SEAPOP Short Report 8-2009

Extensive monitoring of kittiwakes in northern Norway

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Seabirds at high latitudes experience a highly variable environment. This variability will affect them in many ways, probably most significantly by altering their foraging success, and will thus have important consequences for vital demographic parameters such as reproduction and survival. One important criterion for the selection of key-sites in the SEAPOP program is the ability to separate natural population trends from those caused by humans through e.g. oil spills and fisheries. To achieve this, we monitor the diet, breeding success, adult survival rate and population trends (in a few cases also dispersal and recruitment rates) of selected species on a few key-sites. The aim is to have 3-4 such sites in each sea region (Anker-Nilssen et al. 2005), such as those already established in the Lofoten – Barents Sea area.

To test to what degree the key-site populations are representative for the species over a larger area, we have established a more extensive monitoring of one species, the black-legged kittiwake *Rissa tridactyla*. The kittiwake is the only seabird which breeds in large numbers over the whole Barents Sea area, where it is distributed in both small and large colonies with highly variable population trends in different areas. As both its population development and reproductive rates can be monitored more efficiently than for most other seabirds, this species is ideal for studying how environmental variability affects vital demographic parameters in a top predator. Such knowledge is of crucial importance for interpreting the population dynamics observed at the key-sites and will also increase our understanding of how variability in the Barents Sea ecosystem might affect other populations.

Another important aspect that cannot be studied in the key-site colonies is the fact that environmental variability, which affects seabirds through effects on foraging success and consequently reproduction and survival, is scale-dependent (Hunt & Schneider 1987, Fauchald et al. 2000, Fauchald & Erikstad 2002). The observed effects on seabird populations will reflect this scale dependency, and can be monitored from the colony level through to the ecosystem level. On a large scale, physical properties of the oceans generate more or less distinct ecosystems, which differ in productivity, biomass and the presence of particular prey species. On a smaller scale, stochastic changes in the distribution of prey may have impact on local breeding performance in colonies. For example local winds and currents may affect the drift of juvenile fish and the timing and placement of spawning grounds. Such stochastic small-scale events may cause differences in breeding success between single colonies (Barrett & Krasnov 1996). The variability in productivity and prey availability may affect the foraging performance in different regions in different ways, and consequently create incentives for short- or long-distance migration of birds (see below).

Another important aspect of seabird population dynamics, which is not possible to study at the key-sites, is the dynamics of neighbouring populations. The exchange or, more precisely, dispersal of birds among colonies in a variable environment may greatly enhance the viability of a species within a given area, even when populations are strongly declining. However, such an effect depends to a large extent on the rate of covariance in the growth rates among colonies. At the key-sites, adults are colour-ringed and full-grown chicks are ringed with conventional rings (as well as colour-ringed in some colonies), which will also enable us to study the dispersal of birds at spatial scales.

