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NINA Report

The status and trends of seabirds breeding in Norway and Svalbard

Per Fauchald, Tycho Anker-Nilssen, Robert T. Barrett, Jan Ove Bustnes, Bård-Jørgen Bårdsen, Signe Christensen-Dalsgaard, Sébastien Descamps, Sigrid Engen, Kjell Einar Erikstad, Sveinn Are Hanssen, Svein-Håkon Lorentsen, Børge Moe, Tone K. Reiertsen, Hallvard Strøm, Geir Helge Systad

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NORWEGIAN POLAR INSTITUTE

UNIVERSITY OF TROMSØ

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COVER PICTURE
Glaucous Gull and Common Guillemots on Bjørnøya,
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Abstract

Fauchald P, Anker-Nilssen T, Barrett RT, Bustnes JO, Bårdsen B-J, Christensen-Dalsgaard S, Descamps S, Engen S, Erikstad KE, Hanssen SA, Lorentsen S-H, Moe B, Reiertsen TK, Strøm H, Systad GH (2015) The status and trends of seabirds breeding in Norway and Svalbard – NINA Report 1151. 84pp.

This report presents the updated sizes, trends and spatial distributions of the breeding populations of 17 seabird species breeding in Norway and Svalbard. The analyses are based on available census and monitoring data from SEAPOP; the Norwegian monitoring and mapping program for seabirds. In addition, the report presents results from a species-specific literature review of the most important prey items and drivers of population change.

The report documents large-scale decadal changes in the seabird communities along the coast of Norway and Svalbard. A division of the populations into five geographical regions (North Sea & Skagerrak; Norwegian Sea; Barents Sea; Bjørnøya; and Spitsbergen) was used as a basis for the analyses of population dynamics from 1980 to present. 13 of the 35 regional seabird populations assessed have declined by more than 50% the last 25 years. 5 regional populations increased by more than 100% in the same period, while 8 populations showed large decadal fluctuations. Several populations were not assessed due to the lack of census and/or monitoring data. In order to improve the dataset, it is recommended that a census of breeding seabirds from Vesterålen to the Swedish border is completed.

Declining populations were found in all regions and included all major ecological groups (i.e.; Pelagic surface-feeding (Ps), Pelagic diving (Pd), Coastal surface-feeding (Cs), Coastal benthic-feeding (Cb) and Coastal diving (Cd) seabirds). Populations with more than a 50% decline the last 25 years were: Common Gull (Cs), Lesser Black-backed Gull (Ps) and Atlantic Puffin (Pd) in the North Sea & Skagerrak; Great Cormorant (Cd), Common Eider (Cb), Black-legged Kittiwake (Ps) and Common Guillemot (Pd) in the Norwegian Sea; Herring Gull (Cs), Great Black-backed Gull (Cs), Black-legged Kittiwake (Ps) and Brünnich's Guillemot (Pd) in the Barents Sea; Northern Fulmar (Ps) and Glaucous Gull (Ps) on Bjørnøya; and Brünnich's Guillemot (Pd) on Spitsbergen.

The populations of European Shag and Great Cormorant have shown large fluctuations with a notable increase in the population of *Phalacrocorax carbo sinensis* in North Sea & Skagerrak. Common guillemot has been increasing in the Barents Sea since the collapse in the population in the 1980s, however the population in the Norwegian Sea has been steadily declining since the early 1980s. Atlantic Puffin is declining in the North Sea and Norwegian Sea, but the population in the Barents Sea is stable or is increasing slightly. The datasets were too small to assess several of the large gull species in the Norwegian Sea. However, extensive monitoring in the North Sea & Skagerrak and recent censuses in the Barents Sea suggest declines by more than 50% in several of the gull populations in these areas. Black-legged Kittiwake has declined in all regions except for Bjørnøya. The large colonies of Brünnich's Guillemot on Spitsbergen have declined from 1.15 million pairs in 1988 to 522 000 pairs in 2013. The colony on Bjørnøya (about 100 000 pairs) has in the same period been stable or declined slightly, while the small populations on the Norwegian mainland have almost disappeared. Northern Gannet has been increasing in Norway since the establishment of this species on Runde in the 1940s. The species has expanded northward and has recently established a small colony as far north as Bjørnøya.

The review of diet studies highlighted the importance of the young age-classes of cod fish, the importance of pelagic forage fish species and in particular the importance of sandeel. However, the differences in diet among ecological groups combined with the fact that declining seabird populations were found in all regions and included all major ecological groups suggest that the recent changes in Norwegian seabird communities cannot be explained by changes in the abundance of a single group of resources alone. On the contrary, this might suggest a combined effect of simultaneous changes in several prey items, possibly involving entire trophic levels.

Alternatively, it might suggest that bottom-up regulation through food is less important, and that top-down mechanisms such as anthropogenic stressors and predation are more involved in the present changes.

A large number of studies have been conducted to investigate how different anthropogenic and environmental factors affect seabird populations. Factors such as fisheries by-catch, harvest and intentional killing, pollution and disturbance are all anthropogenic stressors with a well-documented negative impact. Although most of these stressors have been reduced in Norwegian waters due to the implementation of regulatory mechanisms and protection measures, they might still have impact on local populations. For example, the decline in the population of Glaucous Gull on Bjørnøya has been related to high levels of persistent organic pollutants. Several case studies suggest that predation from avian and small mammalian predators in the seabird colonies might be important, and we cannot exclude this driver as an important mechanism behind the observed declines. The large spatial and the relatively long temporal scale of the population changes observed in the present report, might suggest that fluctuations in the marine ecosystems, possibly partly due to climate change and past and present fishing pressures, might be important. This is corroborated by numerous studies documenting a direct impact from food deprivation and an indirect impact from climatic factors on seabird population dynamics. Such factors often involve complex indirect trophic links which make it difficult to point out the ultimate cause of the observed change.

We conclude that the two most likely candidates to explain the recent declines in Norwegian seabird populations are 1) increased predation in the seabird colonies from avian and mammalian predators and 2) ecosystem changes affecting the availability of prey. The impact from these drivers might be difficult to document and even more challenging to control. In contrast, more easily managed direct anthropogenic stressors such as fisheries by-catch, pollution, hunting and disturbance have either been constant or have shown a decreasing trend. Although these drivers cannot explain the recent population declines, they still contribute to the cumulative impact on seabird populations and these stressors are therefore especially important to control and minimize in rapidly declining and threatened populations.

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Contents

Foreword

To evaluate the role of food scarcity for the decline in Norwegian seabird populations and to possibly recommend mitigating management actions, a working group of seabird and marine scientists was established in 2013. To aid the evaluation, the Norwegian Environment Agency initiated and funded the task of updating and summarizing the knowledge of population trends, status and environmental drivers of the most important seabird species breeding in Norway and on Svalbard. A draft was presented to the evaluation group in October 2013. It was apparent that more work was needed, especially with respect to estimates of population sizes and dynamics. The work continued throughout 2014 and is finalized here.

Per Fauchald, March, 2015

1 Introduction

Several Norwegian seabird populations have declined in recent years (Ottersen & Auran 2007, von Quillfeldt 2010, Barrett et al. 2014, Descamps et al. 2013). On a national scale, the situation is especially worrying for pelagic, colony breeding seabirds such as Black-legged Kittiwake (*Rissa tridactyla*), Common Guillemot (*Uria aalge*), Brünnich's Guillemot (*Uria lomvia*) and Atlantic Puffin (*Fratercula arctica*) in the Norwegian Sea. As a consequence, these species are currently listed in the Norwegian Red List and/or the Red List for Svalbard as critically endangered, endangered or vulnerable (Kålås et al. 2010). On a global scale, food limitation, and in particular fluctuations in the abundance of small pelagic fish has been suggested to be critical for seabird populations (Cury et al. 2011). This has also been corroborated by Norwegian studies based on monitoring data collected by SEAPOP; the Norwegian monitoring and mapping program for seabirds. For example, the availability of the early life-stages of herring (*Clupea harengus*) is vital for successful reproduction in Atlantic Puffin breeding at Røst, Nordland (Durant et al. 2004, Barrett et al. 2012). In the Barents Sea, capelin (*Mallotus villosus*) is important for adult survival in Kittiwakes (Reiertsen et al. 2014). For Common Guillemots in the Barents Sea, adult survival is positively related to the combined abundance of juvenile fish (0-group cod *Gadus morhua*) and capelin (Erikstad et al. 2013), whereas the chick growth on Hornøya, Finnmark is related to the drift of cod larvae along the Norwegian coast (Myksvoll et al. 2013). In many cases, food limitation has been linked to fluctuations in climatic parameters such as the North Atlantic Oscillation (NAO), sea surface temperature and the sub-polar gyre (Durant et al. 2004, Sandvik et al. 2005, Sandvik et al. 2012, Descamps et al. 2013, Myksvoll et al. 2013, Sandvik et al. 2014), suggesting that climate might play an important indirect role in the observed changes.

The last comprehensive analyses of the sizes and trends of breeding seabird populations was published in 2006 for Norway (Barrett et al. 2006) and in 1994 for Svalbard (Mehlum and Bakken 1994). Monitoring suggests that population sizes have changed considerably since then (Barrett et al. 2014). Moreover, increased monitoring effort combined with censuses of breeding populations in northern Norway and Svalbard warrants an updated analysis. Based on data from SEAPOP, this report summarizes the status, distribution and trends of the breeding populations of 17 seabird species, monitored annually through the Norwegian Monitoring Program for seabirds and the seabird Monitoring program for Svalbard (both currently integrated as a part of SEAPOP), in Norway and Svalbard. In the study by Barrett et al. (2006), most population estimates were assessed from the latest data in the national seabird registry (population census data) after taking into account the most recent population trends. In the present study, we formalize this procedure by combining all data from the population census program (measuring population sizes), with all data from the monitoring program (measuring population trends). The result is time series in population estimates on local, regional and national scales. We are however, at this stage unable to estimate the confidence intervals of the estimates. When data are available, we present the trends and estimates for regional breeding populations from 1980 to present. Otherwise, we present the latest census estimate. For comparisons, the status and trends of international populations are summarized and presented in tables. To identify important prey items and human and environmental drivers affecting population dynamics, we conducted a literature review. The importance of different categories of prey is indicated by summing the number of diet studies from the Northeast Atlantic reporting specific prey items. The results are shown in a table for each species. To address important environmental drivers of population dynamics, we identified studies reporting evidence for a relationship between a specific driver and demographic or population parameters. The sum of reported cases is shown in a table for each species.

2 Materials and Methods

2.1 Norwegian populations; trends and distribution

Breeding population sizes were calculated by combining monitoring data (time series of counts from specific monitoring sites) with population census data (all-covering counts of breeding individuals in specified areas (breeding locations)). The SEAPOP program conducts regional population censuses on a ten year cycle (Anker-Nilssen et al. 2005). Thus, to obtain updated population estimates and trends, it is necessary to combine the census data with data from the monitoring sites. Standardized counts on the monitoring sites provide yearly estimates of site-specific population size and growth. Assuming that the sites are a representative sample of the total population, we combined the population growth from the monitoring sites with the census data to calculate the time-series of the number of breeding pairs on each breeding location. The estimates from the breeding locations were summed up over regions to provide regional and national population estimates and time series. We used the following four regions: North Sea & Skagerrak (Swedish border to Stadt), Norwegian Sea (Stadt to Andenes), Barents Sea (Andenes to Russian border), Bjørnøya and Spitsbergen. Because little monitoring data was available before 1980, the presented time-series span from 1980 (1988 for Spitsbergen) to 2013.

The counts of species with a dispersed breeding or where the nests are difficult to locate will tend to underestimate the true size of the breeding population. This is especially a problem for species such as Northern Fulmar (*Fulmarus glacialis*), Common Eider (*Somateria mollissima*), Common Tern (*Sterna hirundo*), Arctic Tern (*Sterna paradisaea*), Black Guillemot (*Cephus grylle*), Atlantic Puffin (*Fratercula arctica*) and Little Auk (*Alle alle*). There has not been done any attempt to correct for these sources of errors in the present report. However, a note has been made in cases where the counts are considered to grossly underestimate the true value.

Little Auks are difficult to census and estimates for most major colonies were missing. Little Auk is therefore not included in the present report. Moreover, relatively sparsely monitoring and census data combined with low fidelity of the breeding colonies made it unfeasible to make realistic estimates of the population sizes of Common Tern. Common Tern was therefore also excluded from this report. Due to insufficient monitoring and/or census data (see definitions in Chap. *2.1.5 Sample size and uncertainty*), time-series and trend corrected estimates were not presented for the following species (regions): Northern Fulmar (Norwegian Sea, Spitsbergen), Common Eider (Spitsbergen), Common Gull *Larus canus* (Norwegian Sea and Barents Sea), Herring Gull *Larus argentatus* (Norwegian Sea) Glaucous Gull *Larus hyperboreus* (Spitsbergen), Great Black-backed gull *Larus marinus* (Noregian Sea), Arctic Tern (all regions), Common Guillemot *Uria aalge* (Spitsbergen), Razorbill *Alca torda* (Norwegian Sea), Black Guillemot (all regions), Atlantic Puffin (Bjørnøya and Spitsbergen). In these cases, population estimates and maps of breeding populations were based on the most recent census count.

2.1.1 Population census data

The Norwegian seabird registry contains counts of seabirds on defined locations (breeding colonies/areas) along the coast. We retrieved data on complete location counts during the breeding season. Depending on the species specific counting method, the data reflect either the breeding population (e.g. the number of occupied nests) or the number of breeding and non-breeding individuals present at the breeding location. The resulting dataset comprised 52 931 observations from 7 262 locations and 17 species.

The seabird populations breeding in Svalbard were mapped from 2005 to 2012 and a complete census of the breeding populations in northern Norway, from Røst to the Russian boarder, was conducted in the period 2005-2009. The data from further south along the Norwegian coast (i.e. the North Sea and the southern part of the Norwegian Sea) are more fragmentary and many locations have not been counted since the 1980s. Due to different spatial references, old data from Svalbard were difficult to compare with the recent census and we therefore chose to include the recent census only. Accordingly, while the locations in Svalbard were represented by only one count from the recent census (2005-2012), most locations on the Norwegian mainland are represented by more than one observation from the period 1980 to present. The summary of available census data for each species is presented in the table *Samples and population sizes* under each species.

2.1.2 Population monitoring data

Through the Norwegian Monitoring Program for seabirds, breeding populations of selected species are monitored annually in established monitoring plots using standardized methodology (Lorentsen & Christensen-Dalsgaard 2009). The data from the plots are summed up over specific breeding sites or colonies. Such discrete entities with a median count of individuals or nests larger than 20 are hereby referred to as monitoring *sites.* For species showing large local variation or low colony-specific abundance, data from several sites and plots were summed up over larger areas before entering the analyses (see Lorentsen & Christensen-Dalsgaard 2009).

2.1.3 Combining census and monitoring data

For each species-specific breeding location, we calculated the time-series of the number of breeding birds by combining the count data from the census with estimates of population growth. We used two sources of growth estimates; the intrinsic growth rate from the nearest monitoring sites and the predicted intrinsic growth rate from a Generalized Additive Model (GAM) analysis. The predicted values from the GAM analysis were only used when no monitoring data were available within 300 km from the breeding location.

From the monitoring data, we calculated the annual intrinsic (per capita) growth rate. The intrinsic growth rate r_{t1i} from year *t1* to year *t2* at site *i* is given by:

$$r_{t1i} = \frac{\ln N_{t2i} - \ln N_{t1i}}{t2 - t1}$$

Where N_{t1i} and N_{t2i} are site specific counts in year *t1* and *t2*.

As an estimate of the intrinsic growth rate $\widehat{r_{pt1}}$ at breeding location *p* in year *t1*, we used the inverse distance weighted (IDW) average of r_{t1i} from all monitoring sites; *i* lying within a radius of 300 km from the breeding location:

$$\widehat{r_{pt1}} = \frac{\sum_i w_i r_{t1i}}{\sum_i w_i}$$

Where $w_i = 1/d_i^2$ and d_i is the distance between the breeding location and the monitoring site *i*.

When no monitoring sites were available within a 300 km radius, we used the predicted growth rates from a GAM model. To increase the sample size in the GAM analyses, we also included the intrinsic growth rates calculated from the census database. This increased the total sample size from 2 628 (monitoring data only) to 22 993 observations (census and monitoring data combined). The intrinsic growth rate was smoothed with respect to geographic position and year. We used the ''mgcv'' library (Wood 2006) in the R software (R Development Core Team 2011). The growth rates were modeled by two covariates: Year (*t*) and *Dcoast*. *Dcoast* is the position of the breeding location along the Norwegian coast, measured as the distance in km from the Swedish border in southeast to the breeding location along the Norwegian sea-boundary. To allow for different development of the growth rate at different positions along the coast, the covariates were modeled by a two-dimensional smooth function:

$$r_{ti} = I + s(t, D_{coast}) + e$$

Where *I* is the intercept and *e* is the residual error (assuming a normally distributed error).

The variation in r_{ti} was inversely related to population size, and was especially large for populations < 20 individuals. To remove the effects of extreme values, we excluded observations where $(N_{t1} + N_{t2})/2 < 20$ and where $|r_{ti}| > 2$.

Based on the fitted models, we used the ''predict'' function in the ''mgcv'' library to predict the average growth rate on each breeding location from 1970 to 2013.

2.1.4 Calculating time-series

When only one census value was present for a given breeding location, the calculation of the time series based on estimated intrinsic growth rates is straight forward; i.e. by calculating the population size backward; $\widehat{N_{t-1}} = N_t/exp(r_{t-1})$ and forward; $\widehat{N_{t+1}} = N_t exp(r_t)$ from the time of the census.

When two or more census values were present, we used the following least-square procedure to fit the time-series to the data. First, we calculated the census-based intrinsic growth rate between consecutive counts. For each time-step between consecutive counts, we calculated the average of the census-based and monitoring-based growth rates. Based on these average values, a time-series of $\widehat{N_t}$ was fitted by minimizing $\sum_t \left(log\widehat{N_t} - logN_t\right)^2$.

2.1.5 Sample size and uncertainty

Two main sources of error are likely to cause uncertainty in the estimates of populations sizes and trends: 1) Measurement errors associated with the sampling procedure and 2) The extrapolation of growth rates to nearby breeding sites with an unknown population growth. The applied methods make use of all available data however the complexity of the analyses, involving stepwise analyses on two more or less independent datasets made it, at present, unfeasible to calculate the associated confidence levels. It is nevertheless important to assess the relative uncertainty of the estimates and trends. Several measures indicating the uncertainty of the analyses is presented in the species-specific tables (see tables *Samples and population sizes*). The number of independent time series (i.e.; *Total no. series* and *No. long series*) is important for the precision of the population trajectories as well as the trend-corrected population estimates. Similarly, the frequency of population censuses (i.e.; *No. counts* relative to *No. locations*) and the time interval covered by the censuses (i.e.; the time interval from the *Year of first count* to the *Year of last count*) is also important regarding the precision of the population trajectory. Finally, in order to achieve a precise estimate of the present population size, it is important that the last census is up-to-date (i.e.; *Year of last count* is close to the present). Regional population trajectories and trend-corrected estimates of population size (*2013-estimate*) are consequently only given when 1) the regional population is represented by at least two long time series (monitoring covers the time span from the 1980s to present with n > 20 years) or equivalent representative sets of shorter time-series, **or** 2) when each census location, on average, has been counted at least twice and the median year of first count is from before 1990 while the median year of last count is more recent than 2000.

2.2 Literature review

A review of the international population status, diet and the most important drivers of change, was based on already published information. The review was mainly based on searches in the Thomson Reuters Web of Science database using each species' scientific name as a search topic (the literature search ended in September 2013). In addition, we also included information from the 'grey literature' found by searches on the internet and communication with seabird scientists. The resulting number of studies with respect to species and subject area (i.e. diet and drivers of change) is shown in table 1. The species-specific reference lists are given in the Appendix.

Status and trends for international populations were retrieved from the literature and were presented in species-specific tables.

To assess the most important prey items, we summed the number of cases from the Northeast Atlantic reporting different categories of prey items. We separated between the following categories: Gadoids, Polar cod, Capelin, Herring, Sprat, Sandeel, Other fish, Squid, Crustaceans, Other invertebrates, Offal and Other. Because the diet might differ considerably among seasons and between chicks and adults (Barrett et al. 2007), we separated studies from non-breeding and summer, and studies of chicks and adults. To avoid double-counting, we summed the diet categories over colonies/areas and seasons/age class. Accordingly, one study might report from several colonies/areas and seasons/age classes, while several studies might report from one single colony/area and season/age class. One case is accordingly a reported prey category from a given colony/area and season/age class.

Drivers of population dynamics was assessed by summing the number of reported populations/colonies where the different drivers have been demonstrated to play a role. The results are shown for each species in the table "Drivers of population dynamics". Similarly to the diet studies, we summed the drivers over colonies/areas to avoid double-counting, and one case is a reported driver from a given colony/area. Cases from Norwegian populations are shown in parentheses. The set of potential drivers represents different categories that are not mutually exclusive. The categories 'climate' and 'climate and food', for example, separate between studies that only discuss effects of climate from those who document climatic effects being manifested through climatic induced effects on the birds' prey species. Direct drivers refer to drivers with a direct impact on survival and/or reproduction. Indirect drivers are drivers operating mainly through food availability. We also separated between direct effects on survival and breeding success reported as incidental observations, and effects measured as quantitative effects on population parameters.

Table 1. *Number of studies and cases included in the literature review of seabird diet and drivers of population change. "Studies" are the number of published studies encompassed by the review. "Diet cases" are the sum of reported prey categories from all colonies/areas and seasons/age groups. "Drivers of change cases" are the sum of reported drivers from all colonies/areas.*

	Diet		Drivers of change	
	Studies	Cases	Studies	Cases
Northern fulmar (*Fulmarus glacialis*)	9	69	21	25
Northern gannet (*Morus bassanus*)	14	28	21	15
Great cormorant (*Phalacrocorax carbo*)	7	35	23	17
European shag (*Phalacrocorax aristotelis*)	13	38	20	20
Common eider (*Somateria mollissima*)	8	11	53	57
Common gull (*Larus canus*)	4	6	11	8
Lesser black-backed gull (*Larus fuscus*)	12	31	19	24
Herring gull (*Larus argentatus*)	15	39	36	34
Glaucous gull (*Larus hyperboreus*)	13	55	20	19
Great black-backed gull (*Larus marinus*)	7	23	17	25
Black-legged kittiwake (*Rissa tridactyla*)	23	90	49	57
Arctic tern (*Sterna paradisaea*)	9	12	14	19
Common guillemot (*Uria aalge*)	23	52	50	50
Brünnich's guillemot (*Uria lomvia*)	14	62	18	29
Razorbill (*Alca torda*)	9	9	20	21
Black guillemot (*Cephus grylle*)	8	16	12	21
Atlantic puffin (*Fratercula arctica*)	25	59	46	32
Total	213	635	450	473

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3 Results

3.1 Figure and table legends

Legends for the species-specific tables and figures are given below.

3.1.1 Samples and population sizes (table)

The table gives a description of the two datasets (monitoring and census data) and the estimates of the regional population sizes. For the monitoring data, the table shows the total number of monitoring series (*Total no. series:* Number of monitoring *sites* with more than 3 years of monitoring) and the number of series covering the period from the 1980s to the 2010s (*No. long series:* Number of monitoring *sites* with more than 25 and 20 years of monitoring on the Norwegian mainland and Svalbard respectively). For the census data, the table shows the number of breeding locations (*No. locations*) where the species has been observed, the total number of counts on these locations (*No. Counts*), the median year of the first count (*Year first count*) and the median year of the last count (*Year last count*). Population estimates are given as the number of breeding pairs summed over all breeding locations within each region. *Last count* is the population sizes calculated from the last count in the census data. *2013-estimate* is the population estimates for 2013; i.e. population sizes are corrected for recent trends. *2005-estimate* is the population sizes given by Barrett et al. (2006). The trend corrected estimates (*2013-estimates*) are only given when monitoring and/or census data are considered to be adequate (see Chap. *2.1.5 Sample size and uncertainty*). Estimates of the global populations were retrieved from the literature.

3.1.2 Norwegian populations; trends and distribution (figure)

Regional population trajectories are given when monitoring and/or census data are considered to be adequate (see Chap. *2.1.5 Sample size and uncertainty*). Maps of breeding sites are given for either the last count or, when available (see Chap. *2.1.5 Sample size and uncertainty*), the trend corrected 2013-estimate.

3.1.3 International populations; status and trends (table)

Population sizes and recent trends were retrieved from the literature.

3.1.4 Diet (table)

Number of cases in the literature documenting different prey items during summer (adult), summer (chick(s)) and winter respectively. A case is a reported prey category from a given colony/area and season/age class.

3.1.5 Drivers of population dynamics (table)

Number of cases in the literature documenting different drivers of population dynamics. The numbers in parentheses represent the number of cases from Norwegian populations. A case is a reported driver from a given colony/area.

3.2 Northern Fulmar *Fulmarus glacialis*

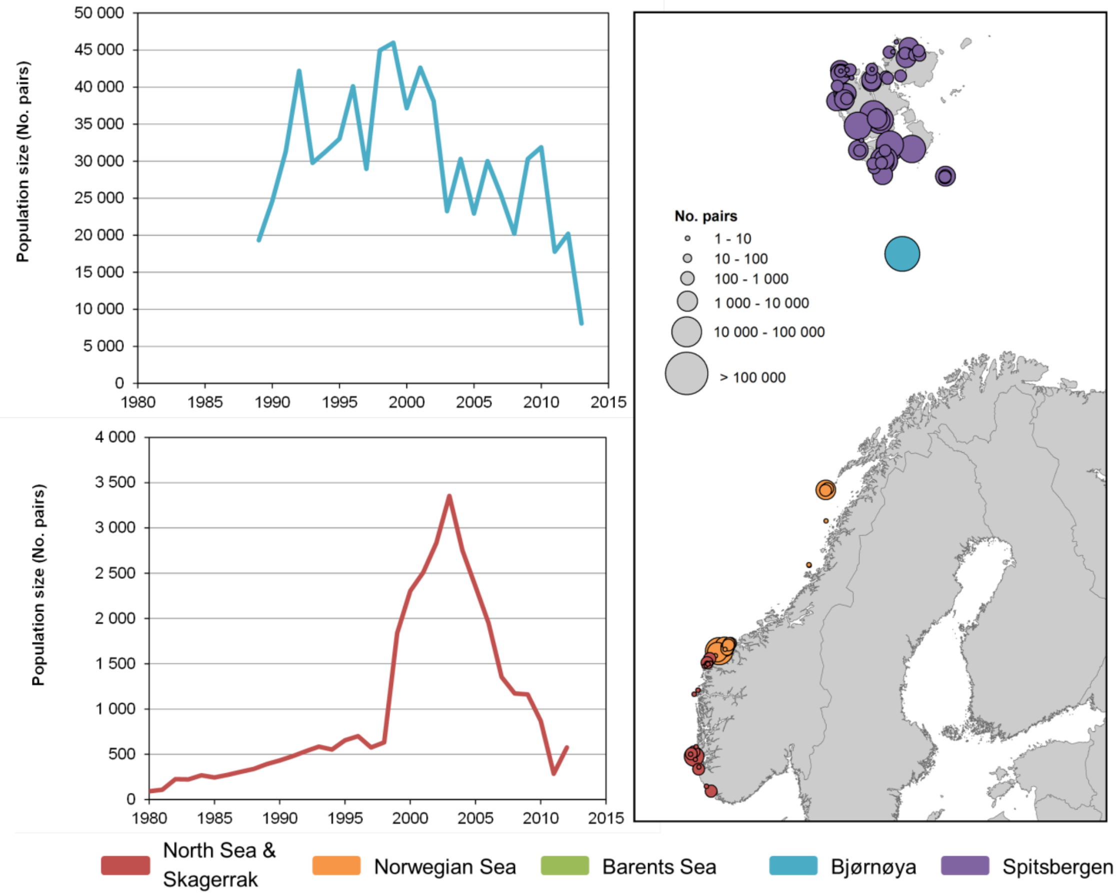
Ecological niche	Pelagic, surface-feeder
Redlist Norway	Near threatened
Redlist, Svalbard	Not listed

Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	4	0	22	129	1984	2006	642	575	1 520
Norwegian Sea	1	0	21	52	1980	1985	5 958		7 500
Barents Sea	1	0	3	26	1981	2005	0		100
Total							**6 600**		**9 120**
Svalbard									
Bjørnøya	1	1	1	1	2006	2006	30 000	8 084	
Spitsbergen[3]	1	0	62	62	2008	2008	34 553		
Total							**64 553**		
Global population[2]							**5 400 000 - 7 100 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004), [3]The count grossly underestimates the population on Spitsbergen.

