Project information

Keywords

Foraging behavior, bird movement, atmospheric-oceanic covariates, climate, oceanography, prey distribution, cod-larvae

Project title

An integrated approach to understanding weather-ocean interactions along seabird feeding routes (MOVECLIM)

Year

2015

Project leader

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Participants

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Flagship

Fjord and Coast

Funding Source

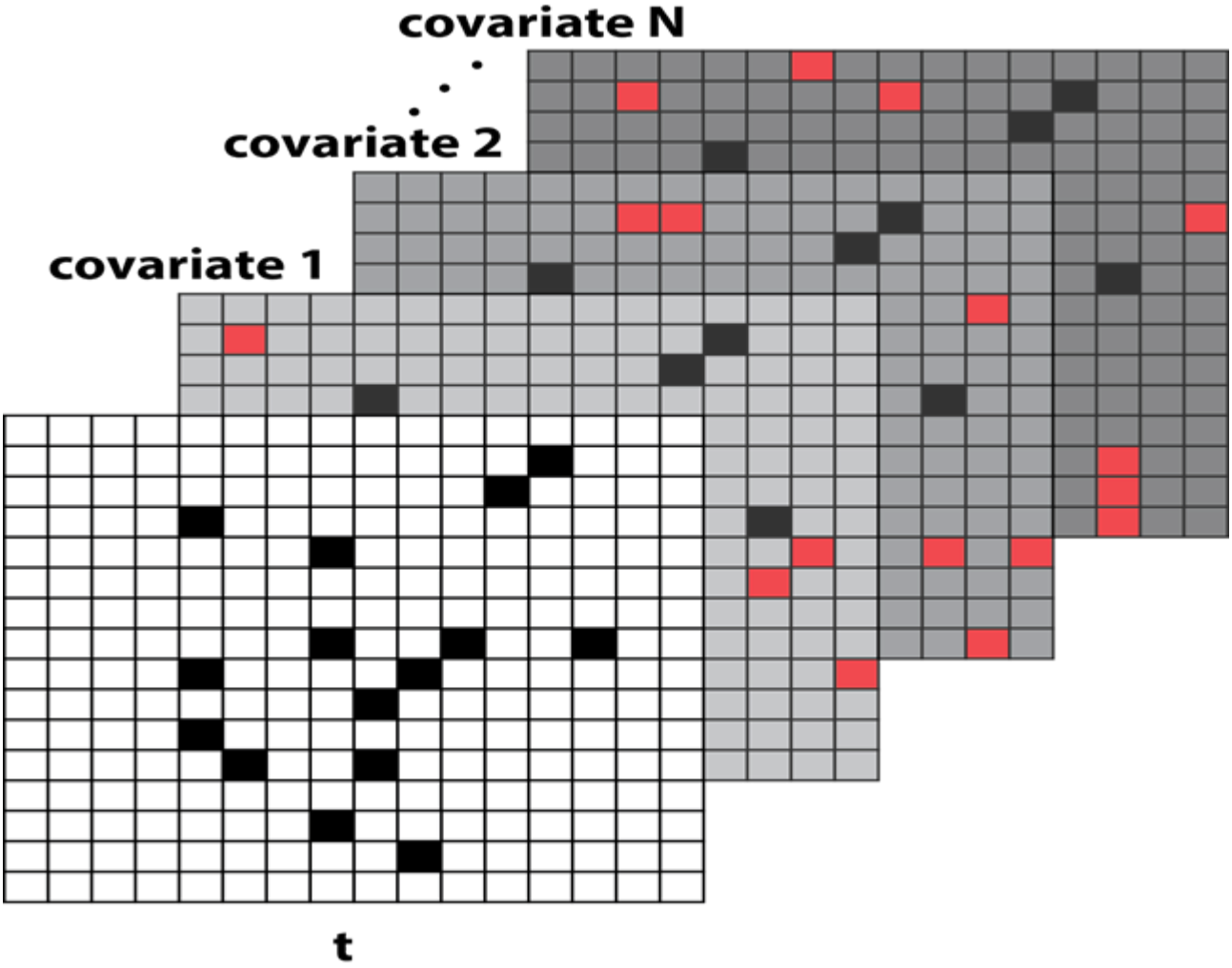
The falggship Fjord and Coast

Own funding NINA

Summary of Results

This project is intended to last for two years. This year which is the first year, the intention is to create a database on seabird movement and climate covariates. The database consist of seabird positions on land, air and sea, including relative distance from colony, as well as a list of variables provided through the GPS system derived from the GPS tagged birds. All these track variables will be tagged as individual sample of flight behavior. Alongside the track variables, atmospheric and oceanic covariates will be added to the database.