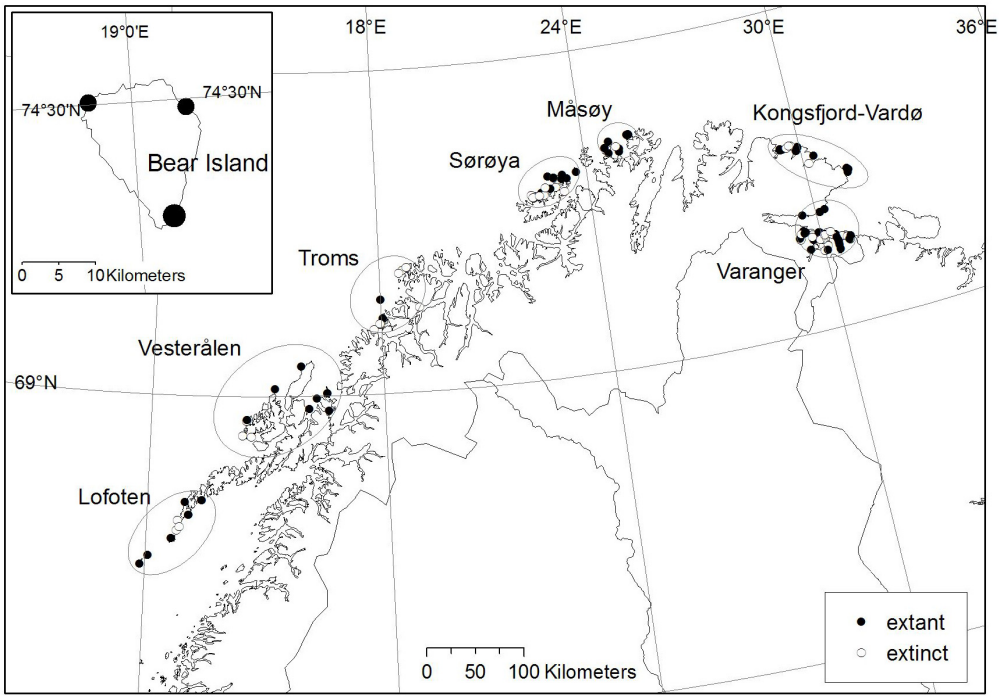

Figure 1

The distribution of extant and extinct breeding colonies of black-legged kittiwakes selected for extensive monitoring in the Lofoten – Barents Sea area.

To study the dynamics of Kittiwake populations we have selected 96 extant colonies and 77 extinct colonies in seven different regions from Lofoten to eastern Finnmark (Figure 1). The selection of extinct colonies will enable us in the future to study any re-colonization by birds. The sizes of the extant colonies vary from a few pairs (<10) to very large colonies (>100,000 pairs). Each of the colonies was visited twice during the 2006, 2007 and 2008 breeding seasons. We recorded the following parameters: 1) colony size, 2) timing of breeding, 3) clutch size, and 4) number of large chicks (assumed to fledge) per nest.

Based on the data from the first three seasons, some trends are apparent. First, the species' breeding success was very low over the whole area with a mean of 0.12 (*SE*=0.02) chicks per pair. Second, the breeding success differed between years and was lower in 2007 (mean=0.06, *SE*=0.02) than in 2008 (0.10± 0.02) and 2006 (0.19±0.04), and this trend was apparent in all regions (Figure 2). Third, the breeding success was higher in Vesterålen (0.29±0.10) and the Lofoten area (0.20±0.05) than in the other regions (range from 0.08±0.06 to 0.10±0.04 chicks per pair) and this was also evident in all years.

Furthermore, the general trend was also that very few colonies produced any chicks at all (less than 50%, Figure 3) and that breeding success was related to the size of the colonies (Wald χ^2=9.85, P=0.002, Figure 4).

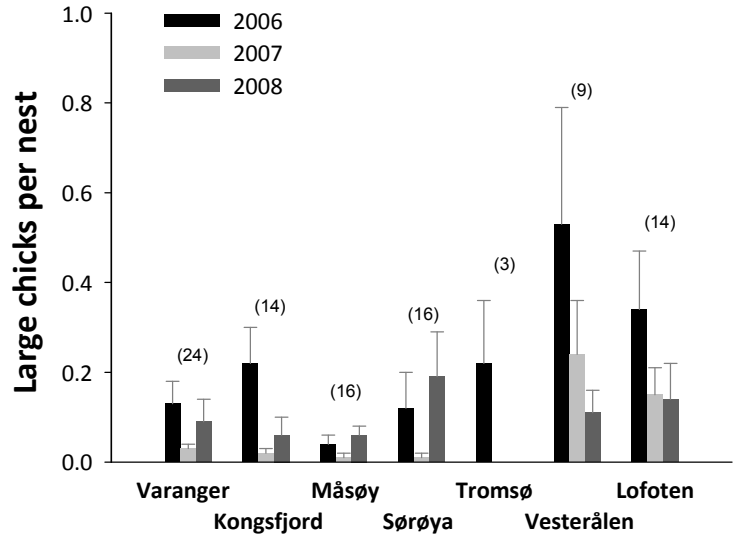

Figure 2

Mean (+1SE) breeding performance (number of large chicks per nest) of kittiwakes in different regions along the coast of northern Norway (cf. Figure 1) in 2006-08. The number of colonies is indicated above each group of bars. Breeding performance differed both between different years (p<0.001) and regions (p<0.001).