Norwegian populations; trends and distribution



Left: Regional dynamics in breeding populations (Bjørnøya and North Sea)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	Population size (number of pairs)	Population trend
Sweden		
Denmark	0-5	
UK & Ireland	539 000	No overall trend[1]
Faeroes	600 000	Declining[1]
Iceland	1 000 000-2 000 000	Declining[1]
Greenland	80 000	No overall trend[1]
Russia	26 000	
Finland		
Europe (rest)	1 208	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	Summer		Non-breeding
	Adult	Chicks	
Gadoids	1	2	
Polar cod	8		2
Capelin	3	1	
Herring	1	2	
Sprat			
Sandeel	2	2	
Other fish	2		1
Squid	9	2	1
Crustaceans	1	3	2
Other invertebrates	6		1
Offal	4	3	1
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		Episodic observations		Population level effects		
		Breeding success	Adult survival	Breeding success	Adult survival	Population growth
Direct	*Climate hazards*			2		
	Fisheries bycatch		3 (2)			
	Harvest & intentional killing	5	6 (1)			
	Pollution		2 (1)	1 (1)		
	Predation & parasitism	1				1 (1)
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*			1	1	1
	Climate & food					
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					1
	Food			1		
	Food (sum)			1		1

3.3 Northern Gannet *Morus bassanus*

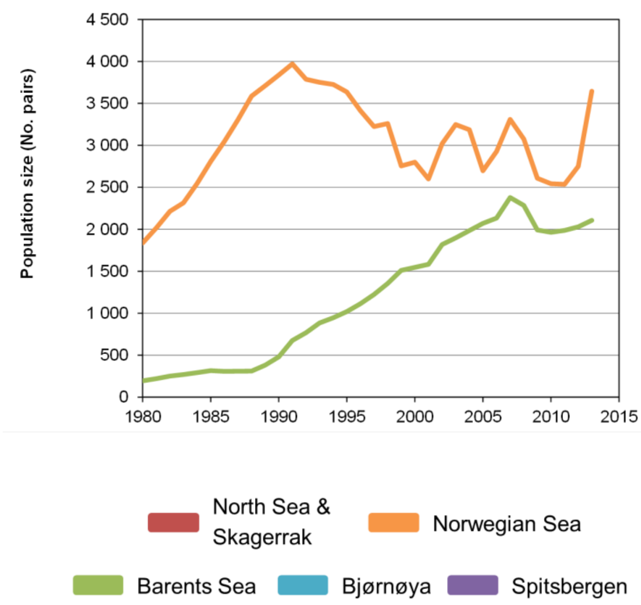
Ecological niche	Pelagic, plunge diving
Redlist Norway	Not listed
Redlist, Svalbard	Not listed

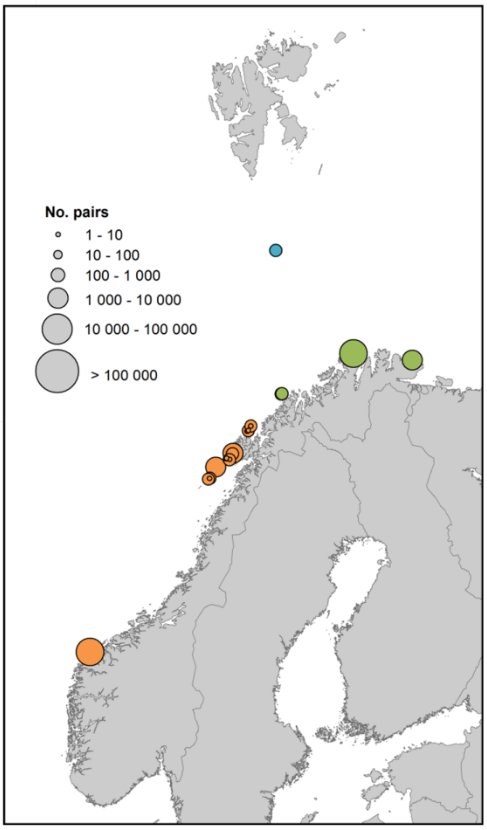
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	0	0					0		0
Norwegian Sea	8	6	22	223	1992	2013	4 644	3 646	2 750
Barents Sea	3	2	5	58	2001	2013	2 098	2 106	1750
Total							**6 742**	**5 752**	**4 500**
Svalbard									
Bjørnøya	0	0	1	1		2014	11		
Spitsbergen									
Total							**11**		
Global population[2]									**390 000**

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea and Norwegian Sea)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
Russia	35	
Faeroe Islands	2 340	Increasing[1]
Iceland	25 400	Increasing[1]
UK & Ireland	263 000	Increasing (Scotland)[1]
France	14 900	
Germany	69	
Canada	77 700	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	**Summer**		**Non-breeding**
	Adult	**Chicks**	
Gadoids		2	
Polar cod			
Capelin	1	1	
Herring	3	5	
Sprat	2		
Sandeel	1	2	
Other fish	4	4	
Squid	1	1	
Crustaceans			
Other invertebrates			
Offal	1		
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		*Episodic observations*		*Population level effects*		
		Breeding success	*Adult survival*	*Breeding success*	*Adult survival*	*Population growth*
Direct	*Climate hazards*					
	Fisheries bycatch		2 (1)			
	Harvest & intentional killing		1 (1)			
	Pollution	2	6 (1)			
	Predation & parasitism			1 (1)		1 (1)
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*					
	Climate & food					1
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food			1		
	Food (sum)			1		1

3.4 Great Cormorant *Phalacrocorax carbo*[1]

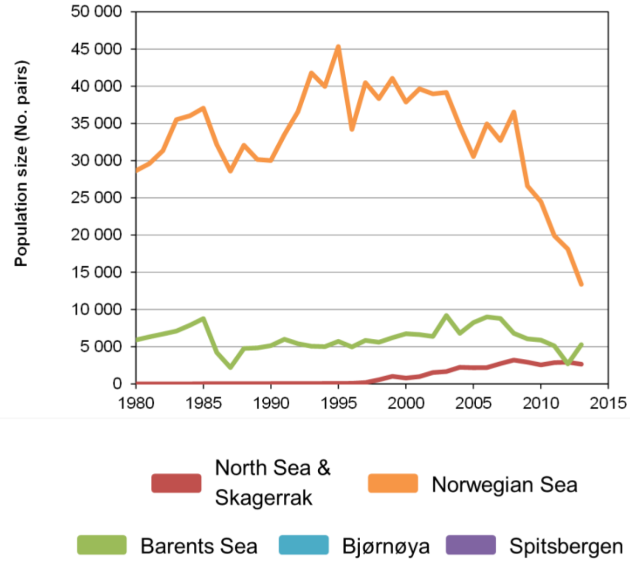
Ecological niche	Coastal, diving
Redlist, Norway	Not listed
Redlist, Svalbard	-

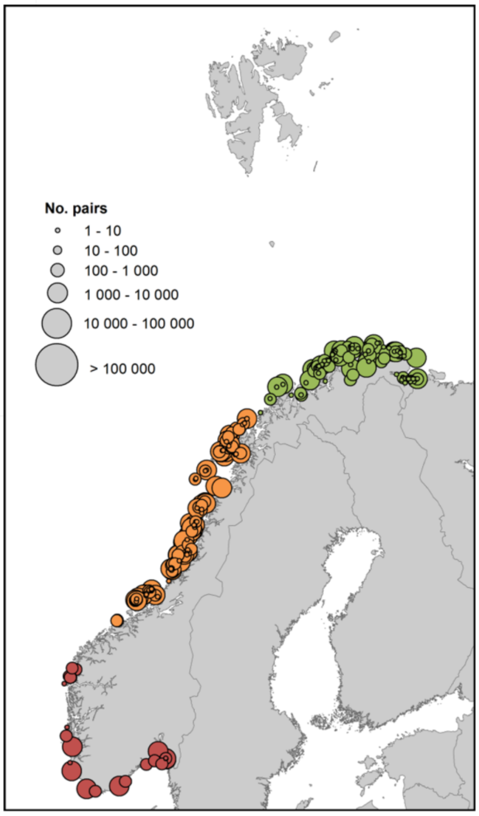
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	10	4	31	205	2002	2010	2 728	2 653	800
Norwegian Sea	22	12	162	1314	1990	2011	23 577	13 376	20 000
Barents Sea	30	2	155	820	1984	2006	7 185	5 270	10 000
Total							**33 490**	**21 299**	**30 800**
Svalbard									
Bjørnøya							0		
Spitsbergen							0		
Total							**0**		
Global population[2]							**570 000 – 590 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea, Norwegian Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

[1] *P. carbo carbo* and *P. carbo sinsensis*

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	Population size (number of pairs)	Population trend
UK & Ireland	13 700	Declining (Scotland)[1]
Denmark	40 126	Declining[1]
Sweden	27 300	Increasing[1]
Central and east Europe	100 000 -120 000	
Greenland	2 000-3 000	Increasing[1]
Iceland	2 200	Increasing[1]
Russia	31 681- 46 681	
Eastern Palearctic	100 000	
Southern and western Africa	100 000	
Northwest Africa	10 000	
Canada	6 300	
Pacific	100 000	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	Summer		Non-breeding
	Adult	Chicks	
Gadoids	7	2	4
Polar cod			
Capelin	1		
Herring	1		1
Sprat			
Sandeel	2		
Other fish	7	1	6
Squid			
Crustaceans	1		2
Other invertebrates			
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		Episodic observations		Population level effects		
		Breeding success	Adult survival	Breeding success	Adult survival	Population growth
Direct	*Climate hazards*					
	Fisheries bycatch		3 (1)			
	Harvest & intentional killing	1	5			1
	Pollution		1 (1)			
	Predation & parasitism					1
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*				1	
	Climate & food					
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food			2 (1)	2	
	Food (sum)			2 (1)	2	

3.5 European Shag *Phalacrocorax aristotelis*

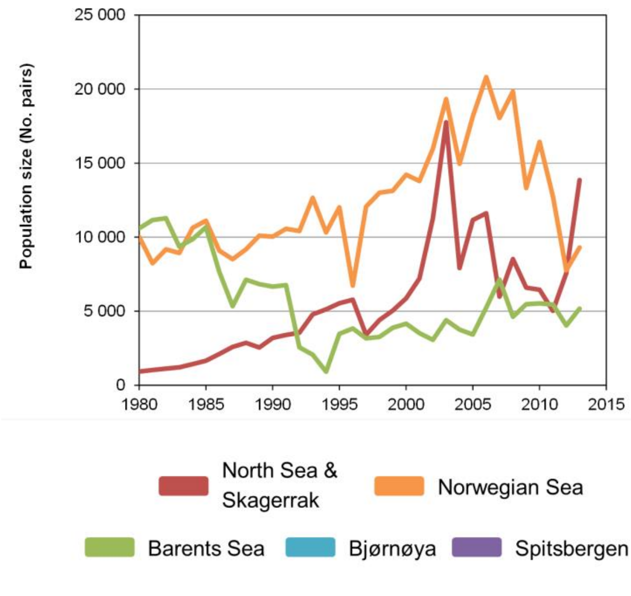
Ecological niche	Coastal, diving
Redlist, Norway	Not listed
Redlist, Svalbard	-

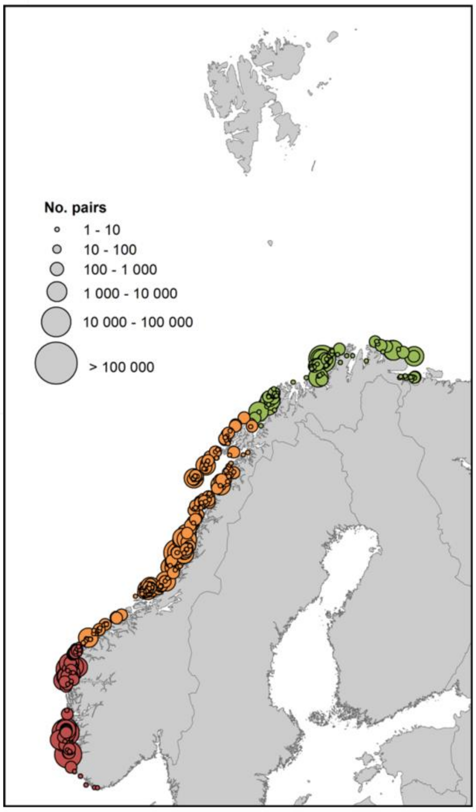
Samples and population sizes (no. of breeding pairs)

	Monitoring data		***Census data***				***Population estimates***		
	Total no. series	***No. long series***	***No. loc-ations***	***No. Counts***	***Year first count***	***Year last count***	***Last count***	***2013-es-timate***	***2005-es-timate[1]***
Norwegian mainland									
North Sea & Skagerrak	11	0	99	361	1992	2008	5 349	13 861	5 000
Norwegian Sea	3	3	315	626	1982	1985	11 043	9303	13 000
Barents Sea	7	1	118	338	1983	1987	6 541	5 177	6 000
Total							**22 933**	**28 341**	**24 000**
Svalbard									
Bjørnøya							0		
Spitsbergen							0		
Total							**0**		
Global population[2]									**73 000 – 83 000**

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea, Norwegian Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	**Population size (number of pairs)**	**Population trend**
Albania	20	
Croatia	2 000-4 000	
Faeroes	1000	No overall trend[1]
France (Atlantic)	6 059-6 130	
France (Corsica)	971	
Gibraltar	7-8	
Greece	1 000	
Iceland	8 000-9 000	Declining[1]
Italy (Sardinia)	1 600- 2 000	
Libya	50	
Morocco	20-40	
Portugal	150	
Russia	350	
Spain	3 962	
Tunisia	30	
Turkey	50-350	
UK & Ireland	29 370	Declining (Scotland)[1]
Ukraine	250-400	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	**Summer**		**Non-breeding**
	Adult	**Chicks**	
Gadoids	5		3
Polar cod			
Capelin			
Herring			
Sprat			
Sandeel	9	4	5
Other fish	3	1	5
Squid			
Crustaceans	1	1	1
Other invertebrates			
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		***Episodic observations***		***Population level effects***		
		Breeding success	***Adult survival***	***Breeding success***	***Adult survival***	***Population growth***
Direct	*Climate hazards*			2	1	1
	Fisheries bycatch		2 (1)			
	Harvest & intentional killing		3 (1)			1
	Pollution		3 (1)	1		1
	Predation & parasitism					
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*					
	Climate & food					1 (1)
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food			2 (1)		2 (1)
	Food (sum)			2 (1)		3 (2)

3.6 Common Eider *Somateria mollissima*

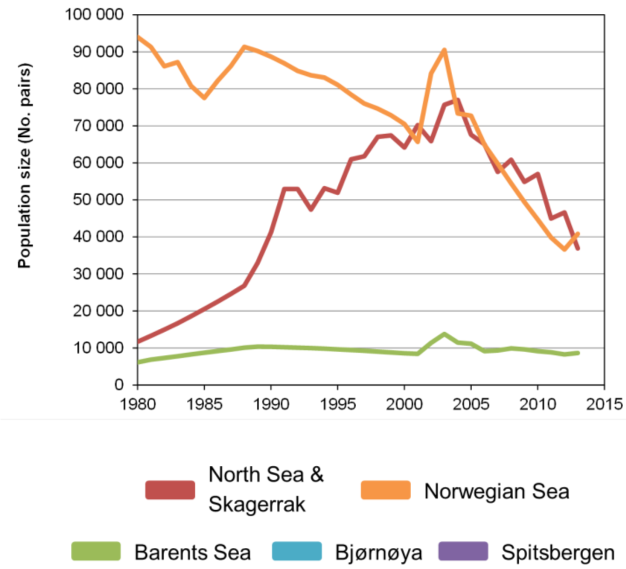
Ecological niche	Coastal, benthic-feeding
Redlist Norway	Not listed
Redlist, Svalbard	Not listed

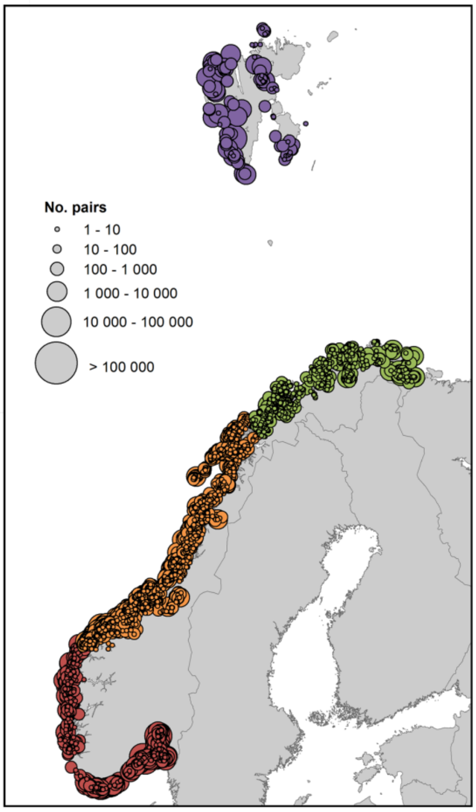
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	16	3	794	3502	1983	1993	36 298	36 917	55 000
Norwegian Sea	27	1	2471	4243	1988	1988	84 502	40 812	100 000
Barents Sea	21	0	840	2505	1988	2005	9 004	8 777	35 000
Total							**129 804**	**86 506**	**190 000**
Svalbard									
Bjørnøya							100		
Spitsbergen	1	1	116	116	2008	2008	17 000		
Total							**17 100**		
Global population[2]							**3 100 000 – 3 800 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea, Norwegian Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	Population size (number of pairs)	Population trend
Finland		
Sweden	30 000[1]	Declining[1]
Denmark	2 200[1]	Increasing[1]
Faeroes	6 000[1]	Increasing[1]
UK		
Iceland	300 000[1]	No overall trend[1]
Greenland	6 000[1]	Increasing[1]
Canada-Atlantic		
Canada-Pacific		Stable[2]
US-Pacific		Stable[2]

[1]Frederiksen (2010), [2]Flint (2013)

Diet (no. of cases)

Prey item	Summer		Non-breeding
	Adult	Chicks	
Gadoids			
Polar cod			
Capelin			
Herring			
Sprat			
Sandeel			
Other fish			1
Squid			
Crustaceans	2		1
Other invertebrates	2		5
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		Episodic observations		Population level effects		
		Breeding success	Adult survival	Breeding success	Adult survival	Population growth
Direct	*Climate hazards*					
	Fisheries bycatch		3			
	Harvest & intentional killing	5 (1)	5			1
	Pollution		5 (4)	2	1	1 (1)
	Predation & parasitism		1 (1)	5 (1)	1 (1)	3 (3)
	Disturbance					1
	Human infrastructure		1			2 (1)
	Disease		4	2	2 (1)	2
Indirect	*Climate*					4 (1)
	Climate & food		1			
	Trophic interactions & food					
	Fisheries & food-competition		1			
	Fisheries & food- discards					
	Food		1	1		2
	Food (sum)		3	1		2

3.7 Common Gull *Larus canus*

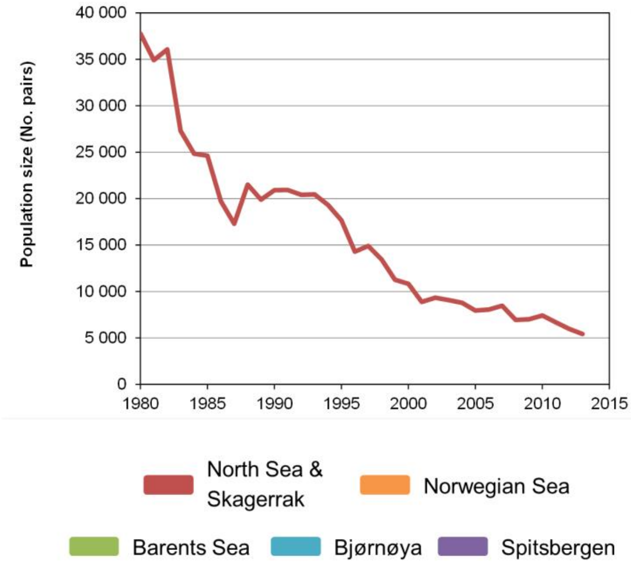
Ecological niche	Coastal, surface-feeding
Redlist, Norway	Near threatened
Redlist, Svalbard	-

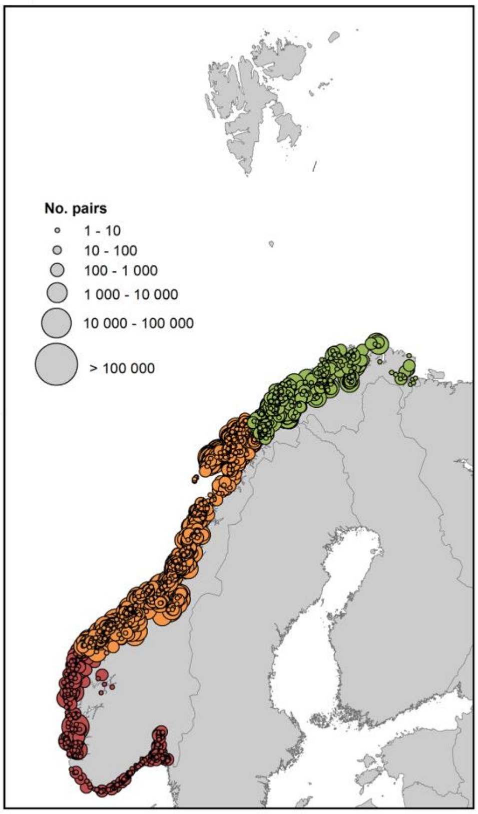
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	12	8	1097	4094	1978	1982	25 407	5 397	50 000
Norwegian Sea	4	0	1765	2629	1982	1983	37 262		75 000
Barents Sea	1	0	555	756	1988	1989	10 500		10 000
Total							73 169		135 000
Svalbard									
Bjørnøya							3		
Spitsbergen							0		
Total							**3**		
Global population[2]							**410 000 – 660 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
Sweden	100 000-200 000	No overall trend[1]
Finland	50 000-70 000	Increasing[2]
Russia	40 000-60 000	
Denmark	25 000	Declining[1]
UK & Ireland	49 600	Increasing (Scotland)[1]
Faeroes	1 000	No overall trend[1]
Iceland	350-450	No overall trend[1]
Europe	37 000-46 000	

[1]Frederiksen (2010), [2]Virkkala (2006)

Diet (no. of cases)

Prey item	**Summer**		**Non-breeding**
	Adult	**Chicks**	
Gadoids			
Polar cod			
Capelin			
Herring			1
Sprat			
Sandeel			
Other fish			1
Squid			
Crustaceans			
Other invertebrates	2		1
Offal			
Other	1		

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		*Episodic observations*		*Population level effects*		
		Breeding success	*Adult survival*	*Breeding success*	*Adult survival*	*Population growth*
Direct	*Climate hazards*					
	Fisheries bycatch					
	Harvest & intentional killing	1 (1)	1 (1)			
	Pollution					
	Predation & parasitism	1	1	2	1	1
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*					
	Climate & food					
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food					
	Food (sum)					

3.8 Lesser Black-backed Gull *Larus fuscus*[2]

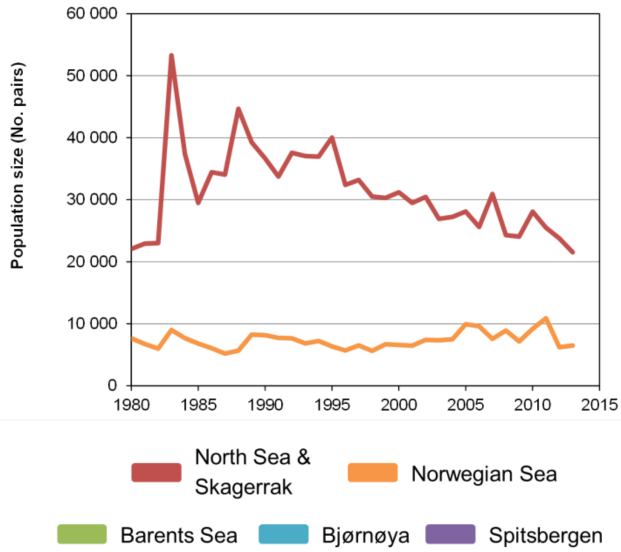
Ecological niche	Pelagic, surface-feeding
Redlist Norway	Not listed
Redlist, Svalbard	-

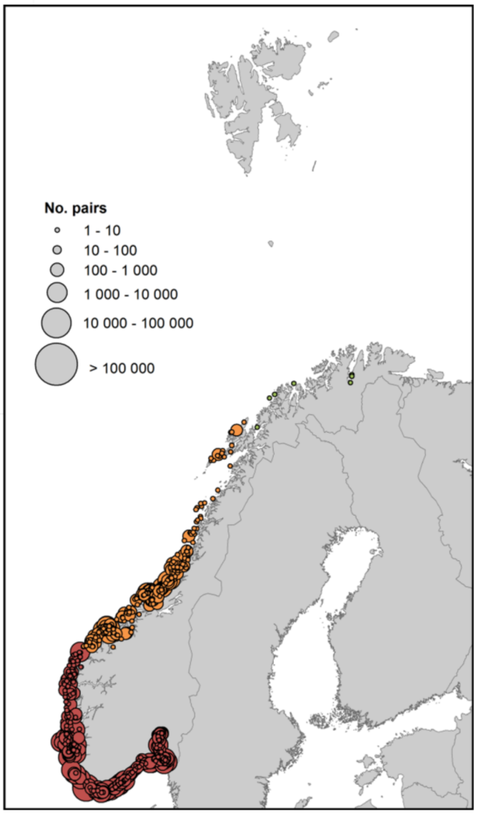
Samples and population sizes (no. of breeding pairs)

	Monitoring data		Census data				Population estimates		
	Total no. series	No. long series	No. loc-ations	No. Counts	Year first count	Year last count	Last count	2013-es-timate	2005-es-timate[1]
Norwegian mainland									
North Sea & Skagerrak	18	12	580	3118	1980	1993	22 749	21 545	48 000
Norwegian Sea	26	0	495	1484	1982	1983	5 841	6 481	c. 2000
Barents Sea	0	0	29	58	1985	2005	85	25	< 300
Total							28 675	28 051	50 300
Svalbard									
Bjørnøya							0		
Spitsbergen							0		
Total							**0**		
Global population[2]							**267 000 – 316 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Norwegian Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

[2] *L. fuscus fuscus* and *L. fuscus intermedius*

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
Sweden	15 000-20 000	No overall trend[1]
Finland	6 000-8 000	Declining[2]
Russia	2 120-2 300	
UK & Ireland	121 800	Stable or declining[3]
Denmark	4 400	Declining[1]
Faeroes	9 000	Declining[1]
Iceland	25 000	Declining[1]
Greenland	>700	Increasing[1]
Europe	85 000-110 000	

[1]Frederiksen (2010), [2]Virkkala (2006), [3]JNCC (2013)

Diet (no. of cases)

Prey item	**Summer**		**Non-breeding**
	Adult	**Chicks**	
Gadoids		2	
Polar cod			
Capelin			
Herring	1	3	
Sprat	1	1	
Sandeel		1	
Other fish	4	1	
Squid			
Crustaceans	2		
Other invertebrates	5	1	
Offal	4		
Other	3	2	

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

	Drivers	*Episodic observations*		*Population level effects*		
		Breeding success	*Adult survival*	*Breeding success*	*Adult survival*	*Population growth*
Direct	*Climate hazards*					1
	Fisheries bycatch					
	Harvest & intentional killing	2	2	1		1
	Pollution			3 (1)	1 (1)	1
	Predation & parasitism			2		1
	Disturbance					
	Human infrastructure					
	Disease	1	2			
Indirect	*Climate*					1 (1)
	Climate & food					1
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food			1		3
	Food (sum)					3

3.9 Herring Gull *Larus argentatus*

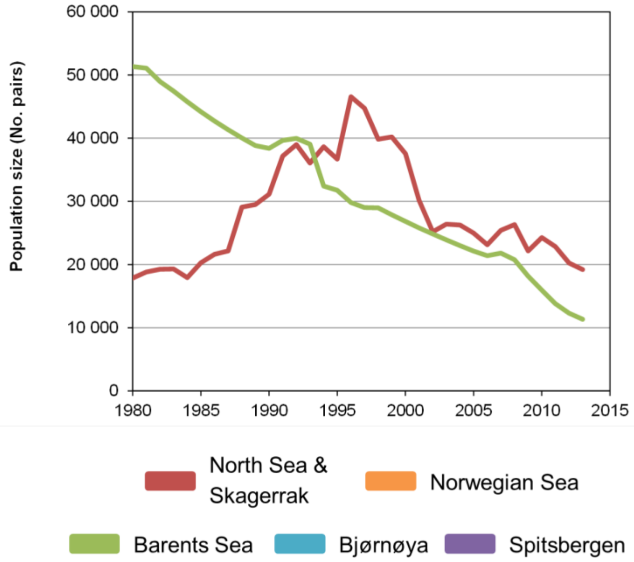
Ecological niche	Coastal, surface-feeding
Redlist Norway	Not listed
Redlist, Svalbard	-

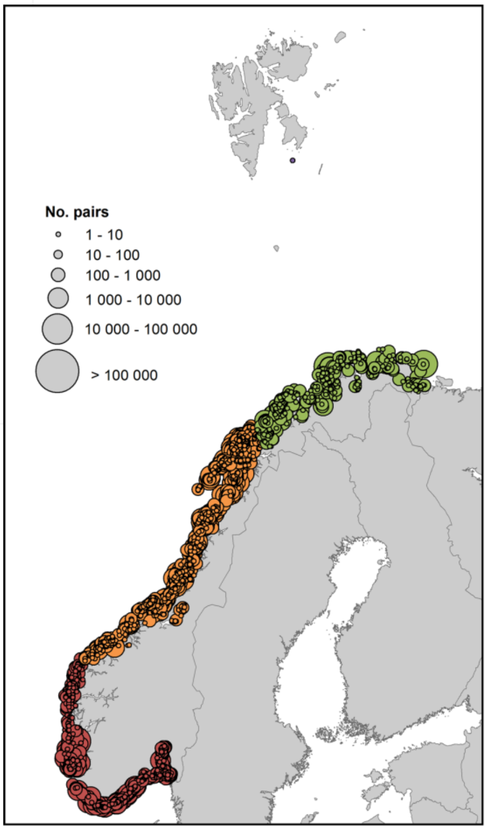
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	26	11	835	4039	1978	1986	16 260	19 201	33 000
Norwegian Sea	7	0	1466	2280	1982	1983	41 553		100 000
Barents Sea	1	0	664	1376	1987	2005	33 631	11 429	100 000
Total							**91 444**		**233 000**
Svalbard									
Bjørnøya							0		
Spitsbergen							0		
Total							**0**		
Global population[2]							**1 100 000 – 1 200 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	Population size (number of pairs)	Population trend
Sweden	60 000-100 000	Declining[1]
Finland	28 300	Increasing[2]
UK & Ireland	149 500	Declining[3]
Faeroes	1 500	No overall trend[1]
Iceland	2 500	Increasing?[1]
Greenland	<50[1]	No overall trend[1]
Europe	800 000 – 850 000	

[1]Frederiksen (2010), [2] Virkkala (2006), [3]JNCC (2013)

Diet (no. of cases)

Prey item	Summer		Non-breeding
	Adult	Chicks	
Gadoids			
Polar cod			
Capelin			
Herring	1	1	
Sprat		1	
Sandeel			
Other fish	4	4	2
Squid			
Crustaceans	3	2	
Other invertebrates	5	3	
Offal	1		
Other	6	5	1

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

	Drivers	Episodic observations		Population level effects		
		Breeding success	Adult survival	Breeding success	Adult survival	Population growth
Direct	Climate hazards	1				
	Fisheries bycatch		1 (1)			
	Harvest & intentional killing	3	1 (1)	3		3
	Pollution		3 (3)			1 (1)
	Predation & parasitism	2		1		2
	Disturbance					
	Human infrastructure					
	Disease	1	2	1		1
Indirect	Climate					
	Climate & food					
	Trophic interactions & food				1	
	Fisheries & food-competition					
	Fisheries & food- discards			1		4
	Food	2 (2)				
	Food (sum)	2 (2)		1	1	4

3.10 Glaucous Gull *Larus hyperboreus*

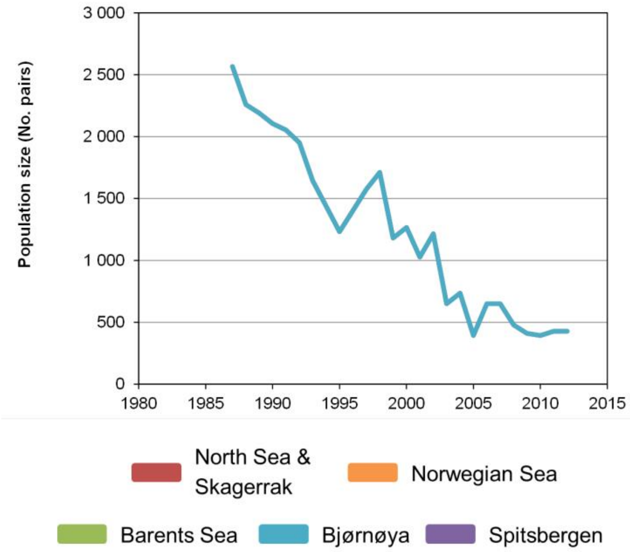
Ecological niche	Pelagic, surface-feeding
Redlist, Norway	-
Redlist, Svalbard	Near threatened

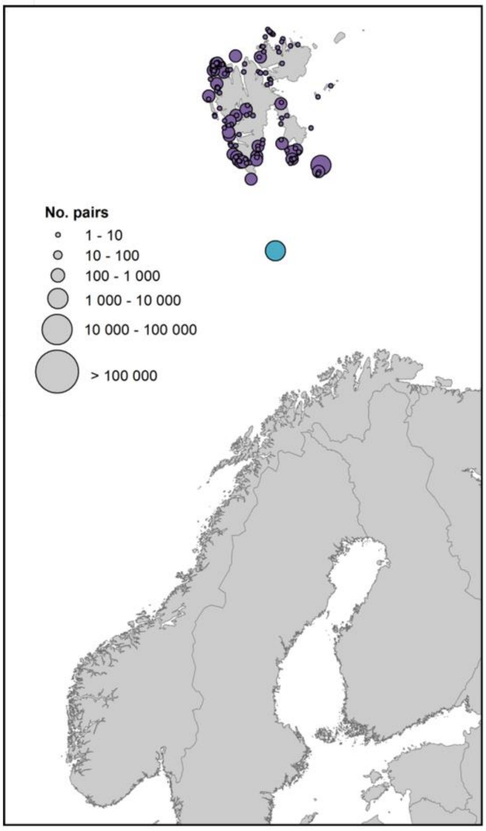
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate[1]*
Norwegian mainland									
North Sea & Skagerrak							0		0
Norwegian Sea							0		0
Barents Sea							0		0
Total							**0**		**0**
Svalbard									
Bjørnøya	1	1	1	1	2006	2006	650	427	
Spitsbergen[3]	1	0	154	155	2008	2008	3600		
Total							**4250**		
Global population[2]							**170 000 – 1 200 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Bjørnøya)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	Population size (number of pairs)	Population trend
Russia		
Iceland	8 000[2]	Declining[1]
Greenland	150 000[2]	No overall trend[1]
Canada		
North America	85 000[2]	