The phase two of the project will be to make use of different statistical techniques and plotting procedures in order to make sense of the collected data. The information then obtained through these exploratory analyses will then inform the multivariate analysis to provide further insights. With the information gathered above, a hierarchical Bayesian model will be fitted using the covariates that are most relevant. These analysis makes it possible to identify the probability that a seabird is found in a specific feature grid box (see fig 1)



Figur 1. Figure showing the principle behind feature point identification. The foreground map is the bird movements, showing feature points (black boxes) identified at time t based on agreement between covariates. Background maps: covariates at time t used in the identification process, where red boxes are points that do not match among the covariates and are therefore not identified in the map, and black boxes are points that match. The procedure is repeated for each time step t, t+1,…t+z in the range z.

A) **B)**

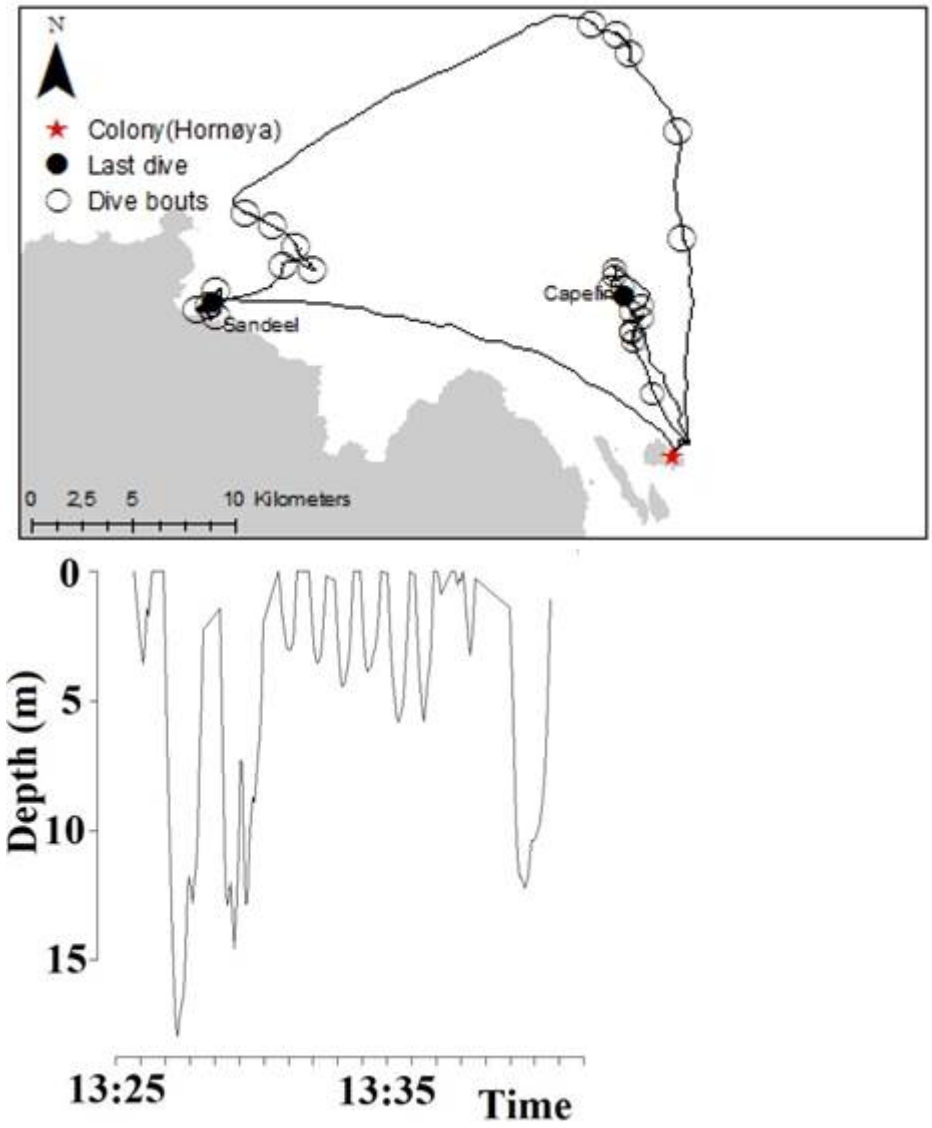


Figure 2 An example of two feeding routes (left) out of a total of 185 of guillemots from the present study population by the use of GPS loggers and dive depth loggers (TDR) and type of data entered to the data base. Open circles indicate areas of diving and where the birds feed themselves and black dots the last dive where they catch a capelin or a Sandeel which they bring to the chick. The figure to the left shows a diving profile during the last diving bout for the bird catching the capelin for the chick before they return to the colony.