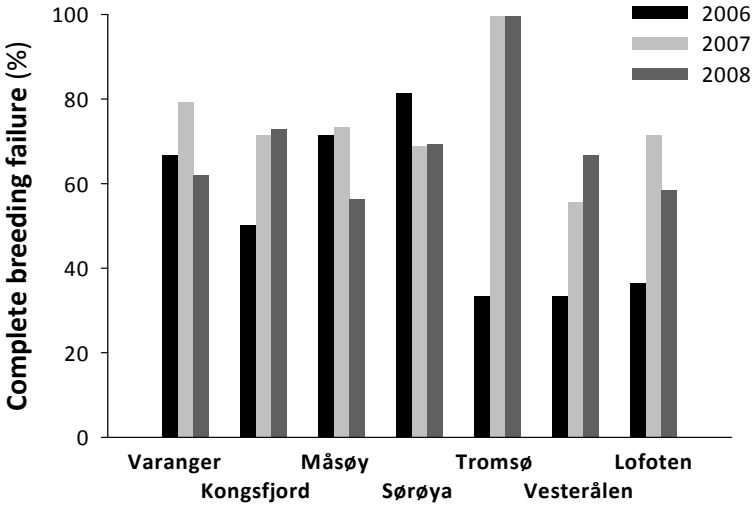

Figure 3

The proportion of kittiwake colonies in different regions along the coast of northern Norway that suffered complete breeding failure in 2006, 2007 and 2008. Sample sizes are the same as in Figure 2.

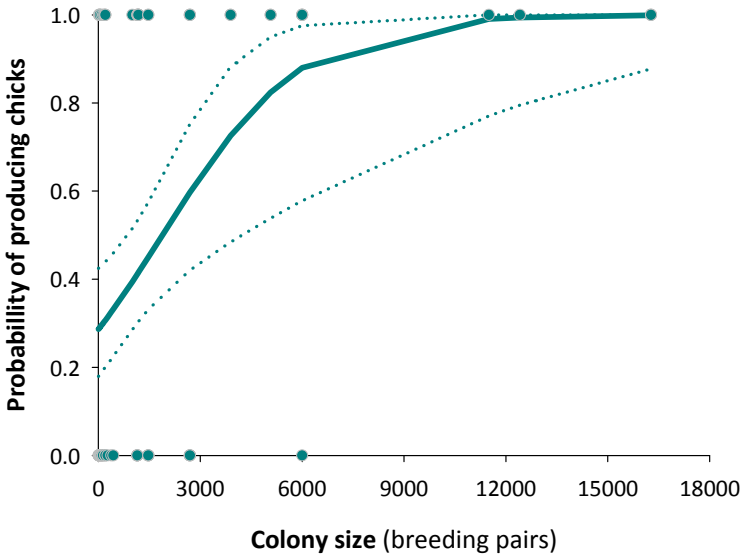

Figure 4

The likelihood that the kittiwake should produce any chicks at all presented as a function of colony size. Solid lines show the mean probability, while stippled lines show upper and lower confidence limits.

The mean estimate of 0.12 chicks per pair over three years is very low and can hardly maintain a stable population. To explore in more detail the effect of variation in reproductive success and adult survival on the population multiplication rate (% annual population change), we have constructed simple stage(age)-structured Leslie matrices. We assume that the kittiwake starts to breed at three years of age, that the survival rate of young birds (from fledging to first breeding) is 0.7 and that the sex ratio at fledging is 0.5. We then estimated the annual population trends (%) based on different combinations of adult survival and reproductive success, shown as contour lines in Figure 5.