[1]Frederiksen (2010), [2]Weiser and Gilchrist (2012)

Diet (no. of cases)

Prey item	Summer		Non-breeding
	Adult	Chicks	
Gadoids			
Polar cod	3		1
Capelin			
Herring			
Sprat			
Sandeel			
Other fish	6	5	1
Squid			
Crustaceans	6	2	
Other invertebrates	4	2	2
Offal	3	1	1
Other	1	8	

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		Episodic observations		Population level effects		
		Breeding success	Adult survival	Breeding success	Adult survival	Population growth
Direct	Climate hazards					
	Fisheries bycatch					
	Harvest & intentional killing	6 (1)	6 (1)			
	Pollution			2 (1)	1 (1)	1 (1)
	Predation & parasitism		1 (1)			
	Disturbance					
	Human infrastructure					
	Disease		1			
Indirect	Climate					
	Climate & food					
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards			1		
	Food					
	Food (sum)			1		

3.11 Great Black-backed Gull *Larus marinus*

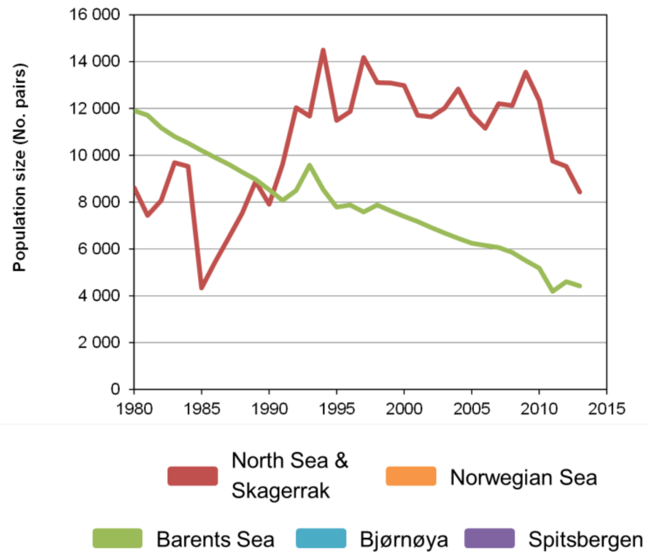
Ecological niche	Coastal, surface-feeding
Redlist, Norway	Not listed
Redlist, Svalbard	Not listed

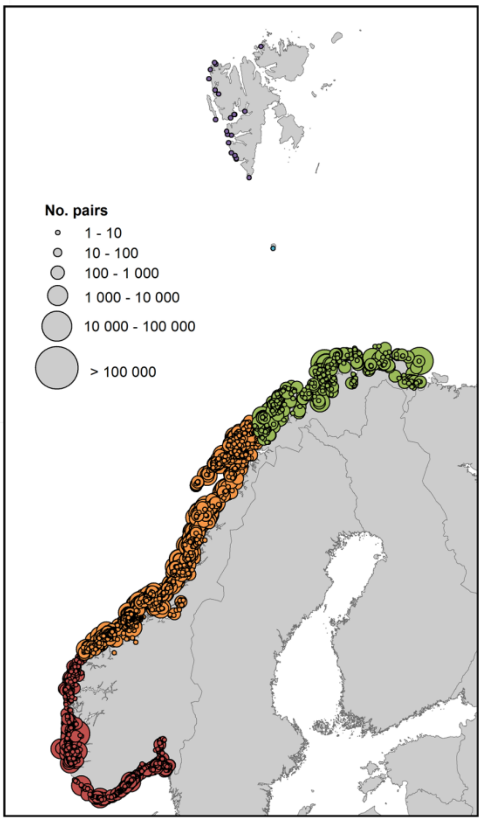
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	5	4	1021	4260	1979	1984	7 412	8 423	8 500
Norwegian Sea	6	0	1989	3045	1982	1982	26 842		30 000
Barents Sea	1	0	749	1577	1988	2005	7 434	4 549	15 000
Total							**41 688**		**53 500**
Svalbard									
Bjørnøya	0	0	1	1	2006	2006	20		
Spitsbergen	0	0	23	23	2008	2008	80		
Total							**100**		
Global population[2]									**170 000 – 180 000**

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
Sweden	15 000	No overall trend[1]
Finland	2 800	
Russia	3 000-4 000	
Denmark	1 500-1 600	Increasing[1]
UK & Ireland	19 300	Declining [2]
Faeroes	1 200	No overall trend[1]
Iceland	15 000-20 000	Declining[1]
Greenland	3 000-5 000	Increasing[1]
Europe	6 000-9 000	
North America	60 000	

[1]Frederiksen (2010), [2]JNCC (2013)

Diet (no. of cases)

Prey item	Summer		Non-breeding
	Adult	Chicks	
Gadoids			
Polar cod			
Capelin			
Herring	2		
Sprat			
Sandeel			
Other fish	4	3	
Squid			
Crustaceans	2	1	
Other invertebrates	1	1	
Offal	1	1	
Other	4	3	

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		*Episodic observations*		*Population level effects*		
		Breeding success	*Adult survival*	*Breeding success*	*Adult survival*	*Population growth*
Direct	*Climate hazards*					
	Fisheries bycatch		1 (1)			
	Harvest & intentional killing	4 (1)	5 (1)	1		1
	Pollution		1 (1)	2 (2)	1 (1)	1 (1)
	Predation & parasitism	1		1		2
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*					
	Climate & food					
	Trophic interactions & food					
	Fisheries & food-competition				2	
	Fisheries & food- discards					
	Food			2 (2)		
	Food (sum)			2 (2)	2	

3.12 Black-legged Kittiwake *Rissa tridactyla*

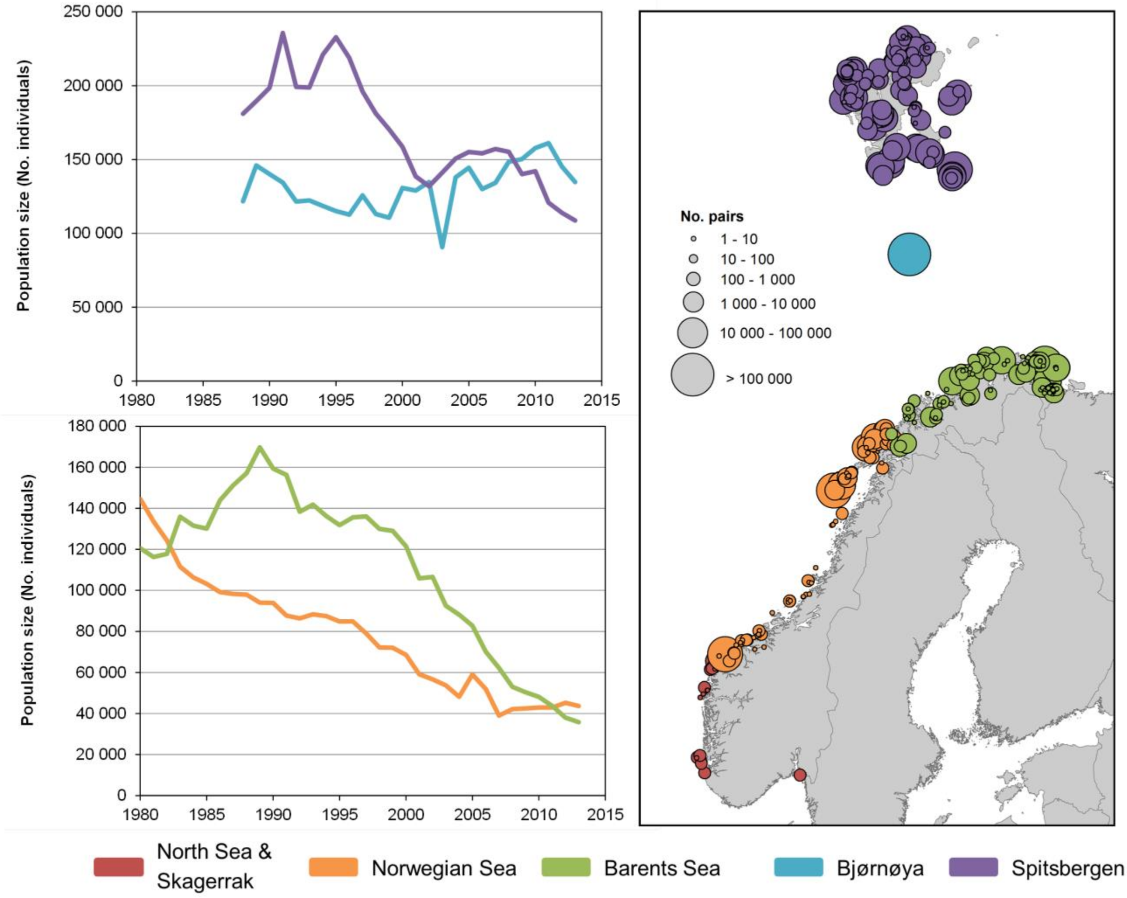
Ecological niche	Pelagic, surface-feeding
Redlist, Norway	Endangered
Redlist, Svalbard	Near threatened

Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	0	0	23	62	1978	1984	1 880		6 000
Norwegian Sea	5	3	123	364	1981	1990	76 216	44 424	80 000
Barents Sea	22	2	214	1279	1979	2009	106 482	37 045	250 000
Total							**184 578**		**336 000**
Svalbard									
Bjørnøya	1	1	1	1	2006	2006	130 000	134 755	
Spitsbergen	9	2	110	110	2007	2007	153 689	108 717	
Total							**283 689**	**243 472**	
Global population[2]							**4 300 000 – 5 200 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution



Left: Regional dynamics in breeding populations (Spitsbergen, Bjørnøya, Barents Sea and Norwegian Sea)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
Russia (Barents Sea)	136 900-146 900	
Sweden	30	No overall trend[1]
Denmark	625	No overall trend[1]
Germany	6 500	Stable or increasing[2]
France	4 690	
Spain	200	
Portugal	3-10	
UK & Ireland	419 000	Declining (Scotland)[1]
Faeroes	230 000	Declining[1]
Iceland	600 000-800 000	Declining[1]
Greenland	100 000-200 000	Declining[1]
Canada	256 500	
Russia (excl. Barents Sea)	1 036 000-1 361 000	
USA(Alaska)	770 000	

[1]Frederiksen (2010), Markones et al. (2009)

Diet (no. of cases)

Prey item	**Summer**		**Non-breeding**
	Adult	**Chicks**	
Gadoids	3	5	1
Polar cod	3	1	1
Capelin	4	5	1
Herring	5	9	
Sprat	2	4	
Sandeel	9	12	1
Other fish	2	5	1
Squid	1	1	
Crustaceans	4	3	
Other invertebrates	1	2	1
Offal	1	1	1
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		*Episodic observations*		*Population level effects*		
		Breeding success	*Adult survival*	*Breeding success*	*Adult survival*	*Population growth*
Direct	*Climate hazards*			1 (1)		
	Fisheries bycatch					
	Harvest & intentional killing	3	4			
	Pollution			2	2	1
	Predation & parasitism	4 (2)	1	1 (1)	2	3
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*			1	2 (1)	
	Climate & food			8		3
	Trophic interactions & food			2 (1)	1	
	Fisheries & food-competition			1	1	
	Fisheries & food- discards			1		1
	Food		2 (1)	7 (1)	2 (1)	1
	Food (sum)		2 (1)	19 (2)	4 (1)	5

3.13 Arctic Tern *Sterna paradisaea*

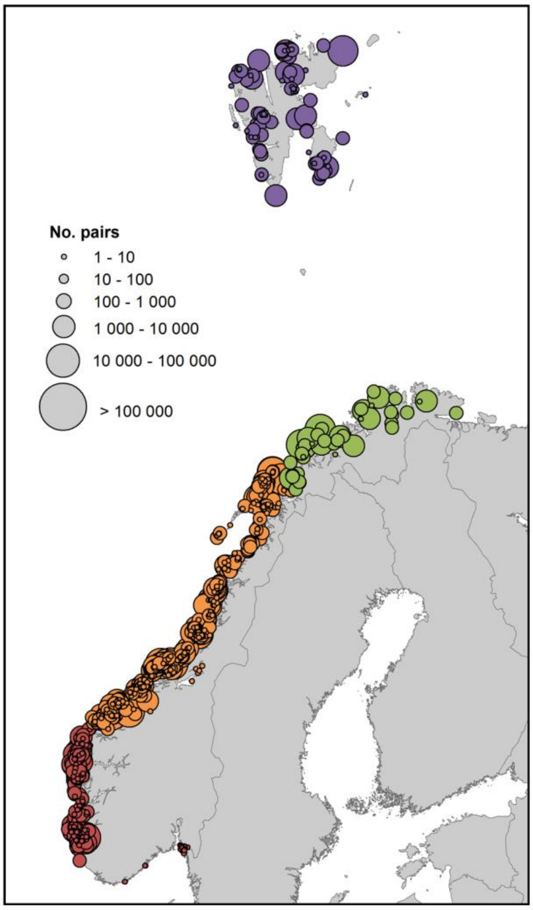
Ecological niche	Coastal, surface feeding
Redlist Norway	Not listed
Redlist, Svalbard	Not listed

Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-esti-mate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	0	0	231	439	1982	1983	6 782		5 100
Norwegian Sea	0	0	610	800	1982	1982	25 668		20 000
Barents Sea	1	0	213	443	1982	2005	3 981		10 000
Total							**36 431**		**35 100**
Svalbard									
Bjørnøya							50		
Spitsbergen	0	0	95	96	2008	2008	5 497		
Total							**5 547**		

[1]Barrett et al. (2006)

Norwegian populations; distribution



Right: Distribution and size of breeding colonies. Trends not available.

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	***Population size (number of pairs)***	***Population trend***
Denmark	8 000-9 000	Declining[1]
Iceland	250 000-500 000	Declining[1]
UK & Ireland	56 100	No overall trend (Scotland)[1]
Faeroes	2 000	Declining[1]
Finland	50 000-60 000	
Russia	25 000-30 000	
Sweden	20 000-25 000	No overall trend[1]
Greenland	65 000[2]	Declining[2]
Europe	15 000-16 500	
North America (east)	10 000-1 000 000	
Alaska	300 000-900 000	

[1]Frederiksen (2010), [2]Egevang and Boertmann (2003)

Diet (no. of cases)

Prey item	**Summer**		**Non-bree-ding**
	Adult	**Chicks**	
Gadoids		2	
Polar cod			
Capelin		1	
Herring		2	
Sprat			
Sandeel		3	
Other fish		2	
Squid			
Crustaceans	1		
Other invertebrates		1	
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		***Episodic observations***		***Population level effects***		
		Breeding success	***Adult survival***	***Breeding success***	***Adult survival***	***Population growth***
Direct	*Climate hazards*	1				
	Fisheries bycatch					1
	Harvest & intentional killing	2	2			
	Pollution					
	Predation & parasitism			4		4
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*					
	Climate & food					
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food	1		3		1
	Food (sum)	1		2		

3.14 Common Guillemot *Uria aalge*

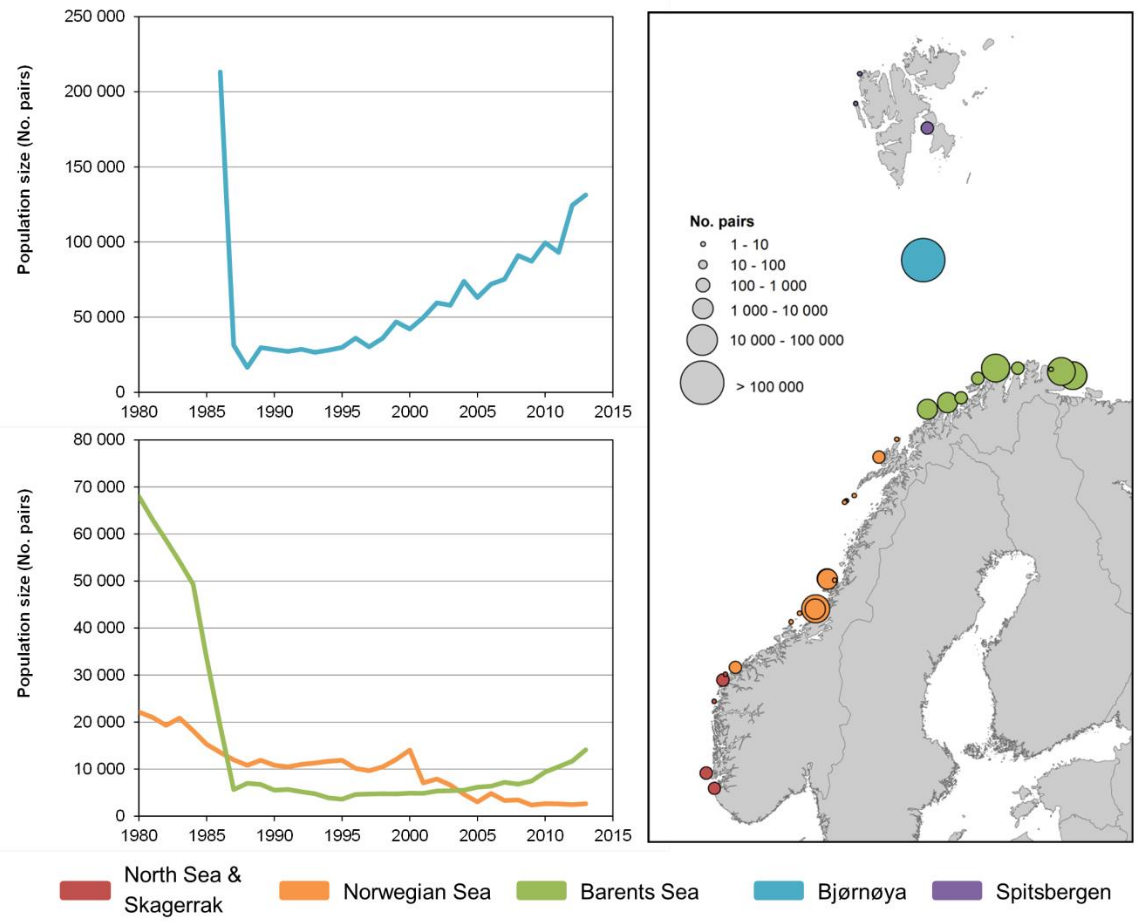
Ecological niche	Pelagic, diving
Redlist Norway	Critically endangered
Redlist, Svalbard	Vulnerable

Samples and population sizes (no. of breeding pairs)

	Monitoring data		***Census data***				***Population estimates***		
	Total no. series	***No. long series***	***No. loc-ations***	***No. Counts***	***Year first count***	***Year last count***	***Last count***	***2013-es-timate***	***2005-es-timate[1]***
Norwegian mainland									
North Sea & Skagerrak	0	0	9	32	2000	2008	188	46	150
Norwegian Sea	3	3	26	37	1984	1985	11 326	2 641	< 5 000
Barents Sea	3	2	16	66	1979	2008	17 837	14 094	< 10 000
Total							29 351	16 781	**15 000**
Svalbard									
Bjørnøya	1	1	1	1	2006	2006	72 000	131 394	
Spitsbergen	0	0	3	3	2008	2008	100		
Total							72 100		
Global population[2]							**7 300 000 – 7 400 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution



Left: Regional dynamics in breeding populations (Bjørnøya, Barents Sea and Norwegian Sea)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	Population size (number of pairs)	Population trend
UK & Ireland	1 050 000	Increasing[1]
Faeroes	175 000	Declining[2]
Iceland	990 000	Declining[2]
Russia	20 000-30 000	
Sweden	12 500	Increasing[3]
Denmark	2 500	
Finland	50	
Greenland	2 000	Declining[1]
Europe	3 800	
Canada	500 000	
Pacific	4 500 000	

[1]JNCC (2013), [2]Frederiksen (2010), [1]Peterz and Blomqvist (2010)

Diet (no. of cases)

Prey item	Summer		Non-bree-ding
	Adult	Chicks	
Gadoids	3	4	2
Polar cod	1		1
Capelin	4	6	3
Herring	1	3	1
Sprat		2	1
Sandeel	4	8	
Other fish		2	1
Squid	1	1	
Crustaceans	1		2
Other invertebrates			
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		Episodic observations		Population level effects		
		Breeding success	Adult survival	Breeding success	Adult survival	Population growth
Direct	*Climate hazards*				1	
	Fisheries bycatch		4 (2)			1
	Harvest & intentional killing	2	4			1
	Pollution		5		1	
	Predation & parasitism	1	1	3 (2)		5 (2)
	Disturbance			1		1
	Human infrastructure					
	Disease					
Indirect	*Climate*				2 (1)	1 (1)
	Climate & food	1	1 (1)	1 (1)		1 (1)
	Trophic interactions & food			2		
	Fisheries & food-competition			3 (2)		2 (2)
	Fisheries & food- discards					
	Food		1	2	1	1 (1)
	Food (sum)	1	2 (1)	8 (3)	1	4 (4)

3.15 Brünnich's Guillemot *Uria lomvia*

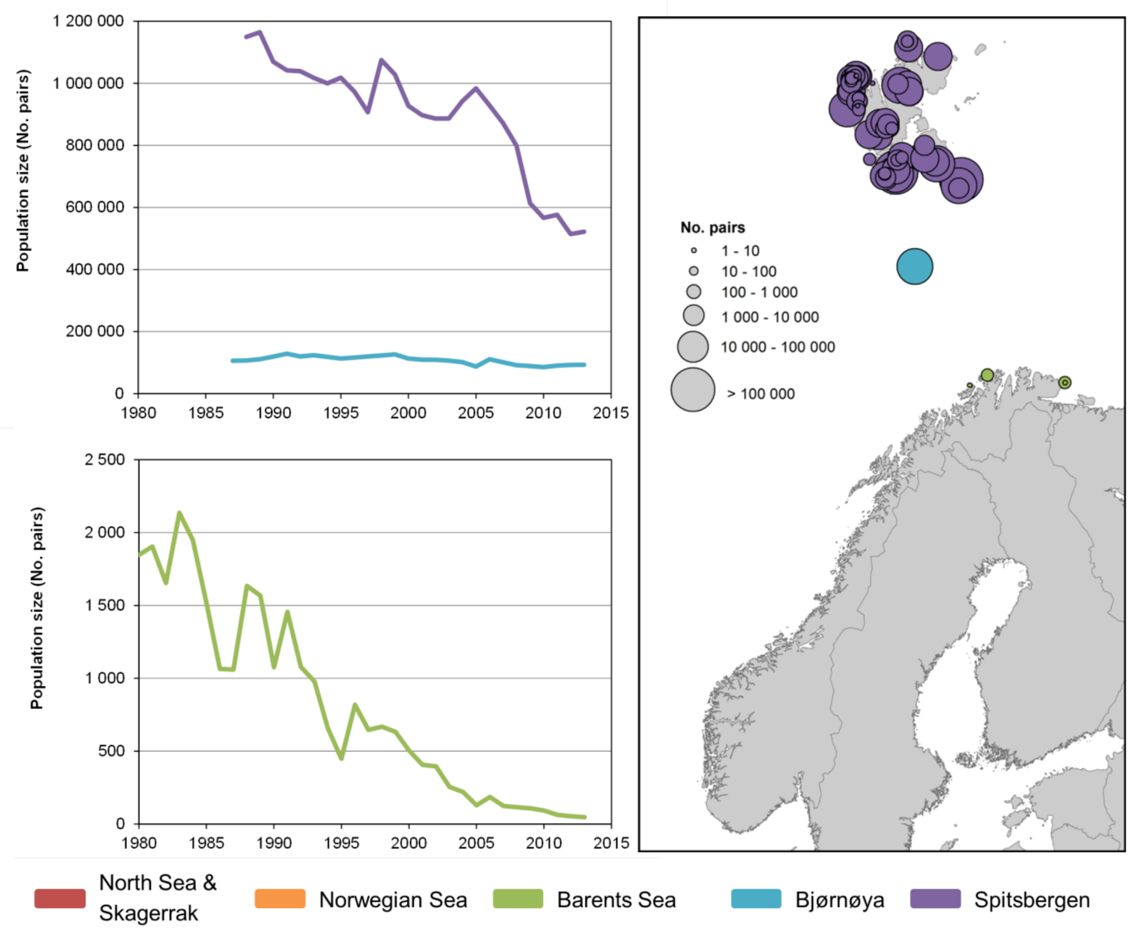
Ecological niche	Pelagic, diving
Redlist Norway	Vulnerable
Redlist, Svalbard	Near threatened

Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak							0		
Norwegian Sea	0	0	2	3	1974	1983	21		< 10
Barents Sea	2	1	10	17	1984	1992	399	47	< 1 500
Total							**420**		
Svalbard									
Bjørnøya	1	1	1	1	2006	2006	111 000	93 449	
Spitsbergen	8	1	69	69	2008	2008	708 493	521 996	
Total							**819 493**	**615 445**	
Global population[2]							**4 000 000 – 7 500 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution



Left: Regional dynamics in breeding populations (Spitsbergen, Bjørnøya and Barents Sea)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
Russia	1 051 000	
Iceland	800 000-2 000 000	Declining[1]
Greenland	465 000	Declining[1]
Canada	1 454 000	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	**Summer**		**Non-breeding**
	Adult	**Chicks**	
Gadoids	2	2	1
Polar cod	3	4	4
Capelin	3	7	2
Herring	1	1	
Sprat			
Sandeel	3	4	
Other fish	3	5	
Squid		2	
Crustaceans	6		4
Other invertebrates	2		
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		*Episodic observations*		*Population level effects*		
		Breeding success	*Adult survival*	*Breeding success*	*Adult survival*	*Population growth*
Direct	*Climate hazards*		1			
	Fisheries bycatch					
	Harvest & intentional killing	2	4		1 (1)	1
	Pollution		1 (1)			1
	Predation & parasitism	2	2	2		2
	Disturbance					
	Human infrastructure		1			
	Disease					
Indirect	*Climate*			3	1	4
	Climate & food					1
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food					
	Food (sum)					1

3.16 Razorbill *Alca torda*

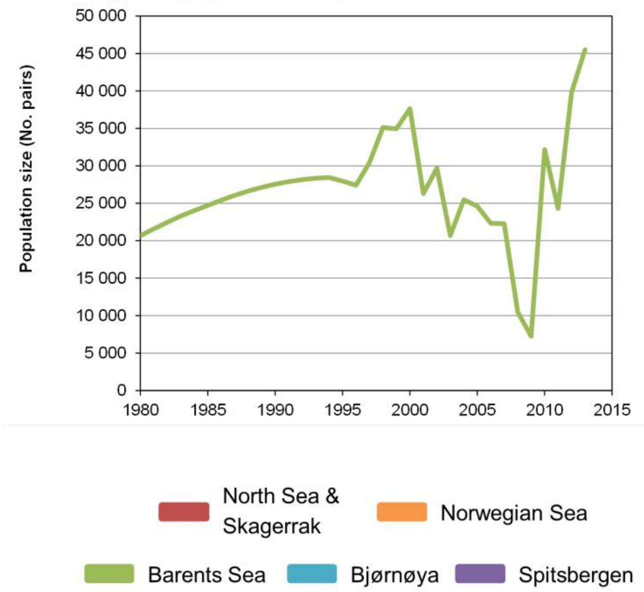
Ecological niche	Pelagic, diving
Redlist Norway	Vulnerable
Redlist, Svalbard	Endangered

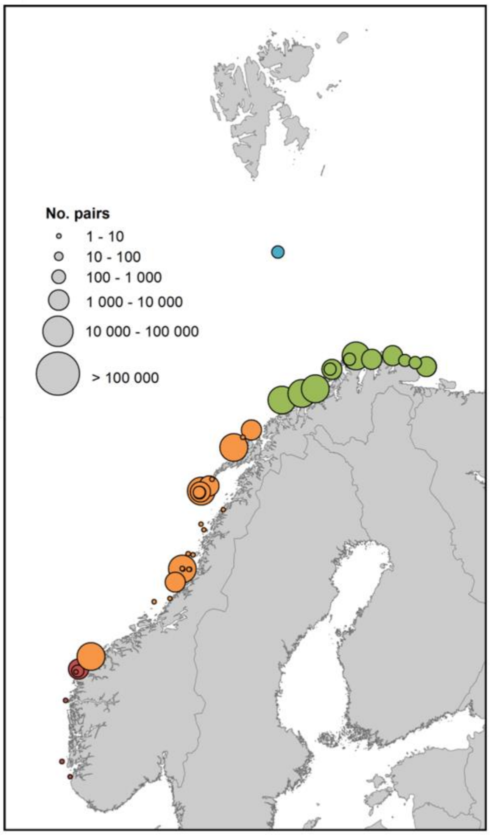
Samples and population sizes (no. of breeding pairs)

	Monitoring data		***Census data***				***Population estimates***		
	Total no. series	***No. long series***	***No. loc-ations***	***No. Counts***	***Year first count***	***Year last count***	***Last count***	***2013-es-timate***	***2005-es-timate***[1]
Norwegian mainland									
North Sea & Skagerrak	0	0	7	33	1977	2008	150		300
Norwegian Sea	2	1	26	63	1984	1985	8 108		< 10 000
Barents Sea	1	0	19	54	1974	2008	24 630	45 498	< 15 000
Total							**32 888**		
Svalbard									
Bjørnøya			1	1	2006	2006	18		
Spitsbergen							20		
Total							**38**		
Global population[2]									**610 000 – 630 000**

[1]Barrett et al. (2006), [2]Mitchell et al. (2004)

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	***Population size (number of pairs)***	***Population trend***
UK & Ireland	145 000	Increasing (Scotland)?[1]
Denmark	610	
Faeroes	4 500	Declining?[1]
Finland	6 000 - 6 500	
France	25	
Germany	16	
Greenland	2 000 - 5 000	No overall trend[1]
Iceland	380 000	Declining?[1]
Russia	3 500	
Sweden	9 000 - 11 000	Increasing[1]
Canada (East)	37 800	
USA (Maine)	277	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	**Summer**		**Non-breeding**
	Adult	**Chicks**	
Gadoids		2	
Polar cod			
Capelin	1	2	
Herring		3	
Sprat			
Sandeel	1	3	
Other fish			
Squid			
Crustaceans			
Other invertebrates			
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		***Episodic observations***		***Population level effects***		
		Breeding success	***Adult survival***	***Breeding success***	***Adult survival***	***Population growth***
Direct	*Climate hazards*					
	Fisheries bycatch		3 (1)			
	Harvest & intentional killing	1	4		1	1
	Pollution					
	Predation & parasitism	1 (1)				2
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*				2 (1)	
	Climate & food				1 (1)	1
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food		1 (1)	1		2
	Food (sum)		1 (1)	1	1 (1)	3

3.17 Black Guillemot *Cepphus grylle*

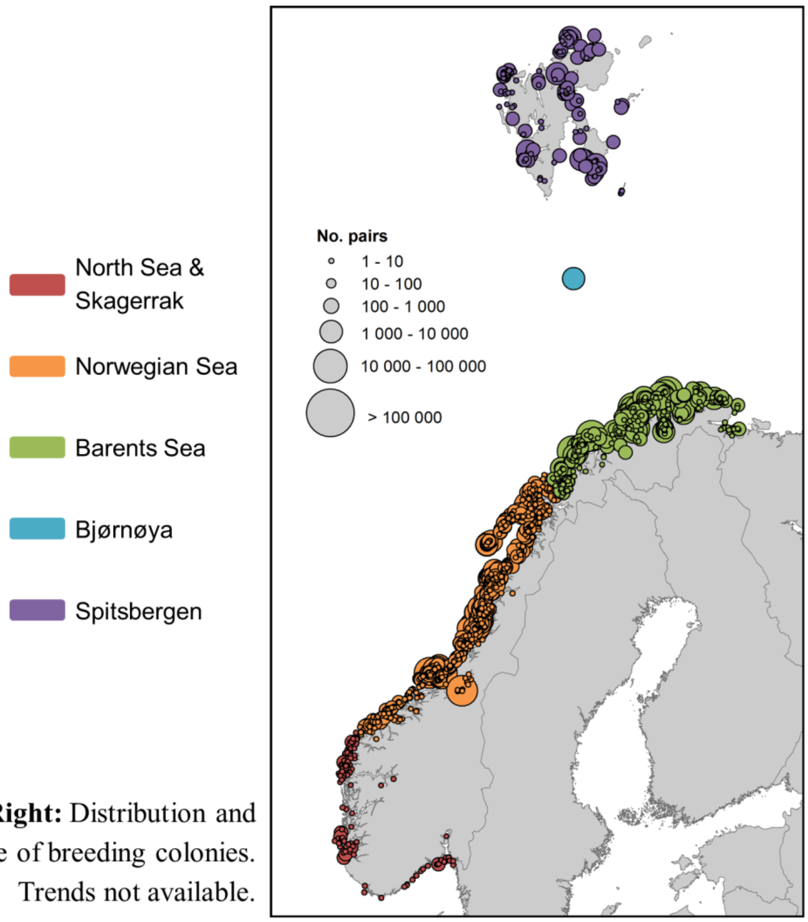
Ecological niche	Coastal, diving
Redlist Norway	Vulnerable
Redlist, Svalbard	Not listed

Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate[1]*
Norwegian mainland									
North Sea & Skagerrak	0	0	179	500	1982	1995	646		380
Norwegian Sea	4	0	1033	1456	1982	1983	21 020		15 000
Barents Sea	0	0	368	603	1984	1987	19 272		20 000
Total							**40 938**		
Svalbard									
Bjørnøya[3]	0	0	1	1	2006	2006	300		
Spitsbergen[3]	0	0	139	139	2008	2008	2 797		
Total							**3 097**		
Global population[2]									**260 000 – 410 000**

[1]Barrett et al. (2006), [2]Mitchell et al. (2004), [3]Grossly underestimated on Bjørnøya and Spitsbergen.