The phase two part of this project will be finished during 2016, and will lead to two papers dealing with questions around fine-scale movement of a central place forager, the Common guillemot. The questions we are asking is; is the flight of seabirds to obtain food random? Is it related to climate variables, such as wind direction, surface temperature or rainfall? Is it related to the concentration of different fish species

around or away from the colony? Is the choice of dive location related to oceanographic features? The answers of these questions, by using the type of approach explained above, will add important new knowledge to the study of bird movement under different climate change scenarios. The outcome of this project will also open doors to a number of future proposals, which the group will work actively to continue.

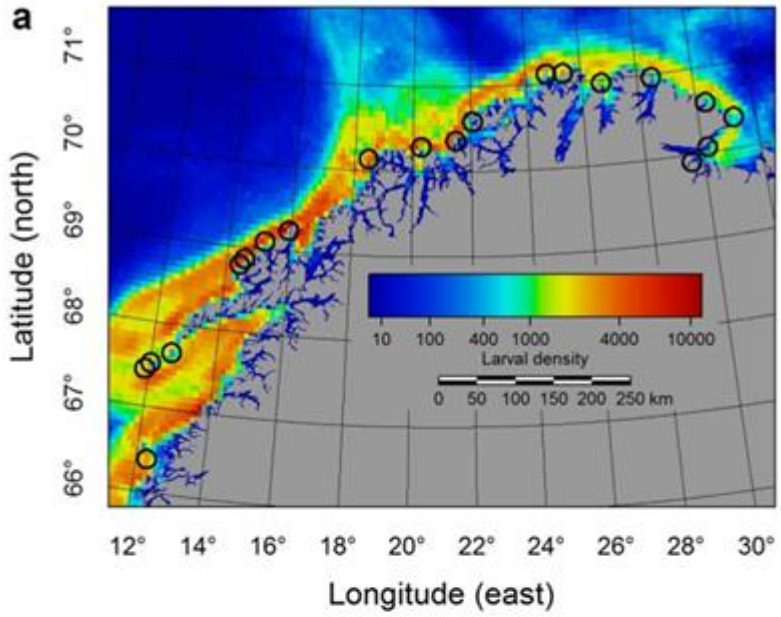
The project is a module derived from a larger project, funded by Incentive funding and funding from the Flagg ship Coast and Fjord from the Fram Centre together with a NFR project ("cod larvae-drift project"). This project was stimulated by the findings of differential diet between adults and chicks, consisting of cod-larvae and mainly capelin for adults and chicks respectively. Additionally, a study of common guillemot's growth rate on Hornøya, seeking out to explain which prey type had the strongest effect on the population growth rate, found that a direct effect of 0-group cod explained most of the growth rate, and indicated an effect through adults.

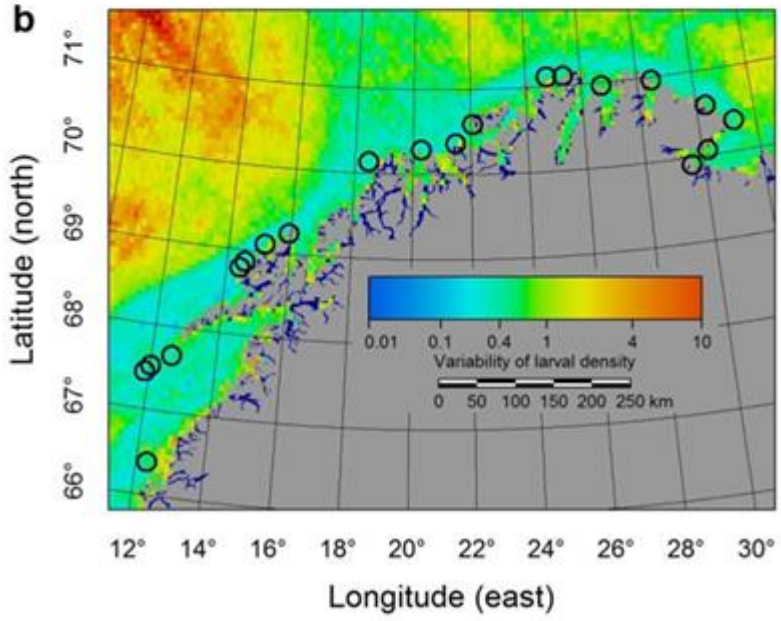
Earlier findings from this larger project are the background of why we find it important to reveal the fine-scale movement patterns and the environmental causes behind this, in order to improve our understanding of how and why seabirds find food during their vulnerable state of breeding.

