Project information

        <u>NINA</u>; Kjell Einar Erikstad**,** (kjell.erikstad@nina.no)

        <u>Norwegian Polar Institute</u>**;** Hallvard Strøm (hallvard.strom@npolar.no)

        <u>Institute for Marine Research</u>; Frode Vikebø (frode.vikeboe@imr.no), Mette Skern- Mauritsen (mette.mauritzen@imr.no)

        National/ International Partners:

        <u>National;</u> Tone Reiertsen, NINA Tromsø, Geir Systad, NINA Tromsø , Manuel Ballesteros , NINA Tromsø, Svein-Håkon Lorentsen, NINA Trondheim, Mari Myksvoll og Jofrid Skardhamar.

        <u>International;</u> Francis Daunt, Sarah Wanless and Mike Harris, Centre for Ecology and Hydrology, UK

Flagship
        MIKON
Summary of Results

Preliminary results and discussions

Seabird moulting and chick rearing area in relation to planned oil activity in the southeastern Barents Sea

The main goal of this project is to establish highly important knowledge relevant to the oil-industry of how and why pelagic diving seabirds are using the southeastern Barents Sea.

The southeastern Barents Sea is an area with increasing interest and concern regarding oil exploration activities. In2016 the Norwegian Minister of Petroleum and Energy awarded new licenses for oil and gas exploration in the Barents Sea. Thirteen companies have been awarded licenses and three of the licenses are in the southeastern Barents Sea (Fig. 1). Additionally, has the Ministry of Petroleum and Energy invited the oil-companies to nominate oil exploration blocks for a 24th licensing round in 2017, and the new licenses will be available during 2018. The new blocks the Ministry wants to receive nominations for are shown in fig1. Both the awarded and the planned oil-exploration licenses in the southeastern Barents Sea are located in areas that appear to be important molting and chick-raising areas for pelagic diving seabirds. Therefore, there is a strong need to increase the knowledge of how and why seabirds use this area, especially in this post-breeding period where they are especially vulnerable (see results below). The four auk-species common and brünnich guillemots, razorbills and puffins are all under concern in the Norwegian red list (Henriksen and Hilmo. 2015). Puffins are considered vulnerable, Brünnich guillemots and Razorbills are considered endangered and common guillemots are considered critically endangered. Accordingly, there is an urgent need to identify key marine areas during non-breeding season and the relationship with environmental factors in these areas for their conservation.

Fig 1. Map showing blocks where the Ministry of Petroleum and Energy have requested nominations from oil-companies for the 24. Licensing round. (Source: Regjeringen.no).
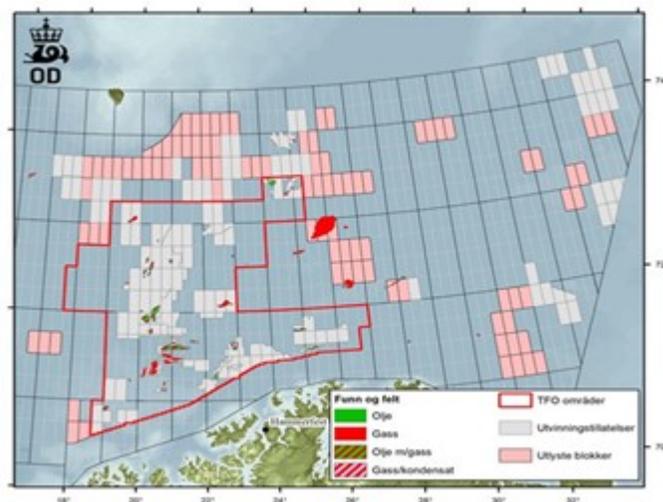
For 2017 we have constructed a database on the 4 auk species during the autumn period based on the use of miniature geolocators (Global Location Sensing, GLS-loggers). Three of the Auk species mout (Common Guillemot, Brunnich Guillemot and Razorbill) their wing feathers and are not able to fly, except for the puffin which molt at other times of the year. Additionally, do these same three species migrate from the breeding colonies where the male accompanies a flightless fledgling from the colony and into this area where they spend 6-8 weeks raising the chick. The birds are especially vulnerable during this molting and swim-migrating period, and rely on predictable food resources. The data on

spatial distribution of the four seabird species analyzed are based on a huge data base of positions from GLS over the years from 2011-2017.