Norwegian populations; distribution



Right: Distribution and size of breeding colonies. Trends not available.

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
UK & Ireland	21 300-42 500	Increasing (Scotland)[1]
Denmark	1 067-1 111	Increasing[1]
Estonia	6-10	
Faeroes	3 500	Increasing?[1]
Finland	12 000-15 000	
Iceland	30 000-50 000	Declining[1]
Russia (Barents & White Seas)	2 710	
Sweden	7 000-10 000	Declining[1]
Canada	71 500	
Greenland	22 950-64 750	No overall trend[1]
Russia	55 150	
USA (Maine)	5 000	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	Summer		Non-bree-ding
	Adult	Chicks	
Gadoids		1	
Polar cod	3		1
Capelin			
Herring			
Sprat			
Sandeel		1	
Other fish	2	2	1
Squid			
Crustaceans	3		
Other invertebrates	1		1
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		*Episodic observations*		*Population level effects*		
		Breeding success	*Adult survival*	*Breeding success*	*Adult survival*	*Population growth*
Direct	*Climate hazards*					
	Fisheries bycatch		4 (2)			2 (2)
	Harvest & intentional killing	3	5			
	Pollution		1 (1)			
	Predation & parasitism			1	1	3 (1)
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*				1 (1)	
	Climate & food					
	Trophic interactions & food					
	Fisheries & food-competition					
	Fisheries & food- discards					
	Food					
	Food (sum)					

3.18 Atlantic Puffin *Fratercula arctica*

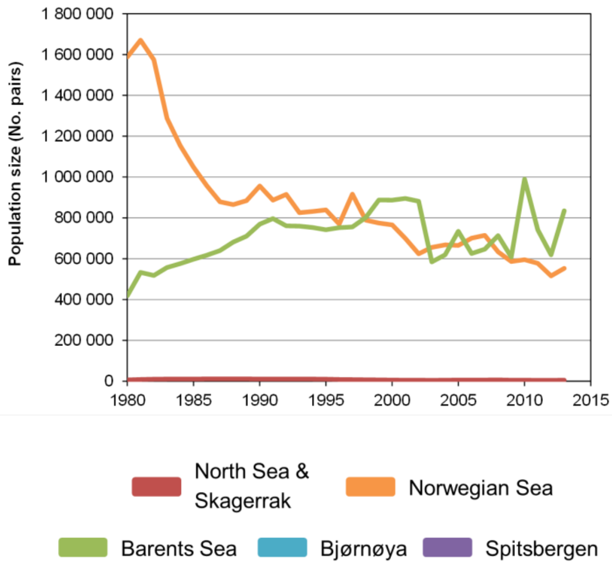
Ecological niche	Pelagic, diving
Redlist, Norway	Vulnerable
Redlist, Svalbard	Not listed

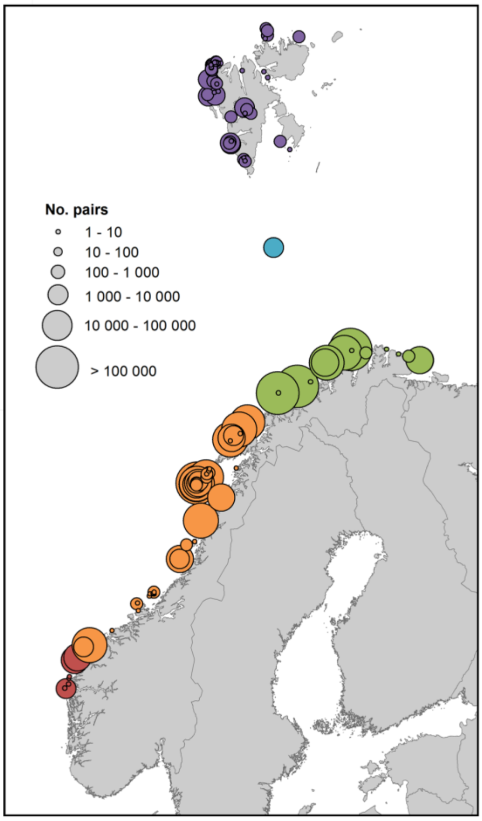
Samples and population sizes (no. of breeding pairs)

	Monitoring data		*Census data*				*Population estimates*		
	Total no. series	*No. long series*	*No. loc-ations*	*No. Counts*	*Year first count*	*Year last count*	*Last count*	*2013-es-timate*	*2005-es-timate*[1]
Norwegian mainland									
North Sea & Skagerrak	1	0	14	49	1979	2005	5 184	4998	14 000
Norwegian Sea	5	3	62	118	1982	1988	939 958	552 718	800 000
Barents Sea	2	1	16	55	1982	2007	939 313	907 259	900 000
Total							**1 884 455**	**1 464 975**	**1714000**
Svalbard									
Bjørnøya[3]	0	0	1	1	2006	2006	360		
Spitsbergen[3]	0	0	58	60	2007	2007	1 686		
Total							2 046		
Global population[2]							**5 500 000 – 6 600 000**		

[1]Barrett et al. (2006), [2]Mitchell et al. (2004), [3]Grossly underestimated on Bjørnøya and Spitsbergen.

Norwegian populations; trends and distribution





Left: Regional dynamics in breeding populations (Barents Sea, Norwegian Sea and North Sea & Skagerrak)

Right: Distribution and size of breeding colonies

International populations; status and trends

From Mitchell et al. (2004), unless stated otherwise

Region	*Population size (number of pairs)*	*Population trend*
Russia	5 050	Stable
Iceland	2 500 000- 3 000 000	Declining[1]
Faeroes	550 000	Declining[1]
Britain and Ireland	621 000	Increasing
France	257	Stable, but small
Greenland	5 300 - 8 300	Declining[1]
Canada	350 000 - 400 000	Stable or increasing
US	550	

[1]Frederiksen (2010)

Diet (no. of cases)

Prey item	**Summer**		**Non-bree-ding**
	Adult	**Chicks**	
Gadoids		11	
Polar cod			
Capelin	3	4	1
Herring	1	12	
Sprat		2	
Sandeel	3	13	1
Other fish	2	1	
Squid			
Crustaceans			3
Other invertebrates	1		1
Offal			
Other			

Drivers of population dynamics

No. of reported cases, Norwegian studies in parentheses

Drivers		***Episodic observations***		***Population level effects***		
		Breeding success	***Adult survival***	***Breeding success***	***Adult survival***	***Population growth***
Direct	*Climate hazards*	1	2 (1)			
	Fisheries bycatch		1 (1)			1
	Harvest		2 (1)			2
	Pollution					
	Predation & parasitism	2 (1)	3 (1)	1	1	1
	Disturbance					
	Human infrastructure					
	Disease					
Indirect	*Climate*					
	Climate & food			3(1)	5 (1)	
	Trophic interactions & food			3 (1)		
	Fisheries & food-competition			1 (1)		
	Fisheries & food- discards					
	Food			3		
	Food (sum)			10 (3)	5 (1)	

4 Discussion

4.1 Populations trends and dynamics

Our analyses document large fluctuations in the seabird communities in Norway and Svalbard. A summary of the time series is given in Table 2. According to our analyses, 13 of the 35 regional populations assessed have shown more than a 50% decrease during the last 25 years. Declining populations were found in all regions and included all the major ecological groups. Declining populations were: Northern Fulmar (Bjørnøya), Great Cormorant (Norwegian Sea), Common Eider (Norwegian Sea), Common Gull (North Sea & Skagerrak), Lesser Black-backed Gull (North Sea & Skagerrak), Herring Gull (Barents Sea), Glaucous Gull (Bjørnøya), Great Black-backed Gull (Barents Sea), Black-legged Kittiwake (Barents Sea and Norwegian Sea), Common Guillemot (Norwegian Sea), Brünnich's Guillemot (Spitsbergen and Barents Sea) and Atlantic Puffin (North Sea & Skagerrak). In the same period 5 regional populations have more than doubled. These were: Northern Gannet (Barents Sea), Great Cormorant (North Sea & Skagerrak), European Shag (North Sea & Skagerrak) and Common Guillemot (Barents Sea and Bjørnøya). In addition, 8 populations have shown large decadal fluctuations with more than a doubling of the population from the minimum to the maximum estimate: These were: Northern Fulmar (North Sea & Skagerrak), Great Cormorant (Barents Sea), European Shag (Norwegian Sea and Barents Sea), Common Eider (North Sea & Skagerrak), Herring Gull (North Sea & Skagerrak), Black-legged Kittiwake (Spitsbergen) and Razorbill (Barents Sea).

The populations of Common Guillemots in Northern Norway and Bjørnøya have been of particular concern due to the decline during the 1960s and 70s and the subsequent collapse in the populations by 70-90% during the winter 1986-87 (Vader et al. 1990). The population on Bjørnøya has increased considerably since then, and is now close to the pre-collapse level. Although the Barents Sea populations have more than doubled, the populations are still low compared to the estimates before the collapse. In contrast to the Barents Sea and Bjørnøya populations, Common Guillemots in the Norwegian Sea show a persistent decline of more than 75% since the early 1980s.

The large populations of Atlantic Puffin in the Norwegian Sea has, according to the analyses, been reduced from 1.6 million pairs in 1980 to 600 000 at present. Although the percentage reduction of the population the last 25 years is less than 50%, the negative trend has been persistent at least since the early 1980s. In the same period, the Barents Sea colonies have been stable or have increased slightly, and the size of total Barents Sea population has according to our analyses at present surpassed the populations further south.

Notably, our estimates indicate that the large colonies of Brünnich's Guillemot on Spitsbergen have declined from 1.15 million pairs in 1988 to 522 000 pairs in 2013. The colony on Bjørnøya (about 100 000 pairs) has in the same period been stable or declined slightly, while the small populations on the Norwegian mainland have almost disappeared.

Unfortunately, the datasets were incomplete in order to assess several of the large gull species in the Norwegian Sea. However, extensive monitoring in the North Sea & Skagerrak and recent censuses in the Barents Sea suggest declines of more than 50% in several populations of the large gulls. This includes the Black-backed and Herring Gulls in the Barents Sea and Common and Lesser Black-backed Gulls in the North Sea and Skagerrak. Notably, the analyses show that the large populations of Black-legged Kittiwake have declined substantially in all regions except on Bjørnøya. On the Norwegian mainland the population has according to our analyses declined from about 280 000 pairs in 1980 to 82 000 pairs in 2013. On Svalbard (Bjørnøya and Spitsbergen), the population has declined from about 300 000 pairs to 240 000 pairs from 1988 to 2013.

The populations of European Shag and Great Cormorant have fluctuated vividly during the last 30 years. It should be noted that the increase in the population of Great Cormorant in the North Sea & Skagerrak is due to an expansion of the subspecies *Phalacrocorax carbo sinensis*, probably from Danish waters (Lorentsen 2006). In contrast, the population of *P. carbo carbo* in the

Norwegian Sea has declined by 58% since 1988. Northern Gannet established a colony on Runde in the mid- 1940s, and has since then expanded to North Norway (Barrett and Folkestad 1996), and has recently also established a small colony on Bjørnøya. The population in the Norwegian Sea has leveled out and has fluctuated around 3000 pairs since the early 1990s. The population in the Barents Sea is however still increasing.

Table 2. *Summary of the regional population dynamics of seabirds breeding in Norway and Svalbard from 1988 to 2013.* **%Change** *is the percentage change in the population from 1988 to 2013.* **%(Max-Min)** *is the percentage difference between the maximum and minimum population sizes recorded during the same period. Missing data are either due to incomplete data (***dd***) (see Chap. 2.1.5 for definitions) or populations close to or equal to zero (open cells). All estimates are based on the analyses presented in the present report.*

		North Sea & Skagerrak		**Norwegian Sea**		**Barents Sea**		**Bjørnøya**		**Spitsbergen**	
	Ecological group	%(Max-Min)	% Change	%(Max-Min)	% Change	%(Max-Min)	% Change	%(Max-Min)	% Change	%(Max-Min)	% Change
Northern Fulmar	Pelagic surface-feeding	1073	70	dd	dd			469	-58	dd	dd
Northern Gannet	Pelagic plunge-diving			57	2	665	577				
Great Cormorant[1]	Coastal diving	10964	9055	239	-58	241	11				
European Shag	Coastal diving	595	384	210	1	679	-27				
Common Eider	Coastal benthic-feeding	187	37	149	-55	67	-14			dd	dd
Common Gull	Coastal surface-feeding	297	-75	dd	dd	dd	dd				
Lesser Black-backed Gull[2]	Pelagic surface-feeding	107	-52	94	14						
Herring Gull	Coastal surface-feeding	142	-34	dd	dd	253	-72				
Glaucous Gull	Pelagic surface-feeding							475	-81	dd	dd
Great Black-backed Gull	Coastal surface-feeding	93	12	dd	dd	128	-52				
Black-legged Kittiwake	Pelagic surface-feeding	dd	dd	147	-55	387	-78	78	11	117	-40
Common Guillemot	Pelagic diving			498	-76	291	102	691	691		
Brünnich's Guillemot	Pelagic diving					3394	-97	51	-13	126	-55
Razorbill	Pelagic diving	dd	dd	dd	dd	528	71				
Atlantic Puffin	Pelagic diving	155	-56	85	-36	68	25			dd	dd

[1]*Phalacrocorax carbo sinensis* and *P. carbo carbo*.
[2]*Larus fuscus fuscus* and *L. fuscus intemedius.*

4.2 Estimation of population size and trends

The presented methodology combines all available monitoring and census data to construct time series and population estimates. Data from the nearest monitoring sites were used to interpolate population dynamics between censuses and extrapolate the dynamics from the first census backwards and from the last census forward. The time series were fitted using a simple least-square algorithm. When no monitoring data was available within 300 km, we used the growth rate estimated from a GAM analysis taking all available data on growth rates into account. These smoothed values gave a relatively conservative estimate of the growth rate.

A variety of species-specific methods are used to census and monitoring seabird populations during breeding, including counting individuals from photographs, counting individuals within stratified plots, or counting apparently occupied nests (Walsh et al. 1995). Clearly, a number of measurement errors are associated with the different methods applied. How well the counts reflect the breeding populations depends on factors such as observer bias, detectability, colony attendance, the presence of juveniles and deferred breeding. These, mostly unknown measurement errors, will in many cases tend to underestimate the true breeding population. It is therefore likely that the presented estimates represent “minimum” estimates.

The analytical method applied is sensitive to infrequent censuses and poor or non-representative monitoring. For example, if more than 20 years have passed since the last census of a colony and the population dynamics at the nearby monitoring sites are mainly governed by local factors, the resulting population estimates might be grossly wrong. Clearly, a higher number of monitoring sites and in particular, increased frequency of censuses will improve the precision of the estimates. At present, the methods used did not include the calculation of confidence intervals. This should be given high priority in a further development of the methods and could be accomplished by including bootstrap methodology and/or Bayesian statistics. Such analyses could potentially answer important questions such as: What is the reliability of the calculated estimates? How sensitive are the estimates to the removal/inclusion of more monitoring sites and how representative are the monitoring sites with respect to predicting the general population trends? How often is it necessary to conduct population censuses and how should the censuses be designed to maximize precision and minimize costs?

For some regional populations the datasets were, according to our definitions (*see Chap. 2.1.5*), considered to be incomplete in order to calculate reliable population trends and estimates. A more recent census of the breeding populations south of Vesterålen on the Norwegian mainland would, to a large degree, solve this problem. In addition, the monitoring of large gulls in the Norwegian and Barents Seas is fragmentary and more series on Common Eider, Glaucous Gull, and Northern Fulmar are needed in order to estimate the population trajectories of these species in Spitsbergen. Finally, some species are difficult to monitor due to high mobility among breeding sites (Common and Arctic Terns) and hidden or inaccessible nests (Black Guillemot, Little Auk and Razorbill). More tailored effort is needed to give reliable estimates for these species.

4.3 Diet

We compiled 213 studies on seabird diet. In total this summed to 635 observations of the different diet categories in specific araea/colonies and seasons/age classes. The distribution of these cases among ecological groups is shown in Figure 1.

Not surprisingly, there was a relatively large difference among the different ecological groups with respect to the reported diet. The diet of pelagic surface-feeding birds was evenly distributed among all the different prey categories. The reported diet of pelagic diving birds was concentrated around *Gadoids* consisting mainly of the young age-classes of cod fishes (e.g. Atlantic Cod, Saithe (*Pollachius virens*) and Haddock (*Melanogrammus aeglefinus*)), the typical pelagic forage fish species (i.e.; Polar Cod (*Boreogadus saida*), Capelin, Herring and Sandeel (*Ammodytes* spp.)), as well as pelagic crustaceans (i.e.; large calanoid copepods, krill and amphipods). The diet of coastal surface-feeding birds consisted to a lesser degree of forage fish species. This group was more dependent on a diverse assemblage of inshore fish species (*Other fish*), inshore crustaceans and other invertebrates, some discards from the fishing industry (*Offal*) and other resources (i.e.; garbage and other terrestrial resources). Finally, the coastal diving species were highly dependent on the young age-classes of cod fishes, sandeel and a diverse assemblage of inshore fish species (*Other fish*).

The diet studies highlight the importance of the young age-classes of cod fish, the importance of pelagic forage fish species and in particular the importance of sandeel (Figure 2). However, the differences in diet among ecological groups combined with the fact that declining seabird populations were found in all regions and included all major ecological groups suggest that the recent changes in Norwegian seabird communities cannot be explained by changes in the abundance of a single group of resources alone. On the contrary, this might suggest a combined effect of simultaneous changes in several prey items, possibly involving entire trophic levels. Alternatively, it might suggest that bottom-up regulation through food is less important, and that top-down mechanisms such as anthropogenic stressors and predation are more involved in the present changes.

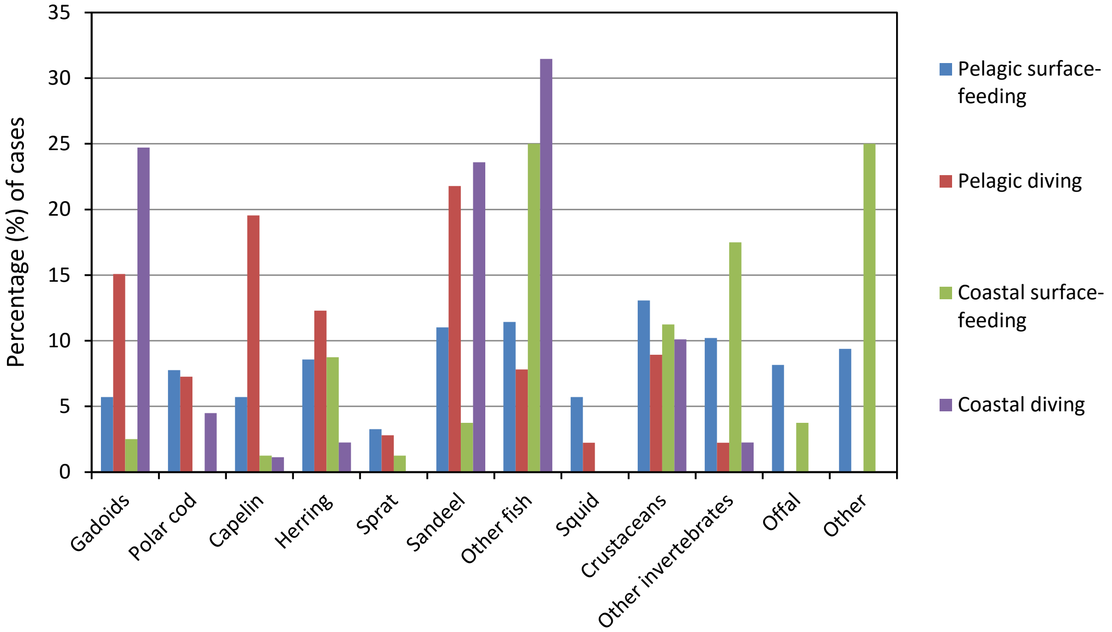


Figure 1. *The percentage of cases documenting different prey categories in the diet of seabirds. Cases were collected from a literature review on seabird diet and were summed over species belonging to the same ecological group. Total sample was 635 cases. Data are given in the species-specific tables; "Diet" and references to the studies are given in the Appendix.*

4.4 Anthropogenic and environmental stressors

Seabirds are exposed to a multitude of anthropogenic stressors and the cumulative impact of pollution, disturbance, harvest, by-catch, competition from fisheries, and climate change are difficult to discern. Many seabird populations in the North East Atlantic increased during the 20th century benefiting from protection measures which reduced the human hunting, harvesting and disturbance (Grandgeorge et al. 2008). Moreover, an increase was also probably enhanced by the fisheries, subsidizing seabirds with discards (Votier et al. 2004) and removing large predatory fishes such as cod from the ecosystems thereby indirectly increasing the abundance of small pelagic fishes that are important as food for seabirds (Grandgeorge et al. 2008). By the end of the century, industrial fisheries of small pelagic fish and climate warming resulting in large-scale ecosystem shifts might have changed the situation, and these drivers are currently suggested to be important challenges facing seabird populations in the North East Atlantic (Frederiksen et al. 2004, Frederiksen et al. 2013, Burthe et al. 2014).

We reviewed 450 relevant studies on environmental drivers affecting seabird population dynamics, many of which were from Norwegian populations. In total, these studies included 473 cases (reported driver from a colony/area) divided on 17 species. This list is probably not exhaustive, and moreover, the review did only record positive or negative results, discarding studies with null-results which tend to be under-represented in the literature. Accordingly, because the number of reported cases documenting effects probably also reflects research effort, the results should be interpreted with care. The distribution of reported cases for each type of driver summed over ecological groups is shown in Figure 2. Interestingly, the ecological groups were relatively similar with respect to the distribution among drivers, suggesting that the most important drivers affecting the population dynamics might be similar across different groups of seabirds.

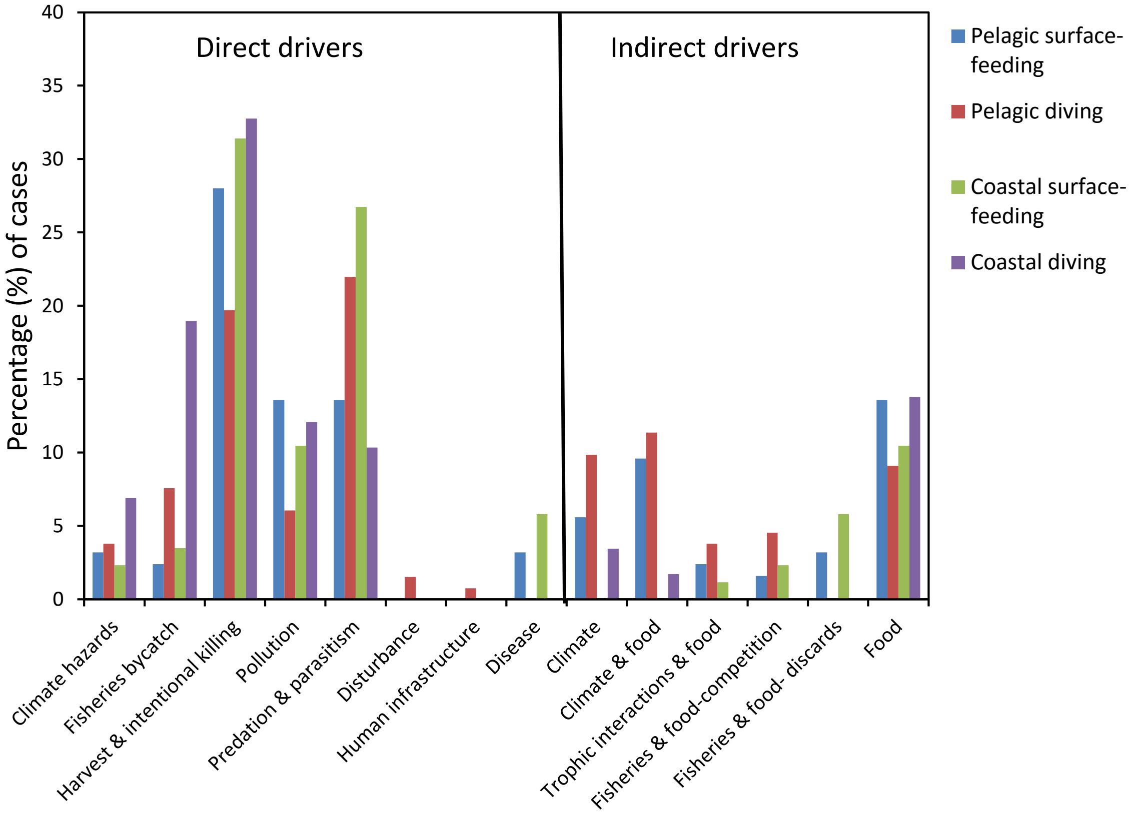


Figure 2.*The percentage of cases documenting effects of different environmental drivers on seabird demography and population dynamics. Cases were collected from a literature review and were summed over species belonging to the same ecological group. Total sample was 473 case studies. Data are given in the species-specific tables; "Driver of population dynamics" and references to the studies are given in the Appendix.*

A majority (71%) of the documented case-studies reported effects of direct drivers. However, the management plans for the marine ecosystems in Norwegian waters[3,4,5] do not report on any acute increase in any direct anthropogenic stressors that might affect seabirds (i.e. pollution, fisheries by-catch, harvesting, disturbance). On the contrary, several of the stressors have been reduced or have been held on a constant level (see below). It is therefore not likely that an increase in the level of direct anthropogenic stressors can explain the recent negative trends in Norwegian seabird populations documented by the present report. Despite this, harvest and intentional killing and predation and parasitism were the two most commonly reported drivers in the review study (Figure 2). It should however be noted that the effect of direct drivers might be

[3] Meld. St. 37 (2012–2013) Helhetlig forvaltning av det marine miljø i Nordsjøen og Skagerrak
[4] St.meld. nr. 37 (2008-2009) Helhetlig forvaltning av det marine miljø i Norskehavet
[5] St.meld. nr. 8 (2005-2006) Helhetlig forvaltning av det marine miljø i Barentshavet og havområdene utenfor Lofoten

more easily studied and documented and that such cases consequently might be over-represented in our review.

While the harvest of seabirds in Norway is negligible and strictly regulated, hunting of seabirds is widespread in other arctic territories and most notably in the Faroe Islands, Iceland, Greenland and Newfoundland (Merkel and Barry 2008, Merkel 2010). Accordingly, Norwegian populations wintering in areas with intensive hunting might be negatively affected. However, a combination of stricter hunting regulations, fewer hunters and declining seabird populations has reduced the harvest of seabirds in the Arctic in recent years (Merkel 2010). Thus, although this driver is frequently reported in the literature and certainly might contribute to a negative cumulative human impact on some Norwegian seabird populations wintering in exposed areas, it is probably not an important factor explaining the recent decline in the Norwegian populations.

In the review study, predation from avian predators such as large gulls (*Larus* spp.), Common Ravens (*Corvus corax*), White-tailed Eagle (*Haliaeetus albicilla*) and small mammalian predators such as foxes (*Vulpes* spp.) and American Mink (*Neovison vison*) was commonly reported as having detrimental impact on seabird colonies. An increase in the meso-predator guild (see e.g. Killengren et al. 2011) with an accompanying increase in the predation pressure could accordingly be a contributing factor to the observed decline in several Norwegian seabird populations. More studies directed towards the abundance and dynamics of relevant predators and how predation might govern the population dynamics of Norwegian seabird colonies, are needed to specifically address this hypothesis.

Pollution, and in particular persistent organic pollutants (POPs), mercury and accidental oil spill, was also often documented as an important factor affecting seabird populations. Stricter national and international regulations have generally reduced the concentrations of POPs in the Arctic (AMAP 2014). On the other hand there is no consistent trend in the concentration of mercury in arctic biota the last 30 years (AMAP 2011). The frequency of accidental oil spills from oil tankers has however generally decreased the last 20 years (Huijer 2005), and similarly, the discharges of oil to the sea from the oil industry have also decreased in the North East Atlantic (OSPAR 2014). Although pollution certainly contributes to the cumulative anthropogenic impact on seabirds, the recent decrease of several of these stressors in Norwegian waters suggest that pollution alone cannot explain the declines documented by the present report. However, some species foraging on the top of the food chain might be particularly vulnerable to long-transported organochlorine pollutants that have been subject to bio-magnification through the food web (Bustnes et al. 2003). For example, on Bjørnøya the decline in the population of Glacous Gull has been attributed to high levels of POPs (Erikstad & Strøm 2012).

Except for effects on coastal diving seabirds (i.e. the Cormorants *Phalacrocorax* spp. and Black Guillemot) relatively few studies reported effects from by-catch in the fisheries. A recent study suggested that about 10 000-12 000 seabirds died in the Norwegian fisheries each year in 2009 and 2010 (Fangel et al. 2011). Northern Fulmars, Cormorants, Black Guillemots, Atlantic Puffins and Razorbills were the species most affected. However, except for the Norwegian populations of Northern Fulmars and possibly some local populations of Black Guillemots, the incident of by-catch was generally low compared to the population size of the affected species. These estimates are much lower than those indicated by a previous study from the Barents Sea which estimated that 20 000 -100 000 Common Guillemots drowned each year in the spring cod and salmon drift-net fisheries in the 1980s (Strann et al. 1991). The salmon driftnet fishery was banned in 1989, and the by-catch in the spring cod fishery is also likely to have declined (cf. Fangel et al. 2011), suggesting that the impact from fisheries by-catch has decreased the last 30 years. Finally, few studies documented impacts from the remaining direct drivers; diseases, human infrastructure and disturbance.

