Finally, we show that breeding timing is correlated to the yearly breeding success of seabirds in kittiwakes at a Barents Sea colony.