In addition, we have used diving depth loggers (TDR) the year around from Hornøya in order to get information about the depth where they feed. This may help assessing the kind of fish or prey that they feed on.
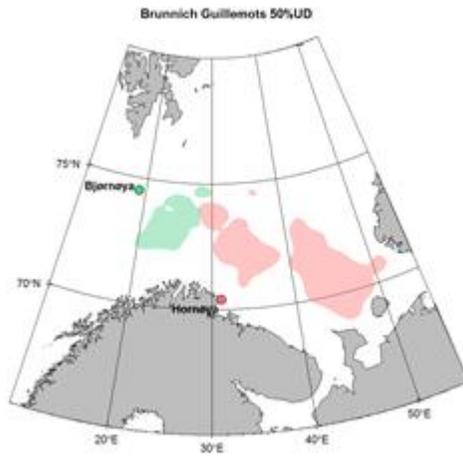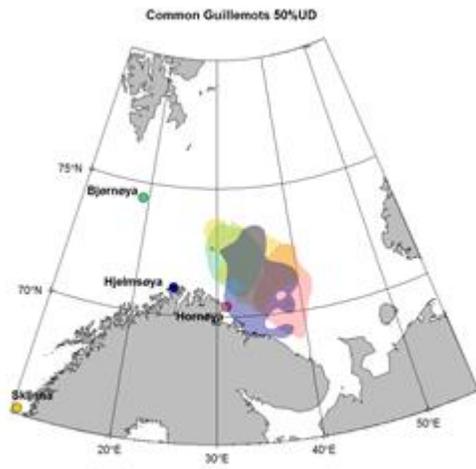
Bird distribution

All four species use the Barents Sea during autumn. Especially the Common Guillemots from the four colonies analyzed (Bjørnøya, Hjelmsøye, Hornøya and Sklinna) gather in a very restrictive area (Fig.2). These colonies cover more than 90% of the Common Guillemot numbers left in Norwegian areas. Especially Common guillemots from different colonies shows great overlap. The Brunnich Gullemots use a more northerly area. The colony Bjørnøya and Hornøya, which isthe only two colonies from Norwegian areas where brünnich guillemot breed, show a low degree of overlap during the autumn time period. For razorbills we only have data from one colony (Hornøya). The data showed that they use an area very close to the coast with some overlaps with the Common Guillemots. Puffin use a more northerly area with some overlaps with the area used by Brunnich Guillemots from Hornøya. In general, Puffins from all three colonies shows low degree of overlap in the area used.

Bird and prey distribution

The most important fish species in the Norwegian Sea and Barents Sea for seabird are the capelin (*Mallotus villosus*), herring (*Clupea harengus*), cod (*Gadus morhua*) and sandeels (*Ammodytes spp.*). The stock dynamics of these species are closely interlinked and coupled to broad-scale climatic changes (e.g. Hjermann et al. 2004). The focus species of this study are 0-group cod, 0 and1-group herring, young age-classes and adult capelin and polar cod. There is considerable overlap with 0-group fish and the areas used by the auk-species. Especially the drift of larvae from their spawning areas in the south seems to be important. This drift of spawning products by the Coastal Current and the North Atlantic current seems to be of great importance for seabird colonies in general (Sandvik et al. 2016), and most important for colonies in the southeastern Barents sea along the north Norwegian Coast (Erikstad et al 2013, Myksvoll 2013, Barrett et al. 2015). This larvae-drift from the spawning areas in the southern Norway ends up in the Barents Sea during late summer and autumn (Vikebø et al. 2011).

The distribution of capelin and polar cod is apparently outside most of the range of the seabird species at this time of the year. However, there are some overlap with the 1-group herring and also one of the krill species (Fig.3).