110 (23%) cases documented effects from indirect drivers related to food availability, either via climate and/or trophic interactions. Only 20 of these cases reported a trophic link to fisheries (i.e. studies where fisheries were suggested to affect food availability). It should however be noted

that such indirect links might be difficult to document and that such cases accordingly might be under-represented in the sample. Nevertheless, the review study indicated that most species are susceptible to changes in the marine ecosystem entailing changes in the availability of food. Moreover, an increasing number of studies also indicated that these changes are related to changes in ocean climate. The expected climate warming will presumably accentuate such changes. As a consequence, we would expect an increase of boreal species and a decrease of arctic and sub-arctic species in Norwegian waters. The importance of such relationships is underlined by the fact that the seabird populations showed large decadal fluctuations taking place on a scale corresponding to the large marine ecosystems (i.e. the Barents Sea, Norwegian Sea and North Sea & Skagerrak). It is therefore possible that ecosystem-specific changes, possibly initiated by past and present fisheries in combination with climate change, are the major indirect drivers behind the observed seabird declines. Indeed, major ecosystem changes have recently been documented in the North Sea (Fauchald et al. 2011, Frederiksen et al. 2013), the Norwegian Sea (Huse et al. 2012, Frederiksen et al. 2013) and the Barents Sea (Johannesen et al. 2012, Fauchald et al. 2014).

In conclusion, the two most likely candidates to explain the recent declines in Norwegian seabird populations are 1) increased predation in the seabird colonies from avian and mammalian predators and 2) ecosystem changes affecting the availability of prey. The impact from these drivers might be difficult to document and even more challenging to control. In contrast, more easily managed direct anthropogenic stressors such as fisheries by-catch, pollution, hunting and disturbance have either been constant or have shown a decreasing trend. Although these drivers cannot explain the recent population declines, they certainly contribute to the cumulative impact on seabird populations and these stressors are therefore especially important to control and minimize in rapidly declining and threatened populations.

5 References

AMAP (2011) AMAP Assessment 2011: Mercury in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xiv + 193 pp.

AMAP (2014) Trends in Stockholm Convention Persistent Organic Pollutants (POPs) in Arctic Air, Human media and Biota. By: S. Wilson, H. Hung, A. Katsoyiannis, D. Kong, J. van Oostdam, F. Riget, A. Bignert. AMAP Technical Report No. 7 (2014). Arctic Monitoring and Asessment Programme (AMAP), Oslo. 54 pp.

Anker-Nilssen T, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Tveraa T, Strøm H, Barrett RT (2005) Seapop. Et nasjonalt sjøfuglprogram for styrket beslutningsstøtte i marine områder. NINA Rapport 1. Norsk institutt for naturforskning.

Anker-Nilssen T, Tatarinkova IP (2000) Atlantic puffin *Fratercula arctica*. In: The status of marine birds breeding in the Barents Sea region, pp. 137-143. Ed. By Anker-Nilssen T, Bakken V, Strøm H, Golovkin, AN, Bianki VV, Tatarinkova IP. Norwegian Polar Institute, Tromsø.

Barrett RT, Camphuysen KCJ, Anker-Nilssen T, Chardine JW, Furness RW, Garthe S, Hu O, Leopold MF, Montevecchi WA, Veit RR, Huppop O (2007) Diet studies of seabirds: a review and recommendations. ICES Journal of Marine Science 64:1675–1691.

Barrett RT, Anker-Nilssen T, Bustnes JO, Christensen-Dalsgaard S, Descamps S, Erikstad KE, Lorentsen S-H, Lorentzen E, Strøm H, Systad GH (2014) Key-site monitoring in Norway 2013, including Svalbard and Jan Mayen. In: Anker-Nilssen T, Barrett R (eds) SEAPOP Short Report 1-2014.

Barrett RT, Folkestad AO (1996) The status of the North Atlantic Gannet *Morus bassanus* after 50 years in Norway. Seabird 18: 30-37.

Barrett RT, Lorentsen S-H, Anker-Nilssen T (2006) The status of breeding seabirds in mainland Norway. Atlantic Seabirds 8.

Barrett RT, Nilsen EB, Anker-Nilssen T (2012) Long-term decline in egg size of Atlantic puffins *Fratercula arctica* is related to changes in forage fish stocks and climate conditions. Marine Ecology Progress Series 457:1-10.

BirdLife International (2013) "Species factsheet: *Larus hyperboreus*." Retrieved 01.10, 2013.

Burthe SJ, Wanless S, Newell MA, Butler A, Daunt F (2014) Assessing the vulnerability of the marine bird community in the western North Sea to climate change and other anthropogenic impacts. Marine Ecology Progress Series 507:277-295.

Bustnes JO, Erikstad KE, Skaare JU, Bakken V, Mehlum F (2003) Ecological effects of organochlorine pollu-tants in the Arctic: A study of the Glaucous Gull. Ecological Applications 13:504-515.

Calvert AM, Robertson GJ (2002) Using multiple abundance estimators to infer population trends in Atlantic Puffins. Canadian Journal of Zoology-Revue Canadienne De Zoologie, 80: 1014-1021.

Cury PM, Boyd IL, Bonhommeau S, Anker-Nilssen T, Crawford RJM, Furness RW, Mills JA, Murphy EJ, Osterblom H, Paleczny M, Piatt JF, Roux JP, Shannon L, Sydeman WJ (2011) Global seabird response to forage fish depletion -one-third for the birds. Science 334:1703-1706.

Descamps S, Strøm H, Steen H (2013) Decline of an arctic top predator: synchrony in colony size fluctuations, risk of extinction and the subpolar gyre. Oecologia 173: 1271-1282.

Durant JM, Anker-Nilssen T, Stenseth NC (2004) Trophic interactions under climate fluctuations: the Atlantic puff in as an example. Proceedings of the Royal Society of London Series B-Biological Sciences 271:2637-2637.

Egevang C, Boertmann D (2003) Havternen i Grønland -Status og undersøgelser 2002. The Arctic tern in Greenland -Status and investigations 2002. Technical Report 438. NERI, Roskilde, National Environmental Research Institute, Denmark: 73.

Erikstad KE, Reiertsen TK, Barrett RT, Vikebo F, Sandvik H (2013) Seabird-fish interactions: the fall and rise of a common guillemot *Uria aalge* population. Marine Ecology Progress Series 475:267.

Erikstad KE, Strøm H (2012) Effekter av miljøgifter på bestanden av polarmåke på Bjørnøya. Norsk Polarinstitutt Kortrapport nr. 25, Tromsø, Norway.

Fangel K, Wold LC, Aas Ø, Christensen-Dalsgaard S, Qvenild M, Anker-Nilssen T (2011) Bifangst av sjøfugl i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line - NINA Rapport 719. 72 s.

Fauchald P, Skov H, Skern-Mauritzen M, Johns D, Tveraa T (2011) Wasp-Waist Interactions in the North Sea Ecosystem. PLoS One 6

Fauchald P, Arneberg P, Berge J, Gerland S, Kovacs KM, Reigstad M, Sundet JH (2014) An assessment of MOSJ -The state of the marine environment around Svalbard and Jan Mayen. Norwegian Polar Institute Report Series no 145, Tromsø, Norway.

Frederiksen M, Wanless S, Rothery P, Wilson L J Harris MP (2004) The role of industrial fisheries and oceanographic change in the decline of North Sea black-legged kittiwakes. Journal of Applied Ecology, 41(6), 1129–1139.

Frederiksen M, Anker-Nilssen T, Beaugrand G, Wanless S (2013) Climate, copepods and seabirds in the boreal Northeast Atlantic - current state and future outlook. Global Change Biology, 19(2), 364–372.

Frederiksen M (2010) Seabirds in the North East Atlantic -A review of status, trends and anthropogenic impact. TemaNord 2010: 587.

Grandgeorge M, Wanless S, Dunn TE, Maumy M, Beaugrand G, Grémillet D (2008) Resilience of the British and Irish seabird community in the twentieth century. Aquatic Biology 4: 187-199.

Huijer, K. (2005). Trends in oil spills from tanker ships 1995-2004. International Tanker Owners Pollution Federation (ITOPF), London.

Huse G, Holst JC, Utne K, Nottestad L, Melle W, Slotte A, Ottersen G, Fenchel T, Uiblein F (2012) Effects of interactions between fish populations on ecosystem dynamics in the Norwegian Sea - results of the INFERNO project. Marine Biology Research 8:415-419.

Johannesen E, Ingvaldsen RB, Bogstad B, Dalpadado P, Eriksen E, Gjøsæter H, Knutsen T, Skern-Mauritzen M, Stiansen JE (2012) Changes in Barents Sea ecosystem state, 1970-2009: climate fluctuations, human impact, and trophic interactions. ICES Journal of Marine Science 69:880-889.

JNCC (2013) Seabird Population Trends and Causes of Change: 1986-2012 Report (http://www.jncc.defra.gov.uk/page-3201). Joint Nature Conservation Committee. Updated July 2013.

Killengreen ST, Lecomte N, Ehrich D, Schott T, Yoccoz NG, Ims RA (2011) The importance of marine vs. human-induced subsidies in the maintenance of an expanding mesocarnivore in the arctic tundra. Journal of Animal Ecology, 80(5), 1049–60.

Kålås JA, Viken Å, Henriksen S, Skjelseth S (2010) The 2010 Norwegian Red List for Species. Norwegian Biodiversity Information Centre, Norway.

Lorentsen SH (2006) Det nasjonale overvåkingsprogrammet for sjøfugl. Resultater til og med hekkesesongen 2006. NINA Rapport 203. Norsk institutt for naturforskning.

Lorentsen SH, Christensen-Dalsgaard S (2009) Det nasjonale overvåkingsprogrammet for sjøfugl. Resultater til og med hekkesesongen 2008. NINA Rapport 439. Norsk institutt for naturforskning.

Mehlum F & Bakken V (1994) Seabirds in Svalbard (Norway): status, recent changes and management. Pp. 155-171 in Nettleship DN, Burger J & Gochfeld M (eds.): Seabirds on Islands: Threats, Case Studies and Action Plans. BirdLife Conservation Series No. 1.

Merkel F, Barry T (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird). CAFF Technical Report No. 16, p. 77.

Merkel FR (2010) Seabird harvest. Arctic Biodiversity Trends 2010 – Selected indicators of change. CAFF International Secretariat, Akureyri, Iceland.

Markones N, Guse N, Huppop O, Garthe S (2009) Unchanging diet in a stable colony: contemporary and past diet composition of black-legged kittiwakes *Rissa tridactyla* at Helgoland, south-eastern North Sea. Helgoland Marine Research, 63: 199-206.

Mitchell PI, Newton SF, Ratcliff N, Dunn TE (2004) Seabird populations of Britain and Ireland. T & A D Poyser, London.

Myksvoll MS, Erikstad KE, Barrett RT, Sandvik H, Vikebo F (2013) Climate-driven ichthyoplankton drift model predicts growth of yop predator young. PLoS One 8.

OSPAR (2014) Assessment of the OSPAR report on discharges, spills and emissions to air from offshore oil and gas 2010-2012, OSPAR Commission 2014.

Ottersen G, Auran JA (2007) Helhetlig forvaltningsplan for Norskehavet: Arealrapport med miljø- og naturressursbeskrivelse. Fisken og Havet 6. Havforskningsinstituttet.

Peterz M, Blomqvist S (2010) Connectivity and age distribution of the Baltic Common Guillemot *Uria aalge* population: evidence from morphometry and ringing recoveries. Ardea 98: 169-178.

Rail JF, Cotter R (2007) Sixteenth census of seabird populations in the sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist, 121: 287-294.

R Development Core Team (2011) R: A Language for Statistical Computing. Vienna: R Foundation for Statistical Computing.

Reiertsen TK, Erikstad KE, Anker-Nilssen T, Barrett RT, Boulinier T, Frederiksen M, Gonzales-Solis J, Gremillet D, Johns D, Moe B, Ponchon A, Skern-Mauritzen M, Sandvik H, Yoccoz NG (2014) Prey density in non-breeding areas affects adult survival of Black-legged Kittiwakes *Rissa tridactyla* breeding in the southern Barents Sea. Marine Ecology Progress Series 509: 289–302.

Rodway MS, Regehr HM, Chardine JW (2003) Status of the largest breeding concentration of Atlantic Puffins, *Fratercula arctica*, in North America. Canadian Field-Naturalist, 117: 70-75.

Sandvik H, Erikstad KE, Barrett RT, Yoccoz NG (2005) The effect of climate on adult survival in five species of North Atlantic seabirds. Journal of Animal Ecology 74:817-831.

Sandvik H, Erikstad KE, Saether BE (2012) Climate affects seabird population dynamics both via reproduction and adult survival. Marine Ecology Progress Series 454:273-284.

Sandvik H, Reiertsen TK, Erikstad KE, Anker-Nilssen T, Barrett RT, Lorentsen S-H, Systad GH, Myksvoll MS (2014) The decline of Norwegian kittiwake populations: modelling the role of ocean warming. Climate Research 60: 91–102.

Strann KB, Vader W, Barret RT (1991) Auk mortality in fishing nets in Norway. Seabird 13: 22-29.

Vader W, Barret RT, Erikstad KE, Strann KB (1990) Differential response of common and thick-billed murres to a crash in the capelin stock in the southern Barents Sea. Studies in Avian Biology 14:175-180.

von Quillfeldt C (2010) Det faglige grunnlaget for oppdateringen av forvaltningsplanen for Barentshavet og havområdene utenfor Lofoten. Fisken og Havet, Særnummer 1a. Havforskningsinstituttet.

Virkkala R (2006) Spatiotemporal variation of breeding gull species in a boreal lake complex in Finland: Implications for conservation. Biological Conservation 128(4): 447-454.

Votier SC, Furness RW, Bearhop S, Crane JE, Caldow RWG, Catry P, Ensor K, Hamer KC, Hudson AV, Kalmbach E, Klomp NI, Pfeiffer S, Phillips RA, Prieto I, Thompson DR (2004) Changes in fisheries discard rates and seabird communities. Nature 427: 727–730.

Walsh P, Halley D, Harris M, Del Nevo A, Sim I, Tasker M (1995) Seabird monitoring handbook for Britain and Ireland: a compilation of methods for survey and monitoring of breeding seabirds. JNCC/RSPB/ITE/Seabird Group.

Weiser E, Gilchrist G (2012). Glaucous gull (*Larus hyperboreus*). The Birds of North America Online. Ithaca, Cornell Lab of Ornithology.

Wood SN (2006) Generalized Additive Models An Introduction with R. Chapman & Hall/CRC, Boca Raton.

6 Appendix: Literature review; references

Northern Fulmar *Fulmarus glacialis*

Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)
Avery-Gomm S, Provencher JF, Morgan KH, Bertram DF (2013) Plastic ingestion in marine-associated bird species from the eastern North Pacific. Mar Pollut Bull 72:257-259
Benjamins S, Kulka DW, Lawson J (2008) Incidental catch of seabirds in Newfoundland and Labrador gillnet fisheries, 2001-2003. Endangered species research 5:149-160
Burke CM, Hedd A, Montevecchi WA, Regular PM (2011) Effects of an Arctic Fox Visit to a Low Arctic Seabird Colony. Arctic 64:302-306
Byers T, Smith A, Mallory ML (2010) Diet of black guillemots and northern fulmars breeding beside a High Arctic polynya. Polar Biol 33:457-467
Camphuysen KCJ, Barreveld H, Dahlmann G, Van Franeker JA (1999) Seabirds in the north sea demobilized and killed by polyisobutylene (C4H8)(n) (PIB). Mar Pollut Bull 38:1171-1176
Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. Bycatch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719
Garthe S, Huppop O (2004) Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology 41:724-734
Garthe S, Montevecchi WA, Ojowski U, Stenhouse IJ (2004) Diets of northern fulmar (Fulmarus glacialis) chicks in the northwest Atlantic Ocean. Polar Biol 27:277-280
Gray CM, Phillips RA, Hamer KC (2003) Non-random nestling mortality in northern fulmars: implications for monitoring marine environments. J Zool 259:109-113
Hamer KC, Thompson DR, Gray CM (1997) Spatial variation in the feeding ecology, foraging ranges, and breeding energetics of northern fulmars in the north-east Atlantic Ocean. Ices Journal of Marine Science 54:645-653
Hobson KA, Welch HE (1992) Observarions of foraging northern fulmars (Fulmarus glacialis) in the Canadian High-Arctic. Arctic 45:150-153
Knudsen LB, Borga K, Jorgensen EH, van Bavel B, Schlabach M, Verreault J, Gabrielsen GW (2007) Halogenated organic contaminants and mercury in northern fulmars (Fulmarus glacialis): levels, relationships to dietary descriptors and blood to liver comparison. Environmental Pollution 146:25-33
Kuhn S, van Franeker JA (2012) Plastic ingestion by the northern fulmar (Fulmarus glacialis) in Iceland. Mar Pollut Bull 64:1252-1254
Lewis S, Elston DA, Daunt F, Cheney B, Thompson PM (2009) Effects of extrinsic and intrinsic factors on breeding success in a long lived seabird. Oikos 118:521-528
Lilliendahl K (2009) Winter diets of auks in Icelandic coastal waters. Marine Biology Research 5:143-154
Lokkeborg S (2003) Review and evaluation of three mitigation measures - bird-scaring line, underwater setting and line shooter - to reduce seabird bycatch in the north Atlantic longline fishery. Fisheries Research 60:11-16
Lokkeborg S, Robertson G (2002) Seabird and longline interactions: effects of a bird-scaring streamer line and line shooter on the incidental capture of northern fulmars Fulmarus glacialis. Biol Conserv 106:359-364
Lorentsen SH, Anker-Nilssen T (1993) Behaviour and oil vulnerability of fulmars Fulmarus glacialis during an oil spill experiment in the Norwegian Sea. . Mar Pollut Bull 26:144-146
Mallory ML, Gaston AJ, Forbes MR, Gilchrist HG (2009) Influence of weather on reproductive success of northern fulmars in the Canadian high Arctic. Polar Biol 32:529-538
Mallory ML, Gaston AJ, Forbes MR, Gilchrist HG, Cheney B, Lewis S, Thompson PM (2008) Flexible incubation rhythm in northern fulmars: a comparison between oceanographic zones. Marine Biology 154:1031-1040
Mallory ML, Karnovsky NJ, Gaston AJ, Hobson KA, Provencher JF, Forbes MR, Hunt GL, Byers T, Dick TA (2010) Temporal and spatial patterns in the diet of northern fulmars Fulmarus glacialis in the Canadian High Arctic. Aquatic Biology 10:181-191
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Ojowski U, Eidtmann C, Furness RW, Garthe S (2001) Diet and nest attendance of incubating and chick-rearing northern fulmars (Fulmarus glacialis) in Shetland. Marine Biology 139:1193-1200
Phillips RA, Petersen MK, Lilliendahl K, Solmundsson J, Hamer KC, Camphuysen CJ, Zonfrillo B (1999) Diet of the northern fulmar Fulmarus glacialis: reliance on commercial fisheries? Marine Biology 135:159-170
Thompson DR, Furness RW, Barrett RT (1992) Mercury concentrations in seabirds from colonies in the northeast Atlantic. Archives of Environmental Contamination and Toxicology 23:383-389
Thompson DR, Furness RW, Lewis SA (1995) Diets and long-term changes in delta N 15 and delta C 13 values in northern fulmars Fulmarus glacialis from two northeast Atlantic colonies. Mar Ecol-Prog Ser 125:3-11

Thompson PM, Ollason JC (2001) Lagged effects of ocean climate change on fulmar population dynamics. Nature 413:417-420

Verreault J, Helgason LB, Gabrielsen GW, Dam M, Braune BM (2013) Contrasting retinoid and thyroid hormone status in differentially-contaminated northern fulmar colonies from the Canadian Arctic, Svalbard and the Faroe Islands. Environ Int 52:29-40

Northern Gannet *Morus bassanus*

Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)

Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger

Barrett RT (2008) Recent establishments and extinctions of Northern Gannet Morus bassanus colonies in North Norway, 1995-2008. Ornis Norvegica 31:172-182

Barrett RT, Folkestad AO (1996) The status of the North Atlantic gannet Morus bassanus after 50 years in Norway. Seabird 18:30-37

Benjamins S, Kulka DW, Lawson J (2008) Incidental catch of seabirds in Newfoundland and Labrador gillnet fisheries, 2001-2003. Endangered species research 5:149-160

Bond AL, Montevecchi WA, Guse N, Regular PM, Garthe S, Rail JF (2012) Prevalence and composition of fishing gear debris in the nests of northern gannets (Morus bassanus) are related to fishing effort. Mar Pollut Bull 64:907-911

Garthe S, Montevecchi WA, Chapdelaine G, Rail JF, Hedd A (2007a) Contrasting foraging tactics by northern gannets (Sula bassana) breeding in different oceanographic domains with different prey fields. Marine Biology 151:687-694

Garthe S, Montevecchi WA, Davoren GK (2007b) Flight destinations and foraging behaviour of northern gannets (Sula bassana) preying on a small forage fish in a low-Arctic ecosystem. Deep-Sea Res Part II-Top Stud Oceanogr 54:311-320

Garthe S, Montevecchi WA, Davoren GK (2011) Inter-annual changes in prey fields trigger different foraging tactics in a large marine predator. Limnol Oceanogr 56:802-812

Gaston AJ, Bertram DF, Boyne AW, Chardine JW, Davoren G, Diamond AW, Hedd A, Montevecchi WA, Hipfner JM, Lemon MJF, Mallory ML, Rail JF, Robertson GJ (2009) Changes in Canadian seabird popula-tions and ecology since 1970 in relation to changes in oceanography and food webs. Environ Rev 17:267-286

Gremillet D, Pichegru L, Siorat F, Georges JY (2006) Conservation implications of the apparent mismatch between population dynamics and foraging effort in French northern gannets from the English Channel. Mar Ecol-Prog Ser 319:15-25

Hamer KC, Humphreys EM, Garthe S, Hennicke J, Peters G, Gremillet D, Phillips RA, Harris MP, Wanless S (2007) Annual variation in diets, feeding locations and foraging behaviour of gannets in the North Sea: flexibility, consistency and constraint. Mar Ecol-Prog Ser 338:295-305

Hamer KC, Phillips RA, Wanless S, Harris MP, Wood AG (2000) Foraging ranges, diets and feeding locations of gannets Morus bassanus in the North Sea: evidence from satellite telemetry. Mar Ecol-Prog Ser 200:257-264

Lewis S, Sherratt TN, Hamer KC, Harris MP, Wanless S (2003) Contrasting diet quality of northern gannets Morus bassanus at two colonies. Ardea 91:167-176

Lewis S, Sherratt TN, Hamer KC, Wanless S (2001) Evidence of intra-specific competition for food in a pelagic seabird. Nature 412:816-819

Martin AR (1989) The diet of Atlantic puffin Fratercula arctica and northern gannet Sula bassana chicks at a Shetland colony during a period of changing prey availability Bird Stud 36:170-180

Montevecchi WA (1991) Incidence and types of plastic in gannets nests in the northwest Atlantic Can J Zool-Rev Can Zool 69:295-297

Montevecchi WA, Barrett RT (1987) Prey Selection by Gannets at breeding colonies in Norway. Ornis Scandinavica 18: 319-322.

Montevecchi WA, Cairns DK, Myers RA (2002) Predation on marine-phase Atlantic salmon (Salmo salar) by gannets (Morus bassanus) in the Northwest Atlantic. Can J Fish Aquat Sci 59:602-612

Montevecchi WA, Hedd A, Tranquilla LM, Fifield DA, Burke CM, Regular PM, Davoren GK, Garthe S, Robertson GJ, Phillips RA (2012) Tracking seabirds to identify ecologically important and high risk marine areas in the western North Atlantic. Biol Conserv 156:62-71

Montevecchi WA, Myers RA (1997) Centurial and decadal oceanographic influences on changes in northern gannet populations and diets in the north-west Atlantic: implications for climate change. Ices Journal of Marine Science 54:608-614

Moss R, Wanless S, Harris MP (2002) How small Northern Gannet colonies grow faster than big ones. Waterbirds 25:442-448

Soanes LM, Atkinson PW, Gauvain RD, Green JA (2013) Individual consistency in the foraging behaviour of Northern Gannets: Implications for interactions with offshore renewable energy developments. Mar Pol 38:507-514

Votier SC, Archibald K, Morgan G, Morgan L (2011a) The use of plastic debris as nesting material by a colonial seabird and associated entanglement mortality. Mar Pollut Bull 62:168-172

Votier SC, Bearhop S, Witt MJ, Inger R, Thompson D, Newton J (2010) Individual responses of seabirds to commercial fisheries revealed using GPS tracking, stable isotopes and vessel monitoring systems. Journal of Applied Ecology 47:487-497

Votier SC, Bicknell A, Cox SL, Scales KL, Patrick SC (2013) A Bird's Eye View of Discard Reforms: Bird-Borne Cameras Reveal Seabird/Fishery Interactions. Plos One 8

Votier SC, Grecian WJ, Patrick S, Newton J (2011b) Inter-colony movements, at-sea behaviour and foraging in an immature seabird: results from GPS-PPT tracking, radio-tracking and stable isotope analysis. Marine Biology 158:355-362

Great Cormorant *Phalacrocorax carbo*

Anker-Nilssen T, Aarvak T (2006) TIdsseriestudier av sjøfugler i Røst kommune, Nordland. Resultater med fokus på 2004 og 2005. NINA Rapport 133

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127

Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger

Barrett RT, Rov N, Loen J, Montevecchi WA (1990) Diets of shags Phalacrocorax aristotelis and cormorants Phalacrocorax carbo in Norway and possible implications for gadoid stock recruitment. Mar Ecol-Prog Ser 66:205-218

Bostrom MK, Ostman O, Bergenius MAJ, Lunneryd SG (2012) Cormorant diet in relation to temporal changes in fish communities. Ices Journal of Marine Science 69:175-183

Chamberlain DE, Austin GE, Newson SE, Johnston A, Burton NHK (2013) Licensed control does not reduce local Cormorant Phalacrocorax carbo population size in winter. J Ornithol 154:739-750

Collas M, Burgun V (2011) Development of great cormorant population (Phalacrocorax carbo sinensis) in North-East France - synthesis of long term monitoring (1997-2008). Knowl Manag Aquat Ecosyst

Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. Bycatch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719

Frederiksen M, Bregnballe T (2000a) Diagnosing a decline in return rate of 1-year-old cormorants: mortality, emigration or delayed return? J Anim Ecol 69:753-761

Frederiksen M, Bregnballe T (2000b) Evidence for density-dependent survival in adult cormorants from a combined analysis of recoveries and resightings. J Anim Ecol 69:737-752

Frederiksen M, Bregnballe T, van Eerden MR, van Rijn S, Lebreton JD (2002) Site fidelity of wintering cormorants Phalacrocorax carbo sinensis in Europe. Wildlife Biol 8:241-250

Green RE (2008) Assessing the impact of culling on population size in the presence of uncertain density dependence: lessons from a great cormorant population. Journal of Applied Ecology 45:1683-1688

Gremillet D, Argentin G, Schulte B, Culik BM (1998) Flexible foraging techniques in breeding cormorants Phalacrocorax carbo and shags Phalacrocorax aristotelis: benthic or pelagic feeding? Ibis 140:113-119

Gremillet D, Kuntz G, Delbart F, Mellet M, Kato A, Robin JP, Chaillon PE, Gendner JP, Lorentsen SH, Le Maho Y (2004) Linking the foraging performance of a marine predator to local prey abundance. Functional Ecology 18:793-801

Hipfner JM, Blight LK, Lowe R, Wilhelm SI, Robertson GJ, Barrett RT, Anker-Nilssen T, Good TP (2012) Unintended consequences: how the recovery of sea eagle Haliaeetus spp. populations in the northern hemishpere is affecting seabirds. Marine Ornithology 40:39-52

Leopold MF, van Damme CJG, van der Veer HW (1998) Diet of cormorants and the impact of cormorant predation on juvenile flatfish in the Dutch Wadden Sea. J Sea Res 40:93-107

Lilliendahl K, Solmundsson J (2006) Feeding ecology of sympatric European shags Phalacrocorax aristotelis and great cormorants P-carbo in Iceland. Marine Biology 149:979-990

Lorentsen S-H, Byrkjeland S, Flagstad Ø, Heggberget TM, Larsen T, Røv N, Balstad T, Haugland T, Østborg GM (2007) Etterkantundersøkelser sjøfugl og oter etter MS Server-forliset januar 2007. Effects on seabirds and Eurasian otter after the oil spill following the wreck of MS Server at Fedje, Hordaland in January 2007. NINA Report 336

Lorentsen SH, Gremillet D, Nymoen GH (2004) Annual variation in diet of breeding great cormorants: Does it reflect varying recruitment of gadoids? Waterbirds 27:161-169

Lorentsen SH, Sjotun K, Gremillet D (2010) Multi-trophic consequences of kelp harvest. Biol Conserv 143:2054-2062

Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Ostman O, Bergenius M, Bostrom MK, Lunneryd SG (2012) Do cormorant colonies affect local fish communities in the Baltic Sea? Can J Fish Aquat Sci 69:1047-1055

Rothery P, Newton I, Little B (2009) Observations of seabirds at offshore wind turbines near Blyth in northeast England. Bird Stud 56:1-14

Smith GC, Parrott D, Robertson PA (2008) Managing wildlife populations with uncertainty: cormorants Phalacrocorax carbo. Journal of Applied Ecology 45:1675-1682
Sonntag N, Schwemmer H, Fock HO, Bellebaum J, Garthe S (2012) Seabirds, set-nets, and conservation management: assessment of conflict potential and vulnerability of birds to bycatch in gillnets. Ices Journal of Marine Science 69:578-589
Zydelis R, Kontautas A (2008) Piscivorous birds as top predators and fishery competitors in the lagoon ecosystem. Hydrobiologia 611:45-54