On larger scales it has been shown that the drift of cod larvae with the Norwegian coastal current (NCC) along the Norwegian coast line towards the Barents Sea, together with the coastal morphology show a strong and significant relationship with the occurrence of the largest seabird colonies in Norway (Sandvik et al. (in review in Nature communications). Drift models of cod and herring larvae, which are ocean model hindcast to quantify the drift of particles, e.g. eggs and larvae, from fish spawning grounds along the coast and their interaction with the physical environment, provides a proxy of the number and biomass of ichtyoplankton anywhere along the coast on a spatial of 4 x 4 km. The larval drift models show clearly that spawning products are not uniformly distributed along the entire Norwegian coast into the Barents Sea, but aggregate in patches with widely varying concentrations. The existing seabird colonies are located close to areas where larvae concentrations are higher than average for the respective coastal segments. Patches close to seabird colonies with low interannual variability in prey abundance showed an even stronger relationship, indicating that seabird colonies are systematically located along the North Norwegian coast to give a much better and more stable, i.e. predictable, access to suitable food than randomly

chosen locations. The results in this paper also shows the significance of cod-larvae in this respect, and argue that cod-larvae play a very important role in determining the large scale distribution of breeding colonies of seabirds along the Norwegian coast, which gives strong implications for the management of seabirds. The models also shows that the most important cod spawning area, determining the predictability of cod-larvae aggregations along the cost was the Lofoten spawning grounds, implying that if a disturbance occurs in this area it will have tremendous effects on 19 out of 21 of the Norwegian larger seabird colonies.

Figure 3.
a) Map of seabird colonies and sites of high modelled larval abundance. There are more high-abundance grid cells within the circles than expected by chance (P = 0.014).
b) Map of seabird colonies and sites of high predictability (low variability) of modelled larval density. There are more low-variability grid cells within the circles than expected by chance (P = 0.0003).





On a smaller scale this project lead to the understanding of the relationship between cod larvae and various climate variables determine the optimal prey selection by Common guillemots during the breeding season.

For the Management

Results from the project, both the large scale and the small scale approach, have high relevance for conservation authorities. The drift of cod fish larvae especially from the Lofoten area are of great importance for all seabird colonies along the coast of

northern Norway. The small scale approach gives detailed description of feeding areas around colonies and important knowledge for any oil pollution and drift of oil from planned and already opened oil fields in the Barents Sea area.

Published Results/Planned Publications

Barrett, R.T., Erikstad, K.E., Sandvik, H., Myksvoll, M., Jenni-Eiermann, S., Kristensen, D.L., Moum, T., Reiertsen, T.K. and Vikebø, F. 2015. The stress hormone corticosterone in a marine top predator reflects short-term changes in food availability. Ecology and Evolution 5(6): 1306-1317.

Benjaminsen, S., Reiertsen, T.K. and Erikstad, K.E. Foraging behaviour of chick-rearing common guillemots, recorded by GPS and time-depth recorder devices (manuscript Plos One)

Sandvik, H., Barrett, R.T., Erikstad, R.T. Myksvoll, M.S.,Vikebø, F.,Tycho Anker-Nilssen, T., Lorentsen5, S.-H.,Reiertsen, T.K.,Skarðhamar,J., Skern-Mauritzen, M. & Systad, G.H. Drift patterns of fish larvae link coastal morphology to seabird colony distribution (Nature Communication in revision).

Mesquita, M.d.S., Erikstad, K.E., Sandvik, H., Barrett, R.T., Reiertsen, T.K., Anker-Nilssen, T.,Hodges, K.I., Bader, J. 2015. There is more to climate than the North Atlantic Oscillation: a new perspective from climate dynamics to explain the variability in population growth rates of a long-lived seabird. Frontiers in Ecology and Evolution http://dx.doi.org/10.3389/fevo.2015.00043.