Common Guillemots 50%UD
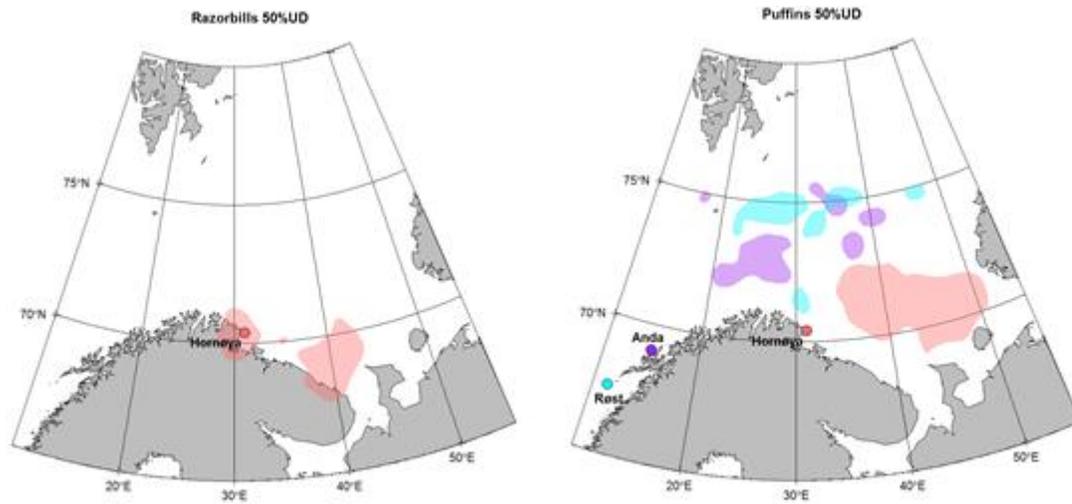

Brunnich Guillemots 50%UD

Fig.2. The 50% kernel distribution of 4 Auk species in the Barents Sea during August and September (autumn) based on a large database constructed from geolocators over the years 2011-2017 for different colonies. For the three species Common Guillemots, Brunnich Guillemots and Razorbills, this is the molting period for adults when they are not able to fly and the period when they raise their chick to independence. Puffin chicks leave the colony fully grown and have no flightless molting at this time of the year, but Puffins also use the Barents Sea area during the autumn period.

Cod   **Haddoc**   **Herring**
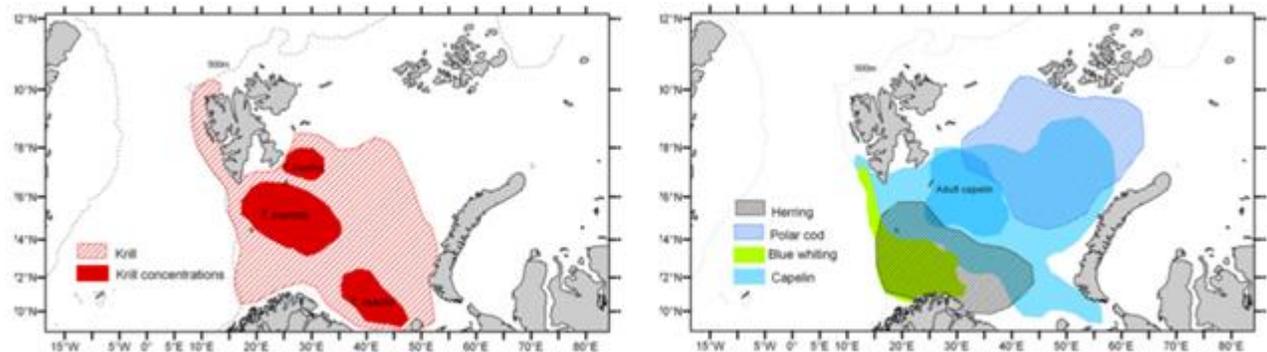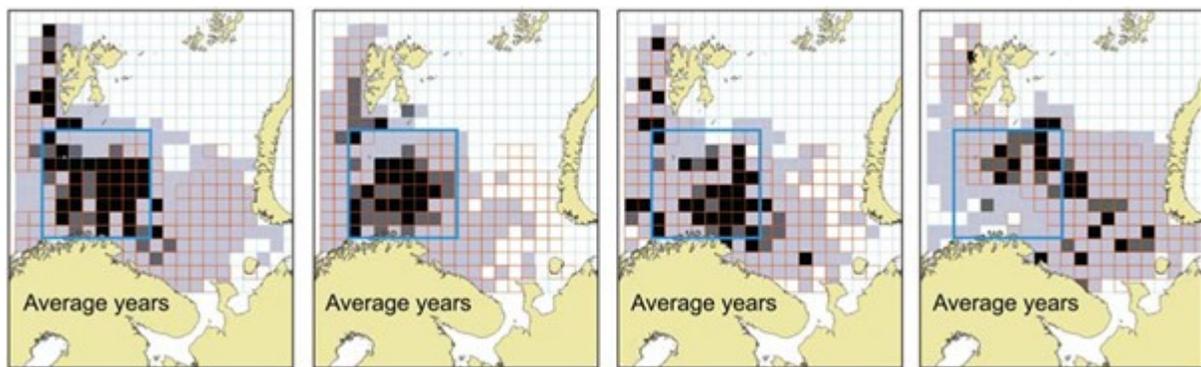**Capelin**