European Shag *Phalacrocorax aristotelis*

Aebischer NJ (1993) Immediate and delayed effects of a gale in late spring on the breeding of the shag Phalacrocorax aristotelis. Ibis 135:225-232
Aebischer NJ, Wanless S (1992) Relationship between colony size, adult non-breeding and environmental conditions for shags Phalacrocorax aristotelis on the Isle of May, Scotland. Bird Stud 39:43-52
Anker-Nilssen T (2009) Key-site monitoring in Røst in 2008. SEAPOP Short Report 5-2009
Anker-Nilssen T (2010) Key-site monitoring on Røst in 2009. SEAPOP Short Report 12-2010
Barrett RT (1989) The effect of egg harvesting on the growth of chicks and breeding success of shag Phalacrocorax aristotelis and the kittiwake Rissa tridactyla on Bleiksoy, North Norway. Ornis Fennica 66:117-122
Barrett RT, Erikstad KE (2009) Key-site monitoring on Hornøya in 2008. SEAPOP Short Report 1-2009
Barrett RT, Erikstad KE (2010) Key-site monitoring on Hornøya in 2009 SEAPOP Short Report 2-2010
Barrett RT, Erikstad KE (2011) Key-site monitoring on Hornøya in 2010. SEAPOP Short Report 3-2011
Barrett RT, Rov N, Loen J, Montevecchi WA (1990) Diets of shags Phalacrocorax aristotelis and cormorants Phalacrocorax carbo in Norway and possible implications for gadoid stock recruitment. Mar Ecol-Prog Ser 66:205-218
Bustnes JO, Anker-Nilssen T, Erikstad KE, Lorentsen SH, Systad GH (2013) Changes in the Norwegian breeding population of European shag correlate with forage fish and climate. Mar Ecol-Prog Ser 489
Daunt F, Afanasyev V, Silk JRD, Wanless S (2006) Extrinsic and intrinsic determinants of winter foraging and breeding phenology in a temperate seabird. Behavioral Ecology and Sociobiology 59:381-388
Daunt F, Wanless S, Harris MP, Money L, Monaghan P (2007) Older and wiser: improvements in breeding success are linked to better foraging performance in European shags. Functional Ecology 21:561-567
Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. Bycatch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719
Gremillet D, Argentin G, Schulte B, Culik BM (1998) Flexible foraging techniques in breeding cormorants Phalacrocorax carbo and shags Phalacrocorax aristotelis: benthic or pelagic feeding? Ibis 140:113-119
Harris MP, Wanless S (1991) The importance of the lesser sandeel Ammodytes marinus in the diet of the shag Phalacrocorax aristotelis. Ornis Scandinavica 22:375-382
Harris MP, Wanless S (1996) Differential responses of guillemot Uria aalge and shag Phalacrocorax aristotelis to a late winter wreck. Bird Stud 43:220-230
Hillersoy G, Lorentsen SH (2012) Annual Variation in the Diet of Breeding European Shag (Phalacrocorax aristotelis) in Central Norway. Waterbirds 35:420-429
Lilliendahl K, Solmundsson J (2006) Feeding ecology of sympatric European shags Phalacrocorax aristotelis and great cormorants P-carbo in Iceland. Marine Biology 149:979-990
Lorentsen S-H, Byrkjeland S, Flagstad Ø, Heggberget TM, Larsen T, Røv N, Balstad T, Haugland T, Østborg GM (2007) Etterkantundersøkelser sjøfugl og oter etter MS Server-forliset januar 2007. Effects on seabirds and Eurasian otter after the oil spill following the wreck of MS Server at Fedje, Hordaland in January 2007. NINA Report 336
Lorentsen SH, Christensen-Dalsgaard S (2009) Det nasjonale overvåkingsprogrammet for sjøfugl. Resultater til og med hekkesesongen 2008. The national monitoring programme for seabirds. Results up to and including the 2008 breeding season. In: 439 NR (ed)
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Munro JF, Crompton DWT, Stoddart RC (1995) Andracantha tunitae (Acanthocephala) in the shag (Phalacrocorax aristotelis) from Shetland, Scotland. J Parasitol 81:496-498
Rindorf A, Wanless S, Harris MP (2000) Effects of changes in sandeel availability on the reproductive output of seabirds. Mar Ecol-Prog Ser 202:241-252
Velando A, Alvarez D, Mourino J, Arcos F, Barros A (2005a) Population trends and reproductive success of the European shag Phalacrocorax aristotelis on the Iberian Peninsula following the Prestige oil spill. J Ornithol 146:116-120
Velando A, Freire J (1999) Intercolony and seasonal differences in the breeding diet of European shags on the Galician coast (NW Spain). Mar Ecol-Prog Ser 188:225-236
Velando A, Freire J (2002) Population modelling of European shags (Phalacrocorax aristotelis) at their southern limit: conservation implications. Biol Conserv 107:59-69
Velando A, Munilla I (2011) Disturbance to a foraging seabird by sea-based tourism: Implications for reserve management in marine protected areas. Biol Conserv 144:1167-1174

Velando A, Munilla I, Leyenda PM (2005b) Short-term indirect effects of the 'Prestige' oil spill on European shags: changes in availability of prey. Mar Ecol-Prog Ser 302:263-274
Velando A, Ortega-Ruano JE, Freire J (1999) Chick mortality in European shag Stictocarbo aristotelis related to food limitations during adverse weather events. Ardea 87:51-59
Wanless S, Harris MP, Redman P, Speakman JR (2005) Low energy values of fish as a probable cause of a major seabird breeding failure in the North Sea. Mar Ecol-Prog Ser 294:1-8
Wanless S, Harris MP, Russell AF (1993) Factors influencing food-load sizes brought in by shags Phalacrocorax aristotelis during chick-rearing. Ibis 135:19-24

Common Eider *Somateria mollissima*

Anker-Nilssen T, Aarvak T (2006) TIdsseriestudier av sjøfugler i Røst kommune, Nordland. Resultater med fokus på 2004 og 2005. NINA Rapport 133
Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)
Balk L, Hagerroth PA, Akerman G, Hanson M, Tjarnlund U, Hansson T, Hallgrimsson GT, Zebuhr Y, Broman D, Morner T, Sundberg H (2009) Wild birds of declining European species are dying from a thiamine deficiency syndrome. Proc Natl Acad Sci U S A 106:12001-12006
Benjamins S, Kulka DW, Lawson J (2008) Incidental catch of seabirds in Newfoundland and Labrador gillnet fisheries, 2001-2003. Endangered species research 5:149-160
Beukema JJ (1992) Expected changes in the Wadden Sea benthos in a warmer world; Lessons from periods with mild winters. Neth J Sea Res 30:73-79
Beukema JJ (1993) Increased mortality in alternative bivalve prey during a period when the tidal flats of the Dutch Wadded Sea were devoid of mussels. Neth J Sea Res 31:395-406
Blicher ME, Rasmussen LM, Sejr MK, Merkel FR, Rysgaard S (2011) Abundance and energy requirements of eiders (Somateria spp.) suggest high predation pressure on macrobenthic fauna in a key wintering habitat in SW Greenland. Polar Biol 34:1105-1116
Burnham KK, Johnson JA, Konkel B, Burnham JL (2012) Nesting Common Eider (Somateria mollissima) Population Quintuples in Northwest Greenland. Arctic 65:456-464
Bustnes JO (2013) Reproductive Recovery of a Common Eider Somateria mollissima Population Following Reductions in Discharges of Polycyclic Aromatic Hydrocarbons (PAHs). Bull Environ Contam Toxicol 91:202-207
Bustnes JO, Erikstad KE (1988) The diets of sympatric wintering populations of common eider Somateria mollissima and king eider S. spectabilis in northern Norway. Ornis Fennica 65:163-167
Bustnes JO, Moe B, Hanssen SA, Herzke D, Fenstad AA, Nordstad T, Borga K, Gabrielsen GW (2012) Temporal Dynamics of Circulating Persistent Organic Pollutants in a Fasting Seabird under Different Environmental Conditions. Environmental Science & Technology 46:10287-10294
Bustnes JO, Systad GH, Ydenberg RC (2013) Changing distribution of flocking sea ducks as non-regenerating food resources are depleted. Mar Ecol-Prog Ser 484:249-257
Camphuysen CJ, Berrevoets CM, Cremers H, Dekinga A, Dekker R, Ens BJ, van der Have TM, Kats RKH, Kuiken T, Leopold MF, van der Meer J, Piersma T (2002) Mass mortality of common eiders (Somateria mollissima) in the Dutch Wadden Sea, winter 1999/2000: starvation in a commercially exploited wetland of international importance. Biol Conserv 106:303-317
Chaulk KG, Mahoney ML (2012) Does spring ice cover influence nest initiation date and clutch size in common eiders? Polar Biol 35:645-653
Christensen TK, Bregnballe T, Andersen TH, Dietz HH (1997) Outbreak of Pasteurellosis among wintering and breeding common eiders Somateria mollissima in Denmark. Wildlife Biol 3:125-128
Coulson JC (1999) Variation in clutch size of the Common Eider: A study based on 41 breeding seasons on Coquet Island, Northumberland, England. Waterbirds 22:225-238
Coulson JC (2010) A long-term study of the population dynamics of Common Eiders Somateria mollissima: why do several parameters fluctuate markedly? Bird Stud 57:1-18
D'Alba L, Monaghan P, Nager RG (2010) Advances in laying date and increasing population size suggest positive responses to climate change in Common Eiders Somateria mollissima in Iceland. Ibis 152:19-28
Descamps S, Forbes MR, Gilchrist HG, Love OP, Bety J (2011) Avian cholera, post-hatching survival and selection on hatch characteristics in a long-lived bird, the common eider Somateria mollisima. Journal of Avian Biology 42:39-48
Descamps S, Gilchrist HG, Bety J, Buttler EI, Forbes MR (2009) Costs of reproduction in a long-lived bird: large clutch size is associated with low survival in the presence of a highly virulent disease. Biology Letters 5:278-281
Descamps S, Yoccoz NG, Gaillard JM, Gilchrist HG, Erikstad KE, Hanssen SA, Cazelles B, Forbes MR, Bety J (2010) Detecting population heterogeneity in effects of North Atlantic Oscillations on seabird body condition: get into the rhythm. Oikos 119:1526-1536
Dieval H, Giroux JF, Savard JPL (2011) Distribution of common eiders Somateria mollissima during the brood-rearing and moulting periods in the St. Lawrence Estuary, Canada. Wildlife Biol 17:124-134

Donehower CE, Bird DM (2008) Gull Predation and Breeding Success of Common Eiders on Stratton Island, Maine. Waterbirds 31:454-462

Ekroos J, Ost M, Karell P, Jaatinen K, Kilpi M (2012) Philopatric predisposition to predation-induced ecological traps: habitat-dependent mortality of breeding eiders. Oecologia 170:979-986

Erikstad KE, Bustnes JO, Hanssen SA (2009) Key-site monitoring on Grindøya in 2008. SEAPOP Short Report 7-2009

Erikstad KE, Bustnes JO, Hanssen SA (2010) Key-site monitoring on Grindøya in 2009. SEAPOP Short Report 11-2010

Flint PL (2013) Changes in size and trends of North American sea duck populations associated with North Pacific oceanic regime shifts. Marine Biology 160:59-65

Follestad A (2012) Akutt skadeomfang og herkomst av sjøfugl etter Godafoss-forliset. Effects on seabird populations following the Godafoss grounding in Southern Norway NINA Report 811

Gilliland SG, Gilchrist HG, Rockwell RF, Robertson GJ, Savard JPL, Merkel F, Mosbech A (2009) Evaluating the sustainability of harvest among northern common eiders Somateria mollissima borealis in Greenland and Canada. Wildlife Biol 15:24-36

Guillemette M, Himmelman JH (1996) Distribution of wintering common eiders over mussel beds: Does the ideal free distribution apply? Oikos 76:435-442

Guillemette M, Reed A, Himmelman JH (1996) Availability and consumption of food by common eiders wintering in the Gulf of St Lawrence: Evidence of prey depletion. Can J Zool-Rev Can Zool 74:32-38

Hanssen SA, Folstad I, Erikstad KE, Oksanen A (2003) Costs of parasites in common eiders: effects of antiparasite treatment. Oikos 100:105-111

Hanssen SA, Moe B, Bårdsen B-J, Hanssen F, Gabrielsen GW (2013) A natural antipredation experiment: predator control and reduced sea ice increases colony size in a long-lived duck. Ecology and Evolution Published online

Hollmen T, Franson JC, Kilpi M, Docherty DE, Hansen WR, Hario M (2002) Isolation and Characterization of a reovirus from common eiders (Somateria mollissima) from Finland. Avian Diseases 46:478-484

Hoover AK, Dickson DL, Dufour KW (2010) Survival and nesting success of the Pacific Eider (Somateria mollissima v-nigrum) near Bathurst Inlet, Nunavut. Can J Zool-Rev Can Zool 88:511-519

Håland A, Mjøs AT (2006) Overlevelse av oljeskadet og rehabilitert sjø-og vannfugl etter Rocknes-forliset ved Bergen, januar 2004. Survival of oiled and rehabilitated seabirds after the Rocknes oil spill. NNI-Report 160

Kristjansson TO, Jonsson JE, Svavarsson J (2013) Spring diet of common eiders (Somateria mollissima) in Breiafjordur, West Iceland, indicates non-bivalve preferences. Polar Biol 36:51-59

Larsen JK, Guillemette M (2007) Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. Journal of Applied Ecology 44:516-522

Laursen K, Frikke J (2008) Hunting from motorboats displaces Wadden Sea eiders Somateria mollissima from their favoured feeding distribution. Wildlife Biol 14:423-433

Laursen K, Kristensen PS, Clausen P (2010) Assessment of Blue Mussel Mytilus edulis Fisheries and Waterbird Shellfish-predator Management in the Danish Wadden Sea. Ambio 39:476-485

Lehikoinen A, Ost M, Hollmen T, Kilpi M (2008) Does sex-specific duckling mortality contribute to male bias in adult common eiders? Condor 110:574-578

Lorentsen S-H, Bakken V, Christensen-Dalsgaard S, Follestad A, Røv N, Winnem A (2010) Akutt skadeomfang og herkomst for sjøfugl etter MV Full City forliset. Effects on seabird populations following the MV Full City grounding in Southern Norway August 2009 NINA Report 548

Lorentsen S-H, Byrkjeland S, Flagstad Ø, Heggberget TM, Larsen T, Røv N, Balstad T, Haugland T, Østborg GM (2007) Etterkantundersøkelser sjøfugl og oter etter MS Server-forliset januar 2007. Effects on seabirds and Eurasian otter after the oil spill following the wreck of MS Server at Fedje, Hordaland in January 2007. NINA Report 336

Matson CW, Franson JC, Hollmen T, Kilpi M, Hario M, Flint PL, Bickham JW (2004) Evidence of chromosomal damage in common eiders (Somateria mollissima) from the Baltic Sea. Mar Pollut Bull 49:1066-1071

Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Merkel FR (2004) Impact of hunting and gillnet fishery on wintering eiders in Nuuk, southwest Greenland. Waterbirds 27:469-479

Merkel FR (2010) Evidence of Recent Population Recovery in Common Eiders Breeding in Western Greenland. Journal of Wildlife Management 74:1869-1874

Merkel FR, Jamieson SE, Falk K, Mosbech A (2007) The diet of common eiders wintering in Nuuk, Southwest Greenland. Polar Biol 30:227-234

Merkel FR, Johansen KL (2011) Light-induced bird strikes on vessels in Southwest Greenland. Mar Pollut Bull 62:2330-2336

Merkel FR, Mosbech A, Riget F (2009) Common Eider Somateria mollissima feeding activity and the influence of human disturbances. Ardea 97:99-107

Noel LE, Johnson SR, O'Doherty GM, Butcher MK (2005) Common eider (Somateria mollissima v-nigrum) nest cover and depredation on central Alaskan Beaufort Sea barrier islands. Arctic 58:129-136

Olsson EGA, Thorvaldsen P (2006) The eider conservation paradox in Tautra - a new contribution to the multidimensionality of the agricultural landscapes in Europe. Environ Sci Policy 9:343-349

Ronka MTH, Saari CLV, Lehikoinen EA, Suomela J, Hakkila K (2005) Environmental changes and population trends of breeding waterfowl in northern Baltic Sea. Ann Zool Fenn 42:587-602
Skerratt LF, Franson JC, Meteyer CU, Hollmen TE (2005) Causes of mortality in sea ducks (Mergini) necropsied at the USGS-National Wildlife Health Center. Waterbirds 28:193-207
Stien J, Yoccoz NG, Ims RA (2010) Nest predation in declining populations of common eiders Somateria mollissima: an experimental evaluation of the role of hooded crows Corvus cornix. Wildlife Biol 16:123-134
Tulp I, Craeymeersch J, Leopold M, van Damme C, Fey F, Verdaat H (2010) The role of the invasive bivalve Ensis directus as food source for fish and birds in the Dutch coastal zone. Estuarine Coastal and Shelf Science 90:116-128
Wayland M, Gilchrist HG, Dickson DL, Bollinger T, James C, Carreno RA, Keating J (2001) Trace elements in king eiders and common eiders in the Canadian Arctic. Archives of Environmental Contamination and Toxicology 41:491-500
Weslawski JM, Stempniewicz L, Galaktionov K (1994) Summer diet of seabirds from the Franz Josef Land archipelago, Russian Arctic. Polar Res 13:173-181
Wilson HM, Flint PL, Powell AN (2007) Coupling contaminants with demography: Effects of lead and selenium in Pacific common eiders. Environmental Toxicology and Chemistry 26:1410-1417

Common Gull *Larus canus*

Bishop MA, Green SP (2001) Predation on Pacific herring (Clupea pallasi) spawn by birds in Prince William Sound, Alaska. Fish Oceanogr 10:149-158
Brommer JE, Rattiste K, Wilson AJ (2008) Exploring plasticity in the wild: laying date-temperature reaction norms in the common gull Larus canus. Proceedings of the Royal Society B-Biological Sciences 275:687-693
Bukacinski D, Bukacinska M (2000) The impact of mass outbreaks of black flies (Simuliidae) on the parental behaviour and breeding output of colonial common gulls (Larus canus). Ann Zool Fenn 37:43-49
Desprez M, Rybarczyk H, Wilson JG, Ducrotoy JP, Sueur F, Olivesi R, Elkaim B (1992) Biological impact of eutrophication in the Bay of Somme and the induction and impact of anoxia. Neth J Sea Res 30:149-159
Kilpi M (1992) Responses of herring gulls Larus argentatus and common gulls L. canus to warm years - early migration and early breeding. Ornis Fennica 69:82-87
Kilpi M (1995) Breeding success, predation and local dynamics of colonial common gulls Larus canus. Ann Zool Fenn 32:175-182
Kubetzki U, Garthe S (2003) Distribution, diet and habitat selection by four sympatrically breeding gull species in the south-eastern North Sea. Marine Biology 143:199-207
Kubetzki U, Garthe S (2007) Nests with a view: Distribution, nest habitats and diets of roof-breeding Common Gulls (Larus canus) in northern Germany. Waterbirds 30:602-608
Lorentsen SH, Christensen-Dalsgaard S (2009) Det nasjonale overvåkingsprogrammet for sjøfugl. Resultater til og med hekkesesongen 2008. The national monitoring programme for seabirds. Results up to and including the 2008 breeding season. In: 439 NR (ed)
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Nordstrom M, Hogmander J, Laine J, Nummelin J, Laanetu N, Korpimaki E (2003) Effects of feral mink removal on seabirds, waders and passerines on small islands in the Baltic Sea. Biol Conserv 109:359-368
Schwemmer P, Garthe S, Mundry R (2008) Area utilization of gulls in a coastal farmland landscape: habitat mosaic supports niche segregation of opportunistic species. Landsc Ecol 23:355-367
Skorka P, Martyka R, Wojcik JD, Babiarz T, Skorka J (2006) Habitat and nest site selection in the Common Gull Larus canus in southern Poland: significance of man-made habitats for conservation of an endangered species. Acta Ornithol 41:137-144
Tonnessen R, Kristoffersen AB, Jonassen CM, Hjortaas MJ, Hansen EF, Rimstad E, Hauge AG (2013) Molecular and epidemiological characterization of avian influenza viruses from gulls and dabbling ducks in Norway. Virol J 10

Lesser Black-backed Gull *Larus fuscus*

Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)
Boertmann D (2007) The lesser black-backed gull, Larus fuscus, in Greenland. Arctic 61:129-133
Bustnes JO, Anker-Nilssen T, Lorentsen SH (2010a) Local and large-scale climatic variables as predictors of the breeding numbers of endangered Lesser Black-backed Gulls on the Norwegian Coast. J Ornithol 151:19-26
Bustnes JO, Barrett RT, Helberg M (2010b) Northern Lesser Black-backed Gulls: What do They Eat? Waterbirds 33:534-540
Bustnes JO, Erikstad KE, Lorentsen SH, Herzke D (2008) Perfluorinated and chlorinated pollutants as predictors of demographic parameters in an endangered seabird. Environmental Pollution 156:417-424
Camphuysen CJ, Gronert A (2012) Apparent survival and fecundity of sympatric Lesser Black-backed Gulls and Herring Gulls with contrasting population trends. Ardea 100:113-122

Costagliola A, Britti D, Russo V, Meomartino L, Castagna F, Giordano D, Insabato L, Paciello O (2011) Malignant Melanoma in a Seagull (Larus fuscus): Morphological and Immunohistochemical Approach. Avian Diseases 55:147-150
Coulson JC, Coulson BA (2008) Lesser Black-backed Gulls Larus fuscus nesting in an inland urban colony: the importance of earthworms (Lumbricidae) in their diet. Bird Stud 55:297-303
Coulson JC, Coulson BA (2009) Ecology and Colonial Structure of Large Gulls in an Urban Colony Investigations and Management at Dumfries, SW Scotland. Waterbirds 32:1-15
Erikstad KE, Bustnes JO, Lorentsen SH, Reiertsen TK (2009) Sex ratio in lesser black-backed gull in relation to environmental pollutants. Behavioral Ecology and Sociobiology 63:931-938
Furness RW, Ensor K, Hudson AV (1992) The use of fishery waste by gull populatios around the British Isles. Ardea 80:105-113
Garthe S, Freyer T, Huppop O, Wolke D (1999) Breeding Lesser Black-Backed Gulls Larus graellsii and Herring Gulls Larus argentatus: Coexistence or competition? Ardea 87:227-236
Hallgrimsson GT, Hersteinsson P (2012) Spatial contraction in a large gull colony in relation to the position of arctic fox dens. European Journal of Wildlife Research 58:441-450
Hallgrimsson GT, Palsdottir ES, Helgason HH, Hersteinsson P, Palsson S (2011) A collapse in breeding numbers and changes in the ecology of Lesser black-backed gulls in Iceland signal changes in food availability. Phd thesis: Ecological constraints on two species of large gulls, University of Iceland
Hario M (1990) Breeding failure and feeding conditions of lesser black-backed gulls Larus f. fuscus in the Gulf of Finland Ornis Fennica 67:113-129
Hario M (1994) Reproductive performance of the nominate lesser black-backed gull under pressure of herring gull predation. Ornis Fennica 71:1-10
Hario M, Himberg K, Hollmen T, Rudback E (2000) Polychlorinated biphenyls in diseased lesser black-backed gull (Larus fuscus fuscus) chicks from the Gulf of Finland. Environmental Pollution 107:53-60
Hario M, Hirvi JP, Hollmen T, Rudback E (2004) Organochlorine concentrations in diseased vs. healthy gull chicks from the northern Baltic. Environmental Pollution 127:411-423
Hario M, Rudback E (1996) High frequency of chick diseases in nominate Lesser Black-backed Gulls Larus-f-fuscus from the Gulf of Finland. Ornis Fennica 73:69-77
Hjernquist B, Hjernquist MB (2010) The effects of quantity and quality of prey on population fluctuations in three seabird species. Bird Stud 57:19-25
Kim SY, Monaghan P (2006) Interspecific differences in foraging preferences, breeding performance and demography in herring (Larus argentatus) and lesser black-backed gulls (Larus fuscus) at a mixed colony. J Zool 270:664-671
Kubetzki U, Garthe S (2003) Distribution, diet and habitat selection by four sympatrically breeding gull species in the south-eastern North Sea. Marine Biology 143:199-207
Luczak C, Beaugrand G, Lindley JA, Dewarumez JM, Dubois PJ, Kirby RR (2012) North Sea ecosystem change from swimming crabs to seagulls. Biology Letters 8:821-824
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Noordhuis R, Spaans AL (1992) Interspecific competition for food between herring Larus argentatus and lesser black-backed gulls L. fuscus in the Dutch Wadden Sea area. Ardea 80:114-132
Oro D (1996) Effects of trawler discard availability on egg laying and breeding success in the lesser black-backed gull Larus fuscus in the western Mediterranean. Mar Ecol-Prog Ser 132:43-46
Schwemmer H, Schwemmer P, Ehrich S, Garthe S (2013) Lesser black-backed gulls (Larus fuscus) consuming swimming crabs: An important link in the food web of the southern North Sea. Estuarine Coastal and Shelf Science 119:71-78
Schwemmer P, Garthe S (2005) At-sea distribution and behaviour of a surface-feeding seabird, the lesser black-backed gull Larus fuscus, and its association with different prey. Mar Ecol-Prog Ser 285:245-258
Walter U, Becker PH (1997) Occurrence and consumption of seabirds scavenging on shrimp trawler discards in the Wadden Sea. Ices Journal of Marine Science 54:684-694

Herring Gull *Larus argentatus*

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249
Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger
Balk L, Hagerroth PA, Akerman G, Hanson M, Tjarnlund U, Hansson T, Hallgrimsson GT, Zebuhr Y, Broman D, Morner T, Sundberg H (2009) Wild birds of declining European species are dying from a thiamine deficiency syndrome. Proc Natl Acad Sci U S A 106:12001-12006
Barrett RT, Erikstad KE (2011) Key-site monitoring on Hornøya in 2010. SEAPOP Short Report 3-2011
Belant JL, Ickes SK, Seamans TW (1998) Importance of landfills to urban-nesting herring and ring-billed gulls. Landsc Urban Plan 43:11-19
Belant JL, Seamans TW, Gabrey SW, Ickes SK (1993) Importance of landfills to nesting herring gulls. Condor 95:817-830

Breton AR, Fox GA, Chardine JW (2008) Survival of adult Herring Gulls (Larus argentatus) from a Lake Ontario colony over two decades of environmental change. Waterbirds 31:15-23
Burke CM, Hedd A, Montevecchi WA, Regular PM (2011) Effects of an Arctic Fox Visit to a Low Arctic Seabird Colony. Arctic 64:302-306
Chapdelaine G, Rail JF (1997) Relationship between cod fishery activities and the population of herring gulls on the North Shore of the Gulf of St Lawrence, Quebec, Canada. Ices Journal of Marine Science 54:708-713
Christie KS, Reimchen TE (2005) Post-reproductive Pacific salmon, Oncorhynchus spp., as a major nutrient source for large aggregations of gulls, Larus spp. Canadian Field-Naturalist 119:202-207
Coulson JC, Coulson BA (2009) Ecology and Colonial Structure of Large Gulls in an Urban Colony Investigations and Management at Dumfries, SW Scotland. Waterbirds 32:1-15
Ellis JC, Good TP (2006) Nest attributes, aggression, and breeding success of gulls in single and mixed species subcolonies. Condor 108:211-219
Ellis JC, Shulman MJ, Jessop H, Suomala R, Morris SR, Seng V, Wagner M, Mach K (2007) Impact of Raccoons on breeding success in large colonies of Great Black-backed Gulls and Herring Gulls. Waterbirds 30:375-383
Ewins PJ, Weseloh DV, Groom JH, Dobos RZ, Mineau P (1994) The diet of herring gulls (Larus argentatus) during winter and early spring on the lower Great Lakes. Hydrobiologia 279:39-55
Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. Bycatch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719
Follestad A (2012) Akutt skadeomfang og herkomst av sjøfugl etter Godafoss-forliset. Effects on seabird populations following the Godafoss grounding in Southern Norway NINA Report 811
Furness RW, Ensor K, Hudson AV (1992) The use of fishery waste by gull populatios around the British Isles. Ardea 80:105-113
Garthe S, Freyer T, Huppop O, Wolke D (1999) Breeding Lesser Black-Backed Gulls Larus graellsii and Herring Gulls Larus argentatus: Coexistence or competition? Ardea 87:227-236
Gochfeld M, Burger J (1998) Apparent paralytic shellfish poisoning in captive herring gulls fed commercial scallops. Toxicon 36:411-415
Hebert CE (1998) Winter severity affects migration and contaminant accumulation in northern Great Lakes Herring Gulls. Ecological Applications 8:669-679
Hebert CE, Hobson KA, Shutt JL (2000) Changes in food web structure affect rate of PCB decline in herring gull (Larus argentatus) eggs. Environmental Science & Technology 34:1609-1614
Hebert PN (1989) Decline of the Kent Island, New-Brunswick, herring gull Larus argentatus colony. Canadian Field-Naturalist 103:394-396
Hillstrom L, Kilpi M, Lindstrom K (1994) Diet of herring gulls Larus argentatus during chick rearing in the Gulf of Finland. Ornis Fennica 71:95-101
Hipfner JM, Blight LK, Lowe R, Wilhelm SI, Robertson GJ, Barrett RT, Anker-Nilssen T, Good TP (2012) Unintended consequences: how the recovery of sea eagle Haliaeetus spp. populations in the northern hemishpere is affecting seabirds. Marine Ornithology 40:39-52
Huppop O, Wurm S (2000) Effects of winter fishery activities on resting numbers, food and body condition of large gulls Larus argentatus and L-marinus in the south-eastern North Sea. Mar Ecol-Prog Ser 194:241-247
Håland A, Mjøs AT (2006) Overlevelse av oljeskadet og rehabilitert sjø-og vannfugl etter Rocknes-forliset ved Bergen, januar 2004. Survival of oiled and rehabilitated seabirds after the Rocknes oil spill. NVI-Report 160
Kilpi M (1990) Breeding biology of the herring gull Larus argentatus in the northern Baltic. Ornis Fennica 67:130-140
Kilpi M (1992) Responses of herring gulls Larus argentatus and common gulls L. canus to warm years - early migration and early breeding. Ornis Fennica 69:82-87
Kim SY, Monaghan P (2006) Interspecific differences in foraging preferences, breeding performance and demography in herring (Larus argentatus) and lesser black-backed gulls (Larus fuscus) at a mixed colony. J Zool 270:664-671
Kubetzki U, Garthe S (2003) Distribution, diet and habitat selection by four sympatrically breeding gull species in the south-eastern North Sea. Marine Biology 143:199-207
Lorentsen S-H, Byrkjeland S, Flagstad Ø, Heggberget TM, Larsen T, Røv N, Balstad T, Haugland T, Østborg GM (2007) Etterkantundersøkelser sjøfugl og oter etter MS Server-forliset januar 2007. Effects on seabirds and Eurasian otter after the oil spill following the wreck of MS Server at Fedje, Hordaland in January 2007. NINA Report 336
Lorentsen SH, Tatarinkova IP (2000) Herring gull Larus argentatus. In: Anker-Nilssen T, Bakken V, Strøm H, Golovkin AN, Bianki VV, Tatarinkova IP (eds) The status of marine birds breeding in the Barents Sea Region, Book Report nr. 113. Norwegian Polar Institute
McLellan NR, Shutler D (2009) Sources of Food Delivered to Ring-Billed, Herring and Great Black-Backed Gull Chicks in Marine Environments. Waterbirds 32:507-513
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Neimanis A, Gavier-Widen D, Leighton F, Bollinger T, Rocke T, Morner T (2007) An outbreak of type c botulism in Herring Gulls (Larus argentatus) in southeastern Sweden. J Wildl Dis 43:327-336

Noordhuis R, Spaans AL (1992) Interspecific competition for food between herring Larus argentatus and lesser black-backed gulls L. fuscus in the Dutch Wadden Sea area. Ardea 80:114-132

Olijnyk CG, Brown KM (1999) Results of a seven year effort to reduce nesting by Herring and Great Black-backed Gulls. Waterbirds 22:285-289

Pierotti R, Annett CA (1991) Diet choice in the herring gull - Constraints imposed by reproductive and ecological factors. Ecology 72:319-328

Pons JM (1992) Effects of changes in the availability of human refuse on breeding parameters in a herring gull Larus argentatus population in Brittany, France. Ardea 80:143-150

Pons JM, Migot P (1995) Life-history strategy of the herring gull - Changes in survival and fecundity in a population subjected to various feeding conditions. J Anim Ecol 64:592-599

Regular P, Montevecchi W, Hedd A, Robertson G, Wilhelm S (2013) Canadian fishery closures provide a large-scale test of the impact of gillnet bycatch on seabird populations. Biology Letters 9

Rome MS, Ellis JC (2004) Foraging ecology and interactions between herring gulls and great black-backed gulls in New England. Waterbirds 27:200-210

Savoca MS, Bonter DN, Zuckerberg B, Dickinson JL, Ellis JC (2011) Nesting density is an important factor affecting chick growth and survival in the herring gull. Condor 113:565-571

Steenweg RJ, Ronconi RA, Leonard ML (2011) Seasonal and age-dependent dietary partitioning between the great black-backed and herring gulls. Condor 113:795-805

Tonnessen R, Kristoffersen AB, Jonassen CM, Hjortaas MJ, Hansen EF, Rimstad E, Hauge AG (2013) Molecular and epidemiological characterization of avian influenza viruses from gulls and dabbling ducks in Norway. Virol J 10

Washburn BE, Bernhardt GE, Kutschbach-Brohl L, Chipman RB, Francoeur LC (2013) Foraging ecology of four gull species at a coastal-urban interface. Condor 115:67-76

Glaucous Gull *Larus hyperboreus*

Allard KA, Gilchrist HG, Breton AR, Gilbert CD, Mallory ML (2010) Apparent survival of adult Thayer's and Glaucous Gulls nesting sympatrically in the Canadian high Arctic. Ardea 98:43-50