Planned

Erikstad, K.E., Mesquita, M.d.S, Reiertsen, T.K., Benjaminsen, S., Sandvik, H., Hodges, K., Vikebø, F., Myksvoll, M.& Skarðhamar,J. An integrated approach to understanding weather-ocean interactions along seabird feeding routes.

Communicated Results

The large scale larvae drift project has been communicated in a number channels like conferences, radio, newspapers and TV. A particular outreach channel has been established in this respect for 2016, viz. a co-operation between NRK, SEAPOP and NINA, whose aim is to increase public focus and awareness of seabird populations and their status. NRK will during the breeding season 2016, broadcast live from the seabird colony Hornøya both online and on national TV during the best broadcasting time. The

live broadcasting involves 15 cameras that will be put out in the colony, covering most species, and the public can follow individual nests/families throughout the breeding season. Some of this live broadcasting will also be sent over several days on NRK2 (according to the concept "slow TV"). Additionally, they will have half an hour live broadcasting with different reports and coverage from seabird work, once every week during the best broadcasting time, where different themes related to seabirds in general will be highlighted. Any results from studies about seabird's, climate and population trends will be of great interest in this respect. NRK has agreed that we can use such a seabird-project as a channel for communication (responsible producer in NRK is Nils Arne Sæbø; responsible organiser at NINA is Tone Kristin Reiertsen).

Interdisciplinary Cooperation

The project has two climatologists, who bring climate covariates through the use of state-of-the- art data sets; three ecologists who are well trained in behavioural ecology and modelling. This makes this project quite unique in that it considers an integrated view of the system, using information from the atmosphere, ocean, and modelling. Especially the cooperation with climatologist has given new insight to study the effect of climate in population ecology. This cooperation was stimulated by funding from the Fram Center (incentive finding and the Flaggship in Coastal Ecology). A recent publication by most the same project team on the use of climate models in population ecology has been given great attention both nationally and internationally;

Mesquita, M.d.S., Erikstad, K.E., Sandvik, H., Barrett, R.T., Reiertsen, T.K., Anker-Nilssen, T., Hodges, K.I., Bader, J. 2015. There is more to climate than the North Atlantic Oscillation: a new perspective from climate dynamics to explain the variability in population growth rates of a long-lived seabird. Frontiers in Ecology and Evolution http://dx.doi.org/10.3389/fevo.2015.00043

An application to NFR relevant for the present project for the new "toppforsk initative" was developed with a budget of 20 mill NOK over 4 years; Hemispheric-scale population dynamics; A novel approach to disentangle atmosphere–ocean–seabird interactions (HEMIPOP) from 2016-2019. The aforementioned will promote a better understanding of the relationship between seabird variables and atmospheric-oceanic covariates. Kjell Einar Erikstad at NINA is the project coordinator.

Budget in accordance to results

The funding from Fram and the own funding from NINA has been sufficient to build the database for the use for the analyses the second year.

Budget per partner[1]

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Partner	Specification	Amount per year (in thousand kroner) 2015	2016
NINA	Salary	180	200
	Workshops		100
NTNU	Salary	0	100
Institute for Marine Research	Salary	50	0
Uni Research Climate and Bjerknes Centre	Salary	100	100
University of Reading	Salary	70	0
Subtotal per year		400	500

[1] All data are already available. The costs only cover salaries for analyzing GPS and time depth loggers, building databases, Bayesian modelling and a workshop the second year. Two of the researches at NINA (Kjell Einar Erikstad and Tone Kristin Reiertsen) will in addition use 100h each year of own funding (egenforskning), equalling a cost of 270 000 NOK

Could results from the project be subject for any commercial utilization

No

Conclusions

The research group carrying out this project has already been at the forefront of certain fields in the life-history evolution and climate ecology of seabirds,and also expect to have success with the present project. The group is centred around institutions (**NINA**, **UiT and IMR**) at the FRAM Centre and have a long history of cooperation within the SEAPOP programme, which coordinates the surveillance of Norwegian seabird populations. This strong team has in the recent years been supplemented by population ecologists from a Centre of Excellence at NTNU, and by climatologists from the Bjerknes, Centre and the Max Planck Institute. These interdisciplinary collaborations have have already resulted in several ground-breaking publications and have opened up entirely new perspectives on the effect of climate and oceanography on the dynamics of marine top-predators.