Fig.3. The main distribution of the potential fish and krill species during august and September which are known to be important prey to seabirds. Upper graph shows the 0-group fish species and lower graph shows the distribution of Krill and adult fish (from Eriksen et al. 2017).

Diving depth and prey

To achieve a better understanding of the feeding behavior of birds, we have used Time Depth Recording loggers (TDR) deployed on guillemots the year around from one of the colonies Hornøya in order to get information about the dive patterns and depth they were feeding on. We have also measured stable isotopes from feathers molted at different times of the year to get information about the trophic level they fed on. This may help assessing the diet of the birds. At the same time, we have measured stress levels of feathers. The results shows some consistent patterns (Fig.4). During the autumn birds take shallow dives to around 20-30 meter whereas during mid winter the diving depths increases down to around 150 meter and drops down one trophic level compared to the autumn situation. During the autumn period, they also apparently feed on a higher trophic level than during winter. It is also evident that the birds are more stressed during winter than during autumn. From the distribution patterns of prey (Fig.3) it may look like their diet during autumn consist of 0-group fish whereas during winter they switch to krill. These shallow dives during autumn is consistent with depth of 0-group fish at this time of the year. We have in cooperation with the marine institute collected samples of a number of prey species from the Barents Sea for stable isotope analyses to verify the switch in diet. The analyses will be finished early in 2018.
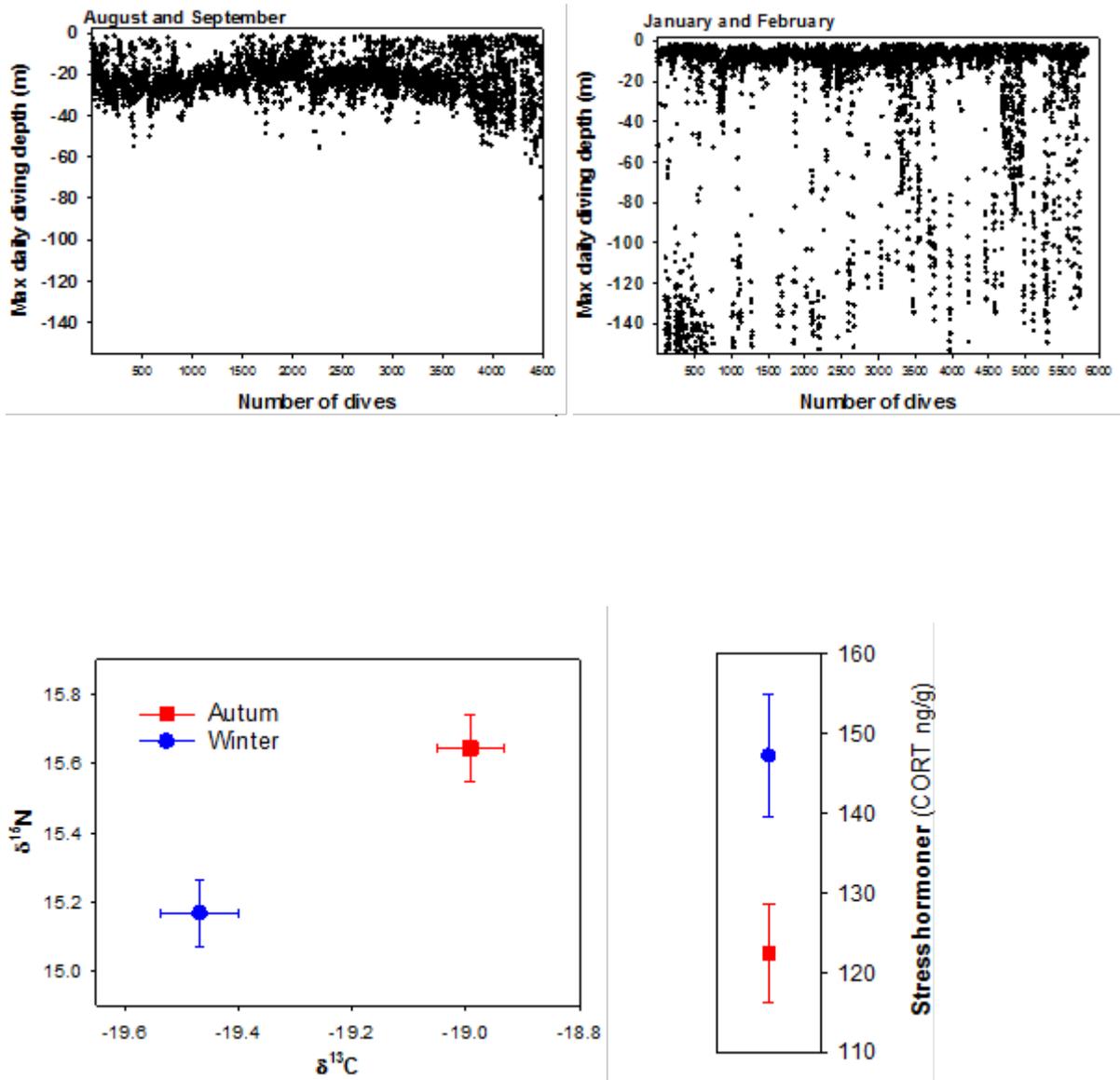
Fig.4. The maximum diving depth in meters during autumn and winter (two upper graphs) and the stable isotope levels and stress levels (Cort) measured from feathers of Common Guillemots from Hornøya (two lower graphs) (From Erikstad et al.unpubl.).