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127

Bakken V, Tertitski GM (2000) Glaucous gull Larus hyperboreus. In: Anker-Nilssen T, Bakken V, Strøm H, Golovkin AN, Bianki VV, Tatarinkova IP (eds) The staus of marine birds breeding in the Barents Sea Region. Norwegian Polar Institute, Report 113

Bowman TD, Stehn RA, Scribner KT (2004) Glaucous gull predation of goslings on the Yukon-Kuskokwim Delta, Alaska. Condor 106:288-298

Bustnes JO (2006) Pinpointing potential causative agents in mixtures of persistent organic pollutants in observational field studies: A review of glaucous gull studies. Journal of Toxicology and Environmental Health-Part a-Current Issues 69:97-108

Bustnes JO, Bakken V, Erikstad KE, Mehlum F, Skaare JU (2001) Patterns of incubation and nest-site attentiveness in relation to organochlorine (PCB) contamination in glaucous gulls. Journal of Applied Ecology 38:791-801

Bustnes JO, Erikstad KE, Bakken V, Mehlum F, Skaare JU (2000) Feeding ecology and the concentration of organochlorines in glaucous gulls. Ecotoxicology 9:179-186

Bustnes JO, Erikstad KE, Hanssen SA, Tveraa T, Folstad I, Skaare JU (2006) Anti-parasite treatment removes negative effects of environmental pollutants on reproduction in an Arctic seabird. Proceedings of the Royal Society B-Biological Sciences 273:3117-3122

Bustnes JO, Erikstad KE, Skaare JU, Bakken V, Mehlum F (2003) Ecological effects of organochlorine pollutants in the Arctic: A study of the Glaucous Gull. Ecological Applications 13:504-515

Bustnes JO, Folstad I, Erikstad KE, Fjeld M, Miland OO, Skaare JU (2002) Blood concentration of organochlorine pollutants and wing feather asymmetry in Glaucous Gulls. Functional Ecology 16:617-622

Bustnes JO, Hanssen SA, Folstad I, Erikstad KE, Hasselquist D, Skaare JU (2004) Immune function and organochlorine pollutants in arctic breeding glaucous gulls. Archives of Environmental Contamination and Toxicology 47:530-541

Bustnes JO, Miland O, Fjeld M, Erikstad KE, Skaare JU (2005) Relationships between ecological variables and four organochlorine pollutants in an artic glaucous gull (Larus hyperboreus) population. Environmental Pollution 136:175-185

Erikstad KE, Moum T, Bustnes JO, Reiertsen TK (2011) High levels of organochlorines may affect hatching sex ratio and hatchling body mass in arctic glaucous gulls. Functional Ecology 25:289-296

Erikstad KE, Strøm H (2012) Effekter av miljøgifter på bestanden av polarmåke på Bjørnøya. Effects of contaminants on the glaucous gull population on Bjørnøya. Brief Report Series nr 25. NPI

Gaston AJ, Descamps S, Gilchrist HG (2009) Reproduction and survival of Glaucous Gulls breeding in an Arctic seabird colony. Journal of Field Ornithology 80:135-145

Gilchrist HG, Gaston AJ, Smith JNM (1998) Wind and prey nest sites as foraging constraints on an avian predator, the Glaucous Gull. Ecology 79:2403-2414

Hobson KA, Gilchrist G, Falk K (2002) Isotopic investigations of seabirds of the North Water Polynya: Contrasting trophic relationships between the eastern and western sectors. Condor 104:1-11

Matley JK, Fisk AT, Dick TA (2012) Seabird predation on Arctic cod during summer in the Canadian Arctic. Mar Ecol-Prog Ser 450:219-228
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Pol SSV, Becker PR, Ellisor MB, Moors AJ, Pugh RS, Roseneau DG (2009) Monitoring organic contaminants in eggs of glaucous and glaucous-winged gulls (Larus hyperboreus and Larus glaucescens) from Alaska. Environmental Pollution 157:755-762
Sagerup K, Henriksen EO, Skaare JU, Gabrielsen GW (2002) Intraspecific variation in trophic feeding levels and organochlorine concentrations in glaucous gulls (Larus hyperboreus) from Bjornoya, the Barents Sea. Ecotoxicology 11:119-125
Sagerup K, Henriksen EO, Skorping A, Skaare JU, Gabrielsen GW (2000) Intensity of parasitic nematodes increases with organochlorine levels in the glaucous gull. Journal of Applied Ecology 37:532-539
Samelius G, Alisauskas R (1999) Diet and growth of glaucous gulls at a large Arctic goose colony. Can J Zool-Rev Can Zool 77:1327-1331
Schmutz JA, Hobson KA (1998) Geographic, temporal, and age-specific variation in diets of Glaucous Gulls in western Alaska. Condor 100:119-130
Schmutz JA, Manly BFJ, Dau CP (2001) Effects of gull predation and weather on survival of emperor goose goslings. Journal of Wildlife Management 65:248-257
Scribner KT, Bowman TD (1998) Microsatellites identify depredated waterfowl remains from glaucous gull stomachs. Molecular Ecology 7:1401-1405
Varpe O (2010) Stealing bivalves from common eiders: kleptoparasitism by glaucous gulls in spring. Polar Biol 33:359-365
Verreault J, Letcher RJ, Ropstad E, Dahl E, Gabrielsen GW (2006) Organohalogen contaminants and reproductive hormones in incubating glaucous gulls (Larus hyperboreus) from the Norwegian Arctic. Environmental Toxicology and Chemistry 25:2990-2996
Weiser EL, Powell AN (2010) Does garbage in the diet improve reporoductive output of glaucous gulls? Condor 112:530-538
Weiser EL, Powell AN (2011) Reduction of Garbage in the Diet of Nonbreeding Glaucous Gulls Corresponding to a Change in Waste Management. Arctic 64:220-226
Weslawski JM, Stempniewicz L, Galaktionov K (1994) Summer diet of seabirds from the Franz Josef Land archipelago, Russian Arctic. Polar Res 13:173-181
Wojczulanis K, Jakubas D, Stempniewicz L (2005) Changes in the Glaucous Gull predatory pressure on Little Auks in southwest Spitsbergen. Waterbirds 28:430-435

Great Black-backed Gull *Larus marinus*

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249
Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger
Barrett RT, Erikstad KE (2011) Key-site monitoring on Hornøya in 2010. SEAPOP Short Report 3-2011
Buckley NJ (1990) Diet and feeding ecology of great black-backed gulls (Larus marinus) at a southern Irish breeding colony. J Zool 222:363-373
Burke CM, Hedd A, Montevecchi WA, Regular PM (2011) Effects of an Arctic Fox Visit to a Low Arctic Seabird Colony. Arctic 64:302-306
Bustnes JO, Fauchald P, Tveraa T, Helberg M & Skaare JU (2008) The potential impact of environmental variation on the concentrations and ecological effects of pollutants in a marine avian top predator. Environmental International 34: 193-201.
Ellis JC, Good TP (2006) Nest attributes, aggression, and breeding success of gulls in single and mixed species subcolonies. Condor 108:211-219
Ellis JC, Shulman MJ, Jessop H, Suomala R, Morris SR, Seng V, Wagner M, Mach K (2007) Impact of Raccoons on breeding success in large colonies of Great Black-backed Gulls and Herring Gulls. Waterbirds 30:375-383
Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. Bycatch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719
Farmer RG, Leonard ML (2011) Long-term feeding ecology of Great Black-backed Gulls (Larus marinus) in the northwest Atlantic: 110 years of feather isotope data. Can J Zool-Rev Can Zool 89:123-133
Follestad A (2012) Akutt skadeomfang og herkomst av sjøfugl etter Godafoss-forliset. Effects on seabird populations following the Godafoss grounding in Southern Norway NINA Report 811
Furness RW, Ensor K, Hudson AV (1992) The use of fishery waste by gull populatios around the British Isles. Ardea 80:105-113
Helberg M, Bustnes JO, Erikstad KE, Kristiansen KO, Skaare JU (2005) Relationships between reproductive performance and organochlorine contaminants in great black-backed gulls (Larus marinus). Environmental Pollution 134:475-483

Hipfner JM, Blight LK, Lowe R, Wilhelm SI, Robertson GJ, Barrett RT, Anker-Nilssen T, Good TP (2012) Unintended consequences: how the recovery of sea eagle Haliaeetus spp. populations in the northern hemishpere is affecting seabirds. Marine Ornithology 40:39-52

Huppop O, Wurm S (2000) Effects of winter fishery activities on resting numbers, food and body condition of large gulls Larus argentatus and L-marinus in the south-eastern North Sea. Mar Ecol-Prog Ser 194:241-247

JNCC (2012) Seabird population trends and causes of change: 2012 Report. Updated July 2012. Joint Nature Conservation Committee

McLellan NR, Shutler D (2009) Sources of Food Delivered to Ring-Billed, Herring and Great Black-Backed Gull Chicks in Marine Environments. Waterbirds 32:507-513

Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Olijnyk CG, Brown KM (1999) Results of a seven year effort to reduce nesting by Herring and Great Black-backed Gulls. Waterbirds 22:285-289

Regular P, Montevecchi W, Hedd A, Robertson G, Wilhelm S (2013) Canadian fishery closures provide a large-scale test of the impact of gillnet bycatch on seabird populations. Biology Letters 9

Rome MS, Ellis JC (2004) Foraging ecology and interactions between herring gulls and great black-backed gulls in New England. Waterbirds 27:200-210

Steenweg RJ, Ronconi RA, Leonard ML (2011) Seasonal and age-dependent dietary partitioning between the great black-backed and herring gulls. Condor 113:795-805

Tonnessen R, Kristoffersen AB, Jonassen CM, Hjortaas MJ, Hansen EF, Rimstad E, Hauge AG (2013) Molecular and epidemiological characterization of avian influenza viruses from gulls and dabbling ducks in Norway. Virol J 10

Washburn BE, Bernhardt GE, Kutschbach-Brohl L, Chipman RB, Francoeur LC (2013) Foraging ecology of four gull species at a coastal-urban interface. Condor 115:67-76

Black-legged Kittiwake *Rissa tridactyla*

Anker-Nilssen T (2009) Key-site monitoring in Røst in 2008. SEAPOP Short Report 5-2009

Anker-Nilssen T (2010) Key-site monitoring on Røst in 2009. SEAPOP Short Report 12-2010

Anker-Nilssen T, Aarvak T (2006) TIdsseriestudier av sjøfugler i Røst kommune, Nordland. Resultater med fokus på 2004 og 2005. NINA Rapport 133

Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249

Barrett RT (1989) The effect of egg harvesting on the growth of chicks and breeding success of shag Phalacrocorax aristotelis and the kittiwake Rissa tridactyla on Bleiksoy, North Norway. Ornis Fennica 66:117-122

Barrett RT (1996) Egg laying, chick growth and food of kittiwakes Rissa tridactyla at Hopen, Svalbard. Polar Res 15:107-113

Barrett RT (2007) Food web interactions in the southwestern Barents Sea: black-legged kittiwakes Rissa tridactyla respond negatively to an increase in herring Clupea harengus. Mar Ecol-Prog Ser 349:269-276

Barrett RT, Anker-Nilssen T, Bustnes JO, Christensen-Dalsgaard S, Descamps S, Erikstad K-E, Lorentsen S-H, Strøm H, Systad GH (2012) Key-site monitoring in Norway 2011. SEAPOP Short Report 1-2012

Barrett RT, Erikstad KE (2009) Key-site monitoring on Hornøya in 2008. SEAPOP Short Report 1-2009

Barrett RT, Erikstad KE (2010) Key-site monitoring on Hornøya in 2009 SEAPOP Short Report 2-2010

Barrett RT, Erikstad KE (2011) Key-site monitoring on Hornøya in 2010. SEAPOP Short Report 3-2011

Barrett RT, Josefsen TD, Polder A (2004) Early spring wreck of black-legged kittiwakes Rissa tridactyla in North Norway, April 2003. Atlantic Seabirds 6:33-45

Barrett RT, Krasnov YV (1996) Recent responses to changes in stocks of prey species by seabirds breeding in the southern Barents Sea. Ices Journal of Marine Science 53:713-722

Bull J, Wanless S, Elston DA, Daunt F, Lewis S, Harris MP (2004) Local-scale variability in the diet of Black-legged Kittiwakes Rissa tridactyla. Ardea 92:43-52

Cadiou B (1999) Attendance of breeders and prospectors reflects the duality of colonies in the Kittiwake Rissa tridactyla. Ibis 141:321-326

Chastel C, Lelay G, Legoff F, Monnat JY (1990) Isolation of soldado virus from a seabird (Rissa tridactyla) in France. Acta Virol 34:109-109

Chastel C, Monnat JY, Lelay G, Balouet G (1987) Infestation and hyperinfestation of kittiwake, Rissa tridactyla L by ticks Ixodes (C.) uriae, Ornithodoros (A.) maritimus infected by arboviruses; pathological effects. Annales De Parasitologie Humaine Et Comparee 62:492-504

Chivers LS, Lundy MG, Colhoun K, Newton SF, Reid N (2012) Diet of Black-legged Kittiwakes (Rissa tridactyla) feeding chicks at two Irish colonies highlights the importance of clupeids. Bird Stud 59:363-367

Coulson JC, Strowger J (1999) The annual mortality rate of Black-legged Kittiwakes in NE England from 1954 to 1998 and a recent exceptionally high mortality. Waterbirds 22:3-13

Cunningham AA, Simmonds M (1992) Unusual mass mortality of juvenile kittiwakes (Rissa tridactyla). Vet Rec 130:448-449

Danchin E (1992) Food shortage as a factor in the 1988 kittiwake Rissa tridactyla breeding failure in Shetland. Ardea 80:92-98

Danchin E, Monnat JY (1992) Population dynamics modeling of two neighboring kittiwake Rissa tridactyla colonies. Ardea 80:170-180

Daunt F, Benvenuti S, Harris MP, Dall'Antonia L, Elston DA, Wanless S (2002) Foraging strategies of the black-legged kittiwake Rissa tridactyla at a North Sea colony: evidence for a maximum foraging range. Mar Ecol-Prog Ser 245:239-247

Frederiksen M, Edwards M, Mavor RA, Wanless S (2007) Regional and annual variation in black-legged kittiwake breeding productivity is related to sea surface temperature. Mar Ecol-Prog Ser 350:137-143

Frederiksen M, Harris MP, Wanless S (2005a) Inter-population variation in demographic parameters: a neglected subject? Oikos 111:209-214

Frederiksen M, Jensen H, Daunt F, Mavor RA, Wanless S (2008) Differential effects of a local industrial sand lance fishery on seabird breeding performance. Ecological Applications 18:701-710

Frederiksen M, Wanless S, Harris MP, Rothery P, Wilson LJ (2004) The role of industrial fisheries and oceanographic change in the decline of North Sea black-legged kittiwakes. Journal of Applied Ecology 41:1129-1139

Frederiksen M, Wright PJ, Harris MP, Mavor RA, Heubeck M, Wanless S (2005b) Regional patterns of kittiwake Rissa tridactyla breeding success are related to variability in sandeel recruitment. Mar Ecol-Prog Ser 300:201-211

Garthe S, Huppop O (2004) Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology 41:724-734

Gaston AJ, Bertram DF, Boyne AW, Chardine JW, Davoren G, Diamond AW, Hedd A, Montevecchi WA, Hipfner JM, Lemon MJF, Mallory ML, Rail JF, Robertson GJ (2009) Changes in Canadian seabird populations and ecology since 1970 in relation to changes in oceanography and food webs. Environ Rev 17:267-286

Gill VA, Hatch SA (2002) Components of productivity in black-legged kittiwakes Rissa tridactyla: response to supplemental feeding. Journal of Avian Biology 33:113-126

Hamer KC, Monaghan P, Uttley JD, Walton P, Burns MD (1993) The influence of food supply on the breeding ecology of kittiwakes Rissa tridactyla in Shetland. Ibis 135:255-263

Harris MP, Freeman SN, Wanless S, Morgan BJT, Wernham CV (1997) Factors influencing the survival of Puffins Fratercula arctica at a North Sea colony over a 20-year period. Journal of Avian Biology 28:287-295

Harris MP, Wanless S (1990) Breeding success of British kittiwakes Rissa tridactyla in 1986-88 - Evidence for changing conditions in the northern North Sea. Journal of Applied Ecology 27:172-187

Harris MP, Wanless S (1997) Breeding success, diet, and brood neglect in the kittiwake (Rissa tridactyla) over an 11-year period. Ices Journal of Marine Science 54:615-623

Hatch SA (2013) Kittiwake diets and chick production signal a 2008 regime shift in the Northeast Pacific. Mar Ecol-Prog Ser 477:271-+

Hipfner JM, Adams PA, Bryant R (2000) Breeding success of Black-legged Kittiwakes, Rissa tridactyla, at a colony in Labrador during a period of low Capelin, Mallotus villosus, availability. Canadian Field-Naturalist 114:413-416

Hobson KA, Gilchrist G, Falk K (2002) Isotopic investigations of seabirds of the North Water Polynya: Contrasting trophic relationships between the eastern and western sectors. Condor 104:1-11

Irons DB, Kendall SJ, Erickson WP, McDonald LL, Lance BK (2000) Nine years after the Exxon Valdez oil spill: Effects on marine bird populations in Prince William Sound, Alaska. Condor 102:723-737

Klicka J, Winker K (1991) Observations of ravens preying on adult kittiwakes. Condor 93:755-757

Lance BK, Irons DB, Kendall SJ, McDonald LL (2001) An evaluation of marine bird population trends following the Exxon valdez oil spill, Prince William Sound, Alaska. Mar Pollut Bull 42:298-309

Lewis S, Wanless S, Wright PJ, Harris MP, Bull J, Elston DA (2001) Diet and breeding performance of black-legged kittiwakes Rissa tridactyla at a North Sea colony. Mar Ecol-Prog Ser 221:277-284

Lilliendahl K (2009) Winter diets of auks in Icelandic coastal waters. Marine Biology Research 5:143-154

Lonne OJ, Gabrielsen GW (1992) Summer diet of seabirds feeding in sea-ice covered waters near Svalbard. Polar Biol 12:685-692

Maccarone AD (1992) Predation by common ravens on cliff-nesting black-legged kittiwakes on Baccalieu Island, Newfoundland. Colonial Waterbirds 15:253-256

Markones N, Guse N, Huppop O, Garthe S (2009) Unchanging diet in a stable colony: contemporary and past diet composition of black-legged kittiwakes Rissa tridactyla at Helgoland, south-eastern North Sea. Helgoland Mar Res 63:199-206

Massaro M, Chardine JW, Jones IL (2001) Relationships between Black-legged Kittiwake nest site characteristics and susceptibility to predation by large gulls. Condor 103:793-801

Massaro M, Chardine JW, Jones IL, Robertson GJ (2000) Delayed capelin (Mallotus villosus) availability influences predatory behaviour of large gulls on black-legged kittiwakes (Rissa tridactyla), causing a reduction in kittiwake breeding success. Can J Zool-Rev Can Zool 78:1588-1596

Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Moe B, Stempniewicz L, Jakubas D, Angelier F, Chastel O, Dinessen F, Gabrielsen GW, Hanssen F, Karnovsky NJ, Ronning B, Welcker J, Wojczulanis-Jakubas K, Bech C (2009) Climate change and phenological responses of two seabird species breeding in the high-Arctic. Mar Ecol-Prog Ser 393:235-246

Murphy EC, Springer AM, Roseneau DG (1991) High annual variability in reproductive success of kittiwakes (Rissa tridactyla) at a colony in western Alaska J Anim Ecol 60:515-534

Oro D, Furness RW (2002) Influences of food availability and predation on survival of kittiwakes. Ecology 83:2516-2528

Paredes R, Harding AMA, Irons DB, Roby DD, Suryan RM, Orben RA, Renner H, Young R, Kitaysky A (2012) Proximity to multiple foraging habitats enhances seabirds' resilience to local food shortages. Mar Ecol-Prog Ser 471:253-269

Regehr HM, Montevecchi WA (1997) Interactive effects of food shortage and predation on breeding failure of black-legged kittiwakes: indirect effects of fisheries activities and implications for indicator species. Mar Ecol-Prog Ser 155:249-260

Regehr HM, Rodway MS, Montevecchi WA (1998) Antipredator benefits of nest-site selection in Black-legged Kittiwakes. Can J Zool-Rev Can Zool 76:910-915

Regular P, Montevecchi W, Hedd A, Robertson G, Wilhelm S (2013) Canadian fishery closures provide a large-scale test of the impact of gillnet bycatch on seabird populations. Biology Letters 9

Reiertsen TK, Erikstad KE, Anker-Nilssen T, Barrett RT, Boulinier T, Frederiksen M, Gonzales-Solis J, Gremillet D, Johns D, Moe B, Ponchon A, Skern-Mauritzen M, Sandvik H, Yoccoz NG (2014) Prey density in non-breeding areas affects adult survival of Black-legged Kittiwakes Rissa tridactyla breeding in the southern Barents Sea. Marine Ecology Progress Series, 509: 289–302

Rindorf A, Wanless S, Harris MP (2000) Effects of changes in sandeel availability on the reproductive output of seabirds. Mar Ecol-Prog Ser 202:241-252

Suryan RM, Irons DB (2001) Colony and population dynamics of black-legged kittiwakes in a heterogeneous environment. Auk 118:636-649

Suryan RM, Irons DB, Benson J (2000) Prey switching and variable foraging strategies of Black-legged Kittiwakes and the effect on reproductive success. Condor 102:374-384

Suryan RM, Irons DB, Kaufman M, Benson J, Jodice PGR, Roby DD, Brown ED (2002) Short-term fluctuations in forage fish availability and the effect on prey selection and brood-rearing in the black-legged kittiwake Rissa tridactyla. Mar Ecol-Prog Ser 236:273-287

Votier SC, Heubeck M, Furness RW (2008) Using inter-colony variation in demographic parameters to assess the impact of skua predation on seabird populations. Ibis 150:45-53

Walton P, Turner CMR, Austin G, Burns MD, Monaghan P (1997) Sub-lethal effects of an oil pollution incident on breeding kittiwakes Rissa tridactyla. Mar Ecol-Prog Ser 155:261-268

Weslawski JM, Stempniewicz L, Galaktionov K (1994) Summer diet of seabirds from the Franz Josef Land archipelago, Russian Arctic. Polar Res 13:173-181

Arctic Tern *Sterna paradisaea*

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127

Avery MI, Suddaby D, Ellis PM, Sim IMW (1992) Exceptionally low body-weights of Arctic terns Sterna paradisaea on Shetland. Ibis 134:87-88

Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger

Donehower CE, Bird DM, Hall CS, Kress SW (2007) Effects of gull predation and predator control on tern nesting success at Eastern Egg Rock, Maine. Waterbirds 30:29-39

Egevang C, Boertmann D (2003) Havternen i Grønland-status og undersøgelser 2002. The Arctic tern in Greenland-status and investigations 2002. Technical Report 438. National Environmental Research Institute, Denmark, NERI, Roskilde

Egevang C, Frederiksen M (2011) Fluctuating Breeding of Arctic Terns (Sterna paradisaea) in Arctic and High-arctic Colonies in Greenland. Waterbirds 34:107-111

Gaston AJ, Bertram DF, Boyne AW, Chardine JW, Davoren G, Diamond AW, Hedd A, Montevecchi WA, Hipfner JM, Lemon MJF, Mallory ML, Rail JF, Robertson GJ (2009) Changes in Canadian seabird populations and ecology since 1970 in relation to changes in oceanography and food webs. Environ Rev 17:267-286

Hall CS, Kress SW, Griffin CR (2000) Composition, spatial and temporal variation of Common and Arctic Tern chick diets in the Gulf of Maine. Waterbirds 23:430-439

Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Moller AP, Flensted-Jensen E, Mardal W (2006) Rapidly advancing laying date in a seabird and the changing advantage of early reproduction. J Anim Ecol 75:657-665

Monaghan P, Uttley JD, Burns MD (1992) Effect of changes in food availability on reproductive effort in Arctic terns Sterna paradisaea. Ardea 80:70-81

Monaghan P, Uttley JD, Burns MD, Thaine C, Blackwood J (1989a) The relationship between food supply, reproductive effort and breeding success in Arctic terns Sterna paradisaea. J Anim Ecol 58:261-274

Monaghan P, Uttley JD, Okill JD (1989b) Terns and sandeels - seabirds as indicators of changes in marine fish populations. Journal of Fish Biology 35:339-340
Nordstrom M, Hogmander J, Laine J, Nummelin J, Laanetu N, Korpimaki E (2003) Effects of feral mink removal on seabirds, waders and passerines on small islands in the Baltic Sea. Biol Conserv 109:359-368
Robinson JA, Hamer KC, Chivers LS (2002) Developmental plasticity in Arctic Terns Sterna paradisaea and Common Terns S-hirundo in response to a period of extremely bad weather. Ibis 144:344-346
Rock JC, Leonard ML, Boyne AW (2007) Do co-nesting Arctic and Common Terns partition foraging habitat and chick diets? Waterbirds 30:579-587
Weslawski JM, Stempniewicz L, Galaktionov K (1994) Summer diet of seabirds from the Franz Josef Land archipelago, Russian Arctic. Polar Res 13:173-181

Common Guillemot *Uria aalge*

Anker-Nilssen T (2009) Key-site monitoring in Røst in 2008. SEAPOP Short Report 5-2009
Anker-Nilssen T (2010) Key-site monitoring on Røst in 2009. SEAPOP Short Report 12-2010
Anker-Nilssen T, Aarvak T (2006) TIdsseriestudier av sjøfugler i Røst kommune, Nordland. Resultater med fokus på 2004 og 2005. NINA Rapport 133
Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)
Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127
Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249
Balseiro A, Espi A, Marquez I, Perez V, Ferreras MC, Marin JFG, Prieto JM (2005) Pathological features in marine birds affected by the prestige's oil spill in the north of Spain. J Wildl Dis 41:371-378
Barrett RT, Asheim M, Bakken V (1997a) Ecological relationships between two sympatric congeneric species, Common Murres and Thick-Billed Murres, Uria aalge and U-lomvia, breeding in the Barents Sea. Can J Zool 75:618-631
Barrett RT, Bakken V, Krasnov JV (1997b) The diets of common and Brunnich's guillemots Uria aalge and U-lomvia in the Barents Sea region. Polar Res 16:73-84
Barrett RT, Erikstad KE (2009) Key-site monitoring on Hornøya in 2008. SEAPOP Short Report 1-2009
Barrett RT, Erikstad KE (2010) Key-site monitoring on Hornøya in 2009 SEAPOP Short Report 2-2010
Barrett RT, Erikstad KE (2011) Key-site monitoring on Hornøya in 2010. SEAPOP Short Report 3-2011
Barrett RT, Erikstad KE (2013) Environmental variability and fledging body mass of common guillemot Uria aalge chicks. Marine Biology Published online
Bignert A, Litzen K, Odsjo T, Olsson M, Persson W, Reutergardh L (1995) Time-related factors influence the concentrations of sDDT, PCBs and shell parameters in eggs of Baltic guillemot (Uria aalge), 1861-1989. Environmental Pollution 89:27-36
Birkhead TR, Nettleship DN (1995) Arctic fox influence on a seabird community in Labrador - A natural experiment. Wilson Bulletin 107:397-412
Bryant R, Jones IL, Hipfner JM (1999) Responses to changes in prey availability by Common Murres and Thick-billed Murres at the Gannet Islands, Labrador. Can J Zool-Rev Can Zool 77:1278-1287
Bugge J, Barrett RT, Pedersen T (2011) Optimal foraging in chick-raising Common Guillemots (Uria aalge). J Ornithol 152:253-259
Burke CM, Hedd A, Montevecchi WA, Regular PM (2011) Effects of an Arctic Fox Visit to a Low Arctic Seabird Colony. Arctic 64:302-306
Cadiou B, Riffaut L, McCoy KD, Cabelguen J, Fortin M, Gélinaud G, Le Roch A, Tirard C, Boulinier T (2004) Ecological impact of the "Erika" oil spill: Determination of the geographic origin of the affected common guillemots. Aquatic Living Resources 17:369-377
Camphuysen KCJ, Barreveld H, Dahlmann G, Van Franeker JA (1999) Seabirds in the north sea demobilized and killed by polyisobutylene (C4H8)(n) (PIB). Mar Pollut Bull 38:1171-1176
Crespin L, Harris MP, Lebreton JD, Frederiksen M, Wanless S (2006) Recruitment to a seabird population depends on environmental factors and on population size. J Anim Ecol 75:228-238
Davoren GK, Montevecchi WA (2003) Signals from seabirds indicate changing biology of capelin stocks. Mar Ecol-Prog Ser 258:253-261
Davoren GK, Montevecchi WA, Anderson JT (2002) Scale-dependent associations of predators and prey: constraints imposed by flightlessness of common murres. Mar Ecol-Prog Ser 245:259-272
Debacker V, Jauniaux T, Coignoul F, Bouquegneau JM (2000) Heavy metals contamination and body condition of wintering guillemots (Uria aalge) at the Belgian coast from 1993 to 1998. Environ Res 84:310-317
Erikstad KE, Reiertsen TK, Barrett RT, Vikebo F, Sandvik H (2013) Seabird-fish interactions: the fall and rise of a common guillemot Uria aalge population. Mar Ecol-Prog Ser 475:267-276
Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. By-catch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719