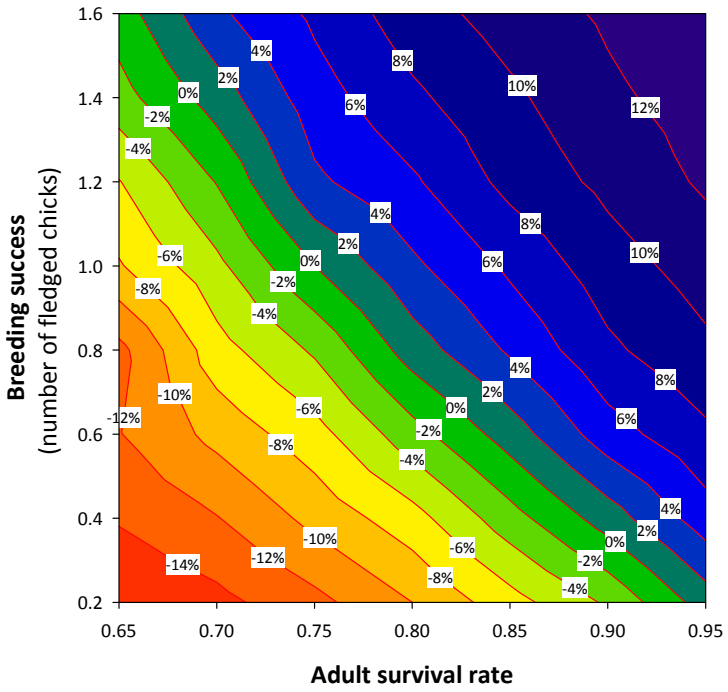

Figure 5
Annual population trends (% change) for kittiwake populations as estimated from the Leslie matrices, based on a combination of adult survival and reproductive rates (contour lines).

This preliminary modelling indicates that to keep a stable population with a reproductive success of 0.12 chicks per pair, there is need for an annual adult survival rate of more than 0.95 (Figure 5). This is far higher than that estimated at the key-sites, which ranges from 0.82 at Hornøya and Bear Island via 0.85 at Hjelmsøya to 0.87 at Anda and Røst. To keep a stable population over time with the current survival rates, there is need for a chick production of about 0.5-0.7 chicks per pair (Figure 5). The recent fledging success over the whole monitoring area was well below this level and only occasionally were there colonies with a fledging success of that magnitude (Figure 2). Notoriously low recruitment rates may therefore be critical for the kittiwake populations over time.

Data from the National monitoring program for seabirds demonstrate that the Norwegian kittiwake population has declined severely since 1980 and that there are indications the trend has accelerated since the mid 1990s (Barrett et al. 2006). Since the adult survival rates measured at the key-sites are within the “normal” range for the species elsewhere in the Northeast Atlantic (e.g. Frederiksen et al. 2005), it seems that low recruitment rates may severely contribute to this trend. We do not know the direct causes, but in East Finnmark the instability (including several collapses) and general decline in the Barents Sea capelin stock may have contributed to this negative trend (Barrett 2007).

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Cover photo: Adult kittiwake. (© T. Anker-Nilssen)

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SEAPOP Short Report (SSR) is published by the Norwegian Institute for Nature Research (NINA), the Norwegian Polar Institute (NP) and Tromsø University Museum (TMU) as a web-based newsletter presenting individual progress reports and analyses of projects within the *SEAPOP* programme. The individual SSRs have no ISNN/ISBN coding, but the reports for each year will be collated and published in the registered report series *NINA Report* as a SEAPOP annual report.

SEAPOP (SEAbird POPulations) is a long-term monitoring and mapping programme for Norwegian seabirds that was established in 2005 and implemented on the full national scale in Norway, Svalbard and adjacent sea areas in 2008. The programme is financed by the Ministry of the Environment, the Ministry of Petroleum and Energy and the Norwegian Oil Industry Association, and aims to provide and maintain the most important base-line knowledge of seabird distribution, demography and ecology needed for an improved management of these marine environments. More info about SEAPOP is found on the programme's web site www.seapop.no, including an up-to-date list of associated publications from which all reports can be freely downloaded as pdf documents.

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