Conclusions (see the report sheet)

The southeastern Barents Sea is definitely a very important area for Auk species during their molting period when they also accompanies their flightless chick for a period of 50-60 days after they leave the breeding colony. This is a very vulnerable time period for the Auk species considered which all are on the Norwegian Red list. The area they use is close to and overlaps with much of the new activity for nominations of new blocks for oil exploration. This need to be considered in the analyses of the vulnerability of these areas. The reason for the accumulation of birds in this area seem to be the high abundance and predictable are of seabirds prey species. The drift patterns of cod and herring larvae from their spawning areas in south into the southeastern Barents Sea where it accumulates in a rather

restricted area, seem to be one of the main reason for the accumulation of birds in this area although more analyses of the datasets are necessary for any firm conclusion. Such analyses will be carried out during rest of 2017 including a workshop for quantifying the overlaps between both bird species and different prey species. For 2018 we will write up two international publications (outlined in the report sheet).

References

Barrett, R.T., Erikstad, K.E., Sandvik, H., Myksvoll, M.S., 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. 5:1306-1317. DOI: 10.1002/ece3.1438

Dalpadado P, Ingvaldsen RB, Stige LC, Bogstad B, Knutsen T et al. (2012)Climate effects on the Barents Sea ecosystem dynamics. ICES J Mar Sci 69: 1303–1316.

Eriksen, E. and Dalpadao (2011). Long-term changes in Krill biomass and distribution in the Barents Sea: are the changes mainly related to capelin stock size and temperature conditions? Polar Biol 34:1399–1409

Eriksen, E., Ingvaldsen, R., Stiansen, J.E., Johansen, O.G., 2012. Thermal habitat for 0-group fishes in the Barents Sea; how climate variability impacts their density, length and geographical distribution. ICES J. Mar. Sci. 69 :870–879. http://dx.doi.org/10.1093/icesjms/fsr210.

Hjermann, D. Ø., Stenseth, N. C., & Ottersen, G. (2004). Indirect climatic forcing of the Barents Sea capelin: a cohort effect. Marine Ecology Progress Series, 273, 209-238.

Kålås, J. A., Viken, Å., Henriksen, S., & K. Skjelseth, S. (2010). The 2010 Norwegian red list for species.

Myksvoll, M., Erikstad, K.E., Berrett, R.T., Sandvik, H. and Vikebø, F. 2013. Climate-driven ichthyoplankton drift model predicts growth of top predator young. Plos One 8 e79225 DOI: 10.1371/journal.pone.0079225.