Finney SK, Wanless S, Harris MP (1999) The effect of weather conditions on the feeding behaviour of a diving bird, the Common Guillemot Uria aalge. Journal of Avian Biology 30:23-30
Frederiksen M, Anker-Nilssen T, Beaugrand G, Wanless S (2013) Climate, copepods and seabirds in the boreal Northeast Atlantic - current state and future outlook. Global Change Biology 19:364-372
Gjosaeter H, Bogstad B, Tjelmeland S (2009) Ecosystem effects of the three capelin stock collapses in the Barents Sea. Marine Biology Research 5:40-53
Harris MP, Bailey RS (1992) Mortality rates of puffin Fratercula arctica and guillemot Uria aalge and fish abundance in the North Sea. Biol Conserv 60:39-46
Harris MP, Beare D, Toresen R, Nottestad L, Kloppmann M, Dorner H, Peach K, Rushton DRA, Foster-Smith J, Wanless S (2007) A major increase in snake pipefish (Entelurus aequoreus) in northern European seas since 2003: potential implications for seabird breeding success. Marine Biology 151:973-983
Harris MP, Heubeck M, Shaw DN, Okill JD (2006) Dramatic changes in the return date of Guillemots Uria aalge to colonies in Shetland, 1962-2005. Bird Stud 53:247-252
Harris MP, Wanless S (1996) Differential responses of guillemot Uria aalge and shag Phalacrocorax aristotelis to a late winter wreck. Bird Stud 43:220-230
Hatchwell BJ (1991a) An experimental study of the effects of timing of breeding on the reproductive success of common guillemots (Uria aalge). J Anim Ecol 60:721-736
Hatchwell BJ (1991b) The feeding ecology of young guillemots Uria aalge on Skomer Island, Wales. Ibis 133:153-161
Hjernquist B, Hjernquist MB (2010) The effects of quantity and quality of prey on population fluctuations in three seabird species. Bird Stud 57:19-25
Irons DB, Anker-Nilssen T, Gaston AJ, Byrd GV, Falk K, Gilchrist G, Hario M, Hjernquist M, Krasnov YV, Mosbech A, Olsen B, Petersen A, Reid JB, Robertson GJ, Strom H, Wohl KD (2008) Fluctuations in circumpolar seabird populations linked to climate oscillations. Global Change Biology 14:1455-1463
Joiris CR, Tapia G, Holsbeek L (1997) Increase of organochlorines and mercury levels in common guillemots Uria aalge during winter in the southern North Sea. Mar Pollut Bull 34:1049-1057
Lilliendahl K (2009) Winter diets of auks in Icelandic coastal waters. Marine Biology Research 5:143-154
Lorentsen SH, Anker-Nilssen T (1999) Diet of Common Murres wintering in the northern Skagerrak during 1988-1990: Variation with sex, age and season. Waterbirds 22:80-89
Mavor RA, Parsons M, Heubeck M, Schmitt S (2005) Seabird numbers and breeding success in Britain and Ireland, 2004 UK Nature Conservation Book 29. Joint Nature Conservation Committee, Peterborough
Mehlum F (2001) Crustaceans in the diet of adult common and Brünnich's guillemots Uria aalge and U. lomvia in the Barents Sea during the breeding period. Marine Ornithology 29:19-22
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Osterblom H, Bignert A, Fransson T, Olsson O (2001) A decrease in fledging body mass in common guillemot Uria aalge chicks in the Baltic Sea. Mar Ecol-Prog Ser 224:305-309
Osterblom H, Casini M, Olsson O, Bignert A (2006) Fish, seabirds and trophic cascades in the Baltic Sea. Mar Ecol-Prog Ser 323:233-238
Osterblom H, Fransson T, Olsson O (2002) Bycatches of common guillemot (Uria aalge) in the Baltic Sea gillnet fishery. Biol Conserv 105:309-319
Parrish JK (1995) Influence of group size and habitat type on reproductive success in Common Murres (Uria aalge). Auk 112:390-401
Parrish JK, Marvier M, Paine RT (2001) Direct and indirect effects: Interactions between Bald Eagles and Common Murres. Ecological Applications 11:1858-1869
Petersen A (2002) Seabird bycatch in fishing gear in Iceland. Náttúrfræoingurinn 71:52-61
Piatt JF, Anderson P (1996) Response of common murres to the Exxon Valdez oil spill and long-term changes in the Gulf of Alaska marine ecosystem. American Fisheries Society Symposium 18:720-737
Regular P, Montevecchi W, Hedd A, Robertson G, Wilhelm S (2013) Canadian fishery closures provide a large-scale test of the impact of gillnet bycatch on seabird populations. Biology Letters 9
Regular PM, Robertson GJ, Montevecchi WA, Shuhood F, Power T, Ballam D, Piatt JF (2010) Relative importance of human activities and climate driving common murre population trends in the Northwest Atlantic. Polar Biol 33:1215-1226
Regular PM, Shuhood F, Power T, Montevecchi WA, Robertson GJ, Ballam D, Piatt JF, Nakashima B (2009) Murres, capelin and ocean climate: inter-annual associations across a decadal shift. Environmental Monitoring and Assessment 156:293-302
Reiertsen TK, Erikstad KE, Barrett RT, Sandvik H, Yoccoz NG (2012) Climate fluctuations and differential survival of bridled and non-bridled common guillemots Uria aalge. Ecosphere 3:1-15
Reynolds TJ, Harris MP, King R, Swann RL, Jardine DC, Frederiksen M, Wanless S (2011) Among-colony synchrony in the survival of Common Guillemots Uria aalge reflects shared wintering areas. Ibis 153:818-831
Rindorf A, Wanless S, Harris MP (2000) Effects of changes in sandeel availability on the reproductive output of seabirds. Mar Ecol-Prog Ser 202:241-252
Rowe S, Jones IL, Chardine JW, Elliot RD, Veitch BG (2000) Recent changes in the winter diet of murres (Uria spp.) in coastal Newfoundland waters. Can J Zool-Rev Can Zool 78:495-500
Sandvik H, Erikstad KE, Barrett RT, Yoccoz NG (2005) The effect of climate on adult survival in five species of North Atlantic seabirds. J Anim Ecol 74:817-831

Strann KB, Vader W, Barrett RT (1991) Auk mortality in fishing nets in north Norway. Seabird 13:22-29
Thayer JA, Sydeman WJ, Fairman NP, Allen SG (1999) Attendance and effects of disturbance on coastal Common Murre colonies at Point Reyes, California. Waterbirds 22:130-139
Uttley JD, Walton P, Monaghan P, Austin G (1994) The effects of food abundance on breeding performance and adult time budgets of guillemots Uria aalge. Ibis 136:205-213
Vader W, Anker-Nilssen T, Bakken V, Barrett RT, Strann KB (1990) Regional and temporal differences in breeding success and population development of fisheating seabirds in Norway after collapses of herring and capelin stocks. Trans 19th IUGB Congress, Trondheim 1989
Votier SC, Hatchwell BJ, Beckerman A, McCleery RH, Hunter FM, Pellatt J, Trinder M, Birkhead TR (2005) Oil pollution and climate have wide-scale impacts on seabird demographics. Ecol Lett 8:1157-1164
Wanless S, Frederiksen M, Walton J, Harris MP (2009) Long-term changes in breeding phenology at two seabird colonies in the western North Sea. Ibis 151:274-285
Wanless S, Harris MP, Redman P, Speakman JR (2005) Low energy values of fish as a probable cause of a major seabird breeding failure in the North Sea. Mar Ecol-Prog Ser 294:1-8
Wiese FK, Robertson GJ (2004) Assessing seabird mortality from chronic oil discharges at sea. Journal of Wildlife Management 68:627-638
Wilhelm S, E. SA (2004) Temporal comparisons in feeding ecology and growth of young common guillemots Uria aalge. Atlantic Seabirds 6:47-64
Wilhelm SI, Robertson GJ, Taylor PA, Gilliland SG, Pinsent DL (2003) Stomach contents of breeding Common Murres caught in gillnets off Newfoundland. Waterbirds 26:376-378
Wilson LJ, Daunt F, Wanless S (2004) Self-feeding and chick provisioning diet differ in the Common Guillemot Uria aalge. Ardea 92:197-207

Brünnich's Guillemot *Uria lomvia*

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127
Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249
Bakken V, Pokrovskaya IV (2000) Brünnich's guillemot Uria lomvia. In: Anker-Nilssen T, Bakken V, Strøm H, Golovkin AN, Bianki VV, Tatarinkova IP (eds) The status of marine birds breeding in the Barents Sea Region, Book Report nr. 113. Norwegian Polar Institute
Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger
Barrett RT, Asheim M, Bakken V (1997a) Ecological relationships between two sympatric congeneric species, Common Murres and Thick-Billed Murres, Uria aalge and U-lomvia, breeding in the Barents Sea. Can J Zool-Rev Can Zool 75:618-631
Barrett RT, Bakken V, Krasnov JV (1997b) The diets of common and Brunnich's guillemots Uria aalge and U-lomvia in the Barents Sea region. Polar Res 16:73-84
Birkhead TR, Nettleship DN (1995) Arctic fox influence on a seabird community in Labrador - A natural experiment. Wilson Bulletin 107:397-412
Bryant R, Jones IL, Hipfner JM (1999) Responses to changes in prey availability by Common Murres and Thick-billed Murres at the Gannet Islands, Labrador. Can J Zool-Rev Can Zool 77:1278-1287
Gaston AJ (2003) Synchronous fluctuations of thick-billed murre (Uria lomvia) colonies in the Eastern Canadian Arctic suggest population regulation in winter. Auk 120:362-370
Gaston AJ, Elliott KH (2013) Effects of Climate-Induced Changes in Parasitism, Predation and Predator-Predator Interactions on Reproduction and Survival of an Arctic Marine Bird. Arctic 66:43-51
Gaston AJ, Gilchrist HG, Hipfner JM (2005) Climate change, ice conditions and reproduction in an Arctic nesting marine bird: Brunnich's guillemot (Uria lomvia L.). J Anim Ecol 74:832-841
Gaston AJ, Hipfner JM, Campbell D (2002) Heat and mosquitoes cause breeding failures and adult mortality in an Arctic-nesting seabird. Ibis 144:185-191
Gaston AJ, Robertson GJ (2010) Trends in the harvest of Brunnich's guillemots Uria lomvia in Newfoundland: effects of regulatory changes and winter sea ice conditions. Wildlife Biol 16:47-55
Gaston AJ, Woo K, Hipfner JM (2003) Trends in forage fish populations in northern Hudson Bay since 1981, as determined from the diet of nestling thick-billed murres Uria lomvia. Arctic 56:227-233
Gilchrist HG (1999) Declining thick-billed murre Uria lomvia colonies experience higher gull predation rates: an inter-colony comparison. Biol Conserv 87:21-29
Irons DB, Anker-Nilssen T, Gaston AJ, Byrd GV, Falk K, Gilchrist G, Hario M, Hjernquist M, Krasnov YV, Mosbech A, Olsen B, Petersen A, Reid JB, Robertson GJ, Strom H, Wohl KD (2008) Fluctuations in circumpolar seabird populations linked to climate oscillations. Global Change Biology 14:1455-1463
Laidre KL, Heide-Jorgensen MP, Nyeland J, Mosbech A, Boertmann D (2008) Latitudinal gradients in sea ice and primary production determine Arctic seabird colony size in Greenland. Proceedings of the Royal Society B-Biological Sciences 275:2695-2702
Lilliendahl K (2009) Winter diets of auks in Icelandic coastal waters. Marine Biology Research 5:143-154
Lonne OJ, Gabrielsen GW (1992) Summer diet of seabirds feeding in sea-ice covered waters near Svalbard. Polar Biol 12:685-692

Mehlum F (2001) Crustaceans in the diet of adult common and Brünnich's guillemots Uria aalge and U. lomvia in the Barents Sea during the breeding period. Marine Ornithology 29:19-22
Mehlum F, Nordlund N, Isaksen K (1998) The importance of the "Polar Front" as a foraging habitat for guillemots Uria spp. breeding at Bjornoya, Barents Sea. J Mar Syst 14:27-43
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)
Merkel FR, Johansen KL (2011) Light-induced bird strikes on vessels in Southwest Greenland. Mar Pollut Bull 62:2330-2336
Rowe S, Jones IL, Chardine JW, Elliot RD, Veitch BG (2000) Recent changes in the winter diet of murres (Uria spp.) in coastal Newfoundland waters. Can J Zool-Rev Can Zool 78:495-500
Smith PA, Gaston AJ (2012) Environmental variation and the demography and diet of thick-billed murres. Mar Ecol-Prog Ser 454:237-249
Tranquilla LM, Hedd A, Burke C, Montevecchi WA, Regular PM, Robertson GJ, Stapleton LA, Wilhelm SI, Fifield DA, Buren AD (2010) High Arctic sea ice conditions influence marine birds wintering in Low Arctic regions. Estuarine Coastal and Shelf Science 89:97-106
Weslawski JM, Stempniewicz L, Galaktionov K (1994) Summer diet of seabirds from the Franz Josef Land archipelago, Russian Arctic. Polar Res 13:173-181
Wiese FK, Robertson GJ (2004) Assessing seabird mortality from chronic oil discharges at sea. Journal of Wildlife Management 68:627-638

Razorbill *Alca torda*

Anker-Nilssen T (2009) Key-site monitoring in Røst in 2008. SEAPOP Short Report 5-2009
Anker-Nilssen T (2010) Key-site monitoring on Røst in 2009. SEAPOP Short Report 12-2010
Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)
Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127
Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249
Balseiro A, Espi A, Marquez I, Perez V, Ferreras MC, Marin JFG, Prieto JM (2005) Pathological features in marine birds affected by the prestige's oil spill in the north of Spain. J Wildl Dis 41:371-378
Barrett RT (2003) The food of Razorbill Alca torda chicks on Hornøya, North Norway. Ornis Norvegica 26: 48-54.
Barrett RT, Erikstad KE (2009) Key-site monitoring on Hornøya in 2008. SEAPOP Short Report 1-2009
Barrett RT, Erikstad KE (2010) Key-site monitoring on Hornøya in 2009 SEAPOP Short Report 2-2010
Barrett RT, Erikstad KE (2011) Key-site monitoring on Hornøya in 2010. SEAPOP Short Report 3-2011
Benjamins S, Kulka DW, Lawson J (2008) Incidental catch of seabirds in Newfoundland and Labrador gillnet fisheries, 2001-2003. Endangered species research 5:149-160
Birkhead TR, Nettleship DN (1995) Arctic fox influence on a seabird community in Labrador - A natural experiment. Wilson Bulletin 107:397-412
Chapdelaine G (1997) Pattern of recoveries of banded Razorbills (Alca torda) in the western Atlantic and survival rates of adults and immatures. Colonial Waterbirds 20:47-54
Espin S, Martinez-Lopez E, Gomez-Ramirez P, Maria-Mojica P, Garcia-Fernandez AJ (2010) Assessment of organochlorine pesticide exposure in a wintering population of razorbills (Alca torda) from the southwestern Mediterranean. Chemosphere 80:1190-1198
Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. Bycatch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719
Gardarsson A (2006) Recent changes in numbers of cliff-breeding seabirds in Iceland. Bliki 27:13-22
Gaston AJ, Woo K (2008) Razorbills (Alca torda) follow subarctic prey into the Canadian Arctic: Colonization results from climate-change? Auk 125:939-942
Heubeck M, Aarvak T, Isaksen K, Johnsen A, Petersen IK, Anker-Nilssen T (2011) Mass mortality of adult Razorbills Alca torda in the Skagerrak and North Sea area, autumn 2007. Seabird 24:11-32
Hjernquist B, Hjernquist MB (2010) The effects of quantity and quality of prey on population fluctuations in three seabird species. Bird Stud 57:19-25
Lavers JL, Jones IL, Diamond AW, Robertson GJ (2008) Annual survival of North American Razorbills (Alca torda) varies with ocean climate indices. Can J Zool-Rev Can Zool 86:51-61
Lavers JL, Jones IL, Robertson GJ, Diamond AW (2009) Contrasting Population Trends at Two Razorbill Colonies in Atlantic Canada: Additive Effects of Fox Predation and Hunting Mortality? Avian Conserv Ecol 4
Lilliendahl K (2009) Winter diets of auks in Icelandic coastal waters. Marine Biology Research 5:143-154
Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Nordstrom M, Hogmander J, Laine J, Nummelin J, Laanetu N, Korpimaki E (2003) Effects of feral mink removal on seabirds, waders and passerines on small islands in the Baltic Sea. Biol Conserv 109:359-368

Nordstrom M, Korpimaki E (2004) Effects of island isolation and feral mink removal on bird communities on small islands in the Baltic Sea. J Anim Ecol 73:424-433

Sandvik H, Erikstad KE, Barrett RT, Yoccoz NG (2005) The effect of climate on adult survival in five species of North Atlantic seabirds. J Anim Ecol 74:817-831

Sonntag N, Schwemmer H, Fock HO, Bellebaum J, Garthe S (2012) Seabirds, set-nets, and conservation management: assessment of conflict potential and vulnerability of birds to bycatch in gillnets. Ices Journal of Marine Science 69:578-589

Wanless S, Harris MP, Redman P, Speakman JR (2005) Low energy values of fish as a probable cause of a major seabird breeding failure in the North Sea. Mar Ecol-Prog Ser 294:1-8

Black Guillemot *Cephus grylle*

Anker-Nilssen T (2009) Key-site monitoring in Røst in 2008. SEAPOP Short Report 5-2009

Anker-Nilssen T (2010) Key-site monitoring on Røst in 2009. SEAPOP Short Report 12-2010

Anker-Nilssen T, Aarvak T (2006) TIdsseriestudier av sjøfugler i Røst kommune, Nordland. Resultater med fokus på 2004 og 2005. NINA Rapport 133

Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249

Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger

Benjamins S, Kulka DW, Lawson J (2008) Incidental catch of seabirds in Newfoundland and Labrador gillnet fisheries, 2001-2003. Endangered species research 5:149-160

Byers T, Smith A, Mallory ML (2010) Diet of black guillemots and northern fulmars breeding beside a High Arctic polynya. Polar Biol 33:457-467

Ewins PJ (1989) The breeding biology of Black Guillemots Cepphus grylle in Shetland. Ibis 131:507-520

Ewins PJ (1990) The diet of Black Guillemots Cepphus grylle in Shetland. Holarctic Ecology 13:90-97

Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. Bycatch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719

Frederiksen M (2010) Seabirds in the North East Atlantic. -A review of status, trends and anthropogenic impact Action plan for seabirds in Western-Nordic areas Report from a workshop in Malmö, Sweden, 4-5 May 2012, Book TemaNord 2010: 587

Greenwood JG (2007) Earlier laying by Black Guillemots Cepphus grylle in Northern Ireland in response to increasing sea-surface temperature. Bird Stud 54:378-379

Lonne OJ, Gabrielsen GW (1992) Summer diet of seabirds feeding in sea-ice covered waters near Svalbard. Polar Biol 12:685-692

Lorentsen S-H, Byrkjeland S, Flagstad Ø, Heggberget TM, Larsen T, Røv N, Balstad T, Haugland T, Østborg GM (2007) Etterkantundersøkelser sjøfugl og oter etter MS Server-forliset januar 2007. Effects on seabirds and Eurasian otter after the oil spill following the wreck of MS Server at Fedje, Hordaland in January 2007. NINA Report 336

Lorentsen SH, Pokrovskaya IV (2000) Black guillemot Cepphus grylle. In: Anker-Nilssen T, Bakken V, Strøm H, Golovkin AN, Bianki VV, Tatarinkova IP (eds) The status of marine birds breeding in the Barents Sea Region, Book Report nr. 113. Norwegian Polar Institute

Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Nordstrom M, Hogmander J, Laine J, Nummelin J, Laanetu N, Korpimaki E (2003) Effects of feral mink removal on seabirds, waders and passerines on small islands in the Baltic Sea. Biol Conserv 109:359-368

Sonntag N, Schwemmer H, Fock HO, Bellebaum J, Garthe S (2012) Seabirds, set-nets, and conservation management: assessment of conflict potential and vulnerability of birds to bycatch in gillnets. Ices Journal of Marine Science 69:578-589

Weslawski JM, Stempniewicz L, Galaktionov K (1994) Summer diet of seabirds from the Franz Josef Land archipelago, Russian Arctic. Polar Res 13:173-181

Atlantic Puffin *Fratercula arctica*

Anker-Nilssen T, Aarvak T (2006) TIdsseriestudier av sjøfugler i Røst kommune, Nordland. Resultater med fokus på 2004 og 2005. NINA Rapport 133

Anker-Nilssen T, Aarvak T, Bangjord G (2003) Mass mortality of Atlantic puffins Fratercula arctica off central Norway, spring 2002: causes and consequences. Atlantic Seabirds 5:57-72

Anker-Nilssen T, Barrett RT, Bustnes JO, Christensen-Dalsgaard S, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, H. SG, Tveraa T (2008) SEAPOP studies in the Barents and Norwegian Seas in 2007. In: Anker-Nilssen T (ed) NINA Report 363. Norwegian Institute of Nature Research (NINA)

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2006) SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127

Anker-Nilssen T, Barrett RT, Bustnes JO, Erikstad KE, Fauchald P, Lorentsen S-H, Steen H, Strøm H, Systad GH, Tveraa T (2007) SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249

Anker-Nilssen T, Tatarinkova IP (2000) Atlantic puffin Fratercula arctica. In: Anker-Nilssen T, Bakken V, Strøm H, Golovkin AN, Bianki VV, Tatarinkova IP (eds) The status of marine birds breeding in the Barents Sea region. Norwegian Polar Institute, Tromsø

Baillie SM, Jones IL (2004) Response of Atlantic Puffins to a decline in Capelin abundance at the Gannet Islands, Labrador. Waterbirds 27:102-111

Bakken V, Runde O, Tjørve E (2003) Norsk ringmerkingsatlas Vol. I Norwegian bird ringing atlas vol. I. Stavanger Museum, Stavanger

Balseiro A, Espi A, Marquez I, Perez V, Ferreras MC, Marin JFG, Prieto JM (2005) Pathological features in marine birds affected by the prestige's oil spill in the north of Spain. J Wildl Dis 41:371-378

Barrett RT (2002) Atlantic puffin Fratercula arctica and common guillemot Uria aalge chick diet and growth as indicators of fish stocks in the Barents Sea. Mar Ecol-Prog Ser 230:275-287

Barrett RT, Anker-Nilssen T, Bustnes JO, Christensen-Dalsgaard S, Descamps S, Erikstad K-E, Lorentsen S-H, Strøm H, Systad GH (2012a) Key-site monitoring in Norway 2011. SEAPOP Short Report 1-2012

Barrett RT, Anker-Nilssen T, Rikardsen F, Valde K, Rov N, Vader W (1987) The food, growth and fledging success of Norwegian puffin chicks Fratercula arctica in 1980-1983 Ornis Scandinavica 18:73-83

Barrett RT, Erikstad KE (2009) Key-site monitoring on Hornøya in 2008. SEAPOP Short Report 1-2009

Barrett RT, Erikstad KE (2010) Key-site monitoring on Hornøya in 2009 SEAPOP Short Report 2-2010

Barrett RT, Erikstad KE (2011) Key-site monitoring on Hornøya in 2010. SEAPOP Short Report 3-2011

Barrett RT, Nilsen EB, Anker-Nilssen T (2012b) Long-term decline in egg size of Atlantic puffins Fratercula arctica is related to changes in forage fish stocks and climate conditions. Mar Ecol-Prog Ser 457:1-10

Benjamins S, Kulka DW, Lawson J (2008) Incidental catch of seabirds in Newfoundland and Labrador gillnet fisheries, 2001-2003. Endangered species research 5:149-160

Berland B (1971) Pigghå og lundefugl med gummistrikk Dogfish and puffin with rubberband. Fauna 24:35-37

Birkhead TR, Nettleship DN (1995) Arctic fox influence on a seabird community in Labrador - A natural experiment. Wilson Bulletin 107:397-412

Brude OW, Systad GH, Moe KA, Østby C (2003) Uhellsutslipp til sjø. Miljøkonsekvenser på sjøfugl, sjøpattedyr, strand, iskant mv. ULB Delutredning - studie 7-b. Accidental discharges at sea. Consequences for seabirds, sea mammals, beach, sea-ice edge. Alpha Miljørådgivning, NINA

Burke CM, Hedd A, Montevecchi WA, Regular PM (2011) Effects of an Arctic Fox Visit to a Low Arctic Seabird Colony. Arctic 64:302-306

Burke CM, Montevecchi WA (2008) Fish and Chicks: Forage Fish and Chick Success in Co-existing Auks. Waterbirds 31:372-384

Burthe S, Daunt F, Butler A, Elston DA, Frederiksen M, Johns D, Newell M, Thackeray SJ, Wanless S (2012) Phenological trends and trophic mismatch across multiple levels of a North Sea pelagic food web. Mar Ecol-Prog Ser 454:119-+

Christensen-Dalsgaard S, Lorentsen S-H (2009) Key site monitoring on Anda in 2008. SEAPOP Short Report 2-2009

Christensen-Dalsgaard S, Lorentsen S-H (2010) Key site monitoring on Anda in 2009. SEAPOP Short Report 5-2010

Diamond AW, Devlin CM (2003) Seabirds as indicators of changes in marine ecosystems: Ecological monitoring on Machias Seal Island. Environmental Monitoring and Assessment 88:153-175

Durant JM, Anker-Nilssen T, Stenseth NC (2003) Trophic interactions under climate fluctuations: the Atlantic puffin as an example. Proceedings of the Royal Society B-Biological Sciences 270:1461-1466

Durant JM, Anker-Nilssen T, Stenseth NC (2006) Ocean climate prior to breeding affects the duration of the nestling period in the Atlantic puffin. Biology Letters 2:628-631

Eilertsen K, Barrett RT, Pedersen T (2008) Diet, growth and early survival of Atlantic Puffin (Fratercula arctica) chicks in North Norway. Waterbirds 31:107-114

Eliasen K, Reinert J, Gaard E, Hansen B, Jacobsen JA, Gronkjaer P, Christensen JT (2011) Sandeel as a link between primary production and higher trophic levels on the Faroe shelf. Mar Ecol-Prog Ser 438:185-194

Falk K, Jensen JK, Kampp K (1992) Winter diet of Atlantic puffins (Fratercula arctica) in the northeast Atlantic. Colonial Waterbirds 15:230-235

Fangel K, Wold LK, Aas Ø, Christensen-Dalsgaard S, Qvenlid M, Anker-Nilssen T (2011) Bifangst av sjøfulg i norske kystfiskerier. Et kartleggings- og metodeutprøvingsprosjekt med fokus på fiske med garn og line. By-catch of seabirds in Norwegian coastal fisheries. A mapping and methodology study with focus on gillnet and longline fisheries. NINA Report 719

Finney SK, Harris MP, Keller LF, Elston DA, Monaghan P, Wanless S (2003) Reducing the density of breeding gulls influences the pattern of recruitment of immature Atlantic puffins Fratercula arctica to a breeding colony. Journal of Applied Ecology 40:545-552

Follestad A (2012) Akutt skadeomfang og herkomst av sjøfugl etter Godafoss-forliset. Effects on seabird populations following the Godafoss grounding in Southern Norway NINA Report 811

Frederiksen M (2010) Seabirds in the North East Atlantic. -A review of status, trends and anthropogenic impact Action plan for seabirds in Western-Nordic areas Report from a workshop in Malmö, Sweden, 4-5 May 2012, Book TemaNord 2010: 587

Frederiksen M, Anker-Nilssen T, Beaugrand G, Wanless S (2013) Climate, copepods and seabirds in the boreal Northeast Atlantic - current state and future outlook. Global Change Biology 19:364-372

Frederiksen M, Edwards M, Richardson AJ, Halliday NC, Wanless S (2006) From plankton to top predators: bottom-up control of a marine food web across four trophic levels. J Anim Ecol 75:1259-1268

Frederiksen M, Elston DA, Edwards M, Mann AD, Wanless S (2011) Mechanisms of long-term decline in size of lesser sandeels in the North Sea explored using a growth and phenology model. Mar Ecol-Prog Ser 432:137-147

Gaard E, Hansen B, Olsen B, Reinert J (2002) Ecological features and recent trends in the physical environment, plankton, fish stocks and seabirds in the Faroe shelf ecosystem. In: Sherman K, Skjoldal HR (eds) Large marine ecosystems of the North Atlantic. Elsevier Science, The Netherlands

Gimenez O, Anker-Nilssen T, Grosbois V (2012) Exploring causal pathways in demographic parameter variation: path analysis of mark-recapture data. Methods in Ecology and Evolution 3:427-432

Grosbois V, Harris MP, Anker-Nilssen T, McCleery RH, Shaw DN, Morgan BJT, Gimenez O (2009) Modeling survival at multi-population scales using mark-recapture data. Ecology 90:2922-2932

Guilford T, Freeman R, Boyle D, Dean B, Kirk H, Phillips R, Perrins C (2011) A Dispersive Migration in the Atlantic Puffin and Its Implications for Migratory Navigation. Plos One 6

Harris MP, Anker-Nilssen T, McCleery RH, Erikstad KE, Shaw DN, Grosbois V (2005) Effect of wintering area and climate on the survival of adult Atlantic puffins Fratercula arctica in the eastern Atlantic. Mar Ecol-Prog Ser 297:283-296

Harris MP, Bailey RS (1992) Mortality rates of puffin Fratercula arctica and guillemot Uria aalge and fish abundance in the North Sea. Biol Conserv 60:39-46

Harris MP, Elkins N (2013) An unprecedented wreck of Puffins in eastern Scotland in March and April 2013 Scottish Birds 33:157-159

Harris MP, Wanless S (1994) Ingested elastic and other artifacts found in puffins in Britain over a 24-year period. Mar Pollut Bull 28:54-55

Hedd A, Fifield DA, Burke CM, Montevecchi WA, Tranquilla LM, Regular PM, Buren AD, Robertson GJ (2010) Seasonal shift in the foraging niche of Atlantic puffins Fratercula arctica revealed by stable isotope (delta N-15 and delta C-13) analyses. Aquatic Biology 9:13-22

Huse G, Kjesbu OS, Gjøsæter H, Bogstad B, Stenevik EK, Holst JC, Fossum P, Ingvaldsen R, Johansen GO, Skern-Mauritzen M (2012) Utvalg til å vurdere fremtidig utvikling i våre mest sentrale fiskebestander Commision for assessing future development of our most important fish stocks. Rapport fra Havforskningen Book 29

Håland A, Mjøs AT (2006) Overlevelse av oljeskadet og rehabilitert sjø-og vannfugl etter Rocknes-forliset ved Bergen, januar 2004. Survival of oiled and rehabilitated seabirds after the Rocknes oil spill. NNI-Report 160

Lillegård M, Engen S, Sæther B-E (2005) Harvesting strategies for Norwegian spring-spawning herring. Oikos 110:567-577

Lilliendahl K, Solmundsson J (1997) An estimate of summer food consumption of six seabird species in Iceland. Ices Journal of Marine Science 54:624-630

Lorentsen S-H, Bakken V, Christensen-Dalsgaard S, Follestad A, Røv N, Winnem A (2010a) Akutt skadeomfang og herkomst for sjøfugl etter MV Full City forliset. Effects on seabird populations following the MV Full City grounding in Southern Norway August 2009 NINA Report 548

Lorentsen S-H, Byrkjeland S, Flagstad Ø, Heggberget TM, Larsen T, Røv N, Balstad T, Haugland T, Østborg GM (2007) Etterkantundersøkelser sjøfugl og oter etter MS Server-forliset januar 2007. Effects on seabirds and Eurasian otter after the oil spill following the wreck of MS Server at Fedje, Hordaland in January 2007. NINA Report 336

Lorentsen S-H, Moe T, Stübner E (2010b) Key-site monitoring in Sklinna in 2009. SEAPOP Short Report 9-2010

Mavor RA, Parsons M, Heubeck M, Schmitt S (2005) Seabird numbers and breeding success in Britain and Ireland, 2004 UK Nature Conservation Book 29. Joint Nature Conservation Committee, Peterborough

Merkel F, Barry T (eds) (2008) Seabird harvest in the Arctic. CAFF International Secretariat, Circumpolar Seabird Group (CBird)

Mitchell PI, Newton SF, Ratcliff N, Dunn TE (2004) Seabird populations of Britain and Ireland. T & A D Poyser, London

Olsen B, Jensen J-K, Reinert A (2000) Population of guillemots, razorbills and puffins in Faroese waters as documented by ringed birds. GEM Report, No C22-161-1

Regular P, Montevecchi W, Hedd A, Robertson G, Wilhelm S (2013) Canadian fishery closures provide a large-scale test of the impact of gillnet bycatch on seabird populations. Biology Letters 9

Robards M, Gilchrist HG, Allard K (2000) Breeding Atlantic Puffins, Fractercula arctica, and other bird species of Coburg Island, Nunavut. Canadian Field-Naturalist 114:72-77

Rodway MS, Chardine JW, Montevecchi WA (1998) Intra-colony variation in breeding performance of Atlantic Puffins. Colonial Waterbirds 21:171-184

Rodway MS, Montevecchi WA (1996) Sampling methods for assessing the diets of Atlantic puffin chicks. Mar Ecol-Prog Ser 144:41-55

Russell J, Montevecchi WA (1996) Predation on adult Puffins Fratercula arctica by Great Black-backed Gulls Larus marinus at a Newfoundland colony. Ibis 138:791-794

Vader W, Anker-Nilssen T, Bakken V, Barrett RT, Strann KB (1990) Regional and temporal differences in breeding success and population development of fisheating seabirds in Norway after collapses of herring and capelin stocks. Trans 19th IUGB Congress, Trondheim 1989

Wanless S, Frederiksen M, Walton J, Harris MP (2009) Long-term changes in breeding phenology at two seabird colonies in the western North Sea. Ibis 151:274-285

Wanless S, Harris MP, Redman P, Speakman JR (2005) Low energy values of fish as a probable cause of a major seabird breeding failure in the North Sea. Mar Ecol-Prog Ser 294:1-8

Wanless S, Wright PJ, Harris MP, Elston DA (2004) Evidence for decrease in size of lesser sandeels Ammodytes marinus in a North Sea aggregation over a 30-yr period. Mar Ecol-Prog Ser 279:237-246

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