Richardson AJ, Brown CJ, Brander K, Bruno JF, Buckley L et al. (2012) Climate change and marine life. Biol Letters 8: 907–909.

Sandvik, H., Reiertsen, T.K., Erikstad, K.E., Anker-Nilssen, T., Barrett, R.T., Lorentsen, S.H., Systad, G.H., Myksvoll, M. 2014. The decline of Norwegian seabird populations: modeling the role of ocean warming. Climate Research .60:91-102. doi:10.3354/cr01227.

Vikebø FB, Ådlandsvik B, Albretsen J, Sundby S, Stenevik EK et al. (2011) Realtime ichthyoplankton drift in Northeast Arctic cod and Norwegian Spring

Spawning herring. PLoS ONE 6: e27367.

Sandvik, H, Barrett, R.T., Erikstad, K.E., Myksvoll, M., Anker-Nilssen, T., Lorentsen, S.-H., Reiertsen, T.K., Skardhamar, J., Skern-Mauritzen, M., Systad, G.H., Vikebø, F. 2016. Drift patterns of fish larvae link coastal morphology to seabird colony distribution. Nature Communication 7: 1306-1317.

Master and PhD-students involved in the project

The main aim of this project is to produce knowledge for the use by management authorities and the results will be reported in scientific papers. There is no students included in this project, but the results and publications may well be linked to educational programmes at UiT and UNIS.

For the Management

The southeastern Barents Sea is an area with increasing interest and concern regarding oil exploration activities. The project has direct relevance to the Fram Centre and the society in general since it will strengthen and improve the knowledge of the Barents Sea, and thus increase our management and conservation abilities of environmental and natural resources in the north. Additionally, the results will provide vital knowledge to business communities and public in general. All four seabird species in this project are listed on the Norwegian red list (Kålås et al. 2010). Results from the present study is therefore also of high importance for management authorities (KLD, MiDi and local agencies).

At least two publications in referee journals are planned:

- Hot spot areas for moulting and their chick raising auks in the southern Barents Sea. Intended for Biological Conservations (Early 2018)
- Spatial distribution of moulting and chick rearing auks at sea and their link to the marine system. Intended for Marine Ecology progress Series (Late 2018).

Communicated Results

The preliminary results from the project has been presented at;

1) The SEAPOP seminar in late spring in Bergen 2017

2) The MIKON project meeting in early august 2017

Results from the prokject has also been communicated both with "Miljødirektoratet" and oil companies throghout the year

Interdisciplinary Cooperation

The project has a strong group of participants covering everything from the physical oceanography, marine biology, seabird ecology and spatial modelling (see table below).

Partner	Resources and infrastructure	PARTICIPANTS
NINA	GLS data, expertise in seabird ecology and spatial analysis, oil-industry related research	KEE, TKR, MB, GS, SHL
NP	GLS data	HS
IMR	Acoustic and trawl data from ecosystem survey, modelled drift data of fish larvae, oceanographic and marine ecology expertise	FV, MSM, MM, JS
CEH	Expertise in seabird ecology, conservation of marine environments, oil-industry related research	FD, SW, MH

Budget in accordance to results

The budget has been fair related to the work done in 2017

Could results from the project be subject for any commercial utilization
         No
Conclusions

The southeastern Barents Sea is definitely a very important area for Auk species during their molting period when they also accompanies their flightless chick for a period of 50-60 days after they leave the breeding colony. This is a very vulnerable time period for the Auk species considered which all are on the Norwegian Red list. The area they use is close to and overlaps with much of the new activity for nominations of new blocks for oil exploration. This need to be considered in the analyses of the

vulnerability of these areas. The reason for the accumulation of birds in this area seem to be the high abundance and predictable are of seabirds prey species. The drift patterns of cod and herring larvae from their spawning areas in south into the southeastern Barents Sea where it accumulates in a rather restricted area, seem to be one of the main reason for the accumulation of birds in this area although more analyses of the datasets are necessary for any firm conclusion. Such analyses will be carried out during rest of 2017 including a workshop for quantifying the overlaps between both bird species and different prey species. For 2018 we will write up two international publications (outlined in the report sheet).