Status and trend of glaucous gulls in Kongsfjorden, Spitsbergen

Final report - Svalbard Miljøvernfond

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De viktigste resultatene

Little is known about the trend of glaucous gulls *Larus hyperboreus* in Svalbard. The population on Bjørnøya is sharply declining and a similar trend seems to exist on Hopen. However, on Spitsbergen, glaucous gull trend is unclear. In 2012, we successfully implemented a demographic and population monitoring of glaucous gulls breeding in Kongsfjorden to assess and understand this trend.
This monitoring consists in estimating the total population size in Kongsfjorden (number of breeding pairs), capturing/ringing adults and chicks to estimate their survival rate and body condition and monitoring nests to estimate their success. In 2012, 55 breeding pairs were found in Kongsfjorden. Seventy per cent of these nests have been monitored to estimate glaucous gull reproductive success ; the other 30 % were either inaccessible nests or nests in areas surrounded by too high densities of breeding geese and eiders. Thirty-six gull chicks and 18 adults have been captured and ringed in 2012.
Those different sample sizes allow estimating, relatively accurately, the main demographic parameters of glaucous gulls breeding in Kongsfjorden and to compare them with Bjørnøya. Our work indicated no major difference in 2012 between demographic parameters (clutch size, breeding success, adult survival) on Bjørnøya and Kongfjorden. However, such results do not allow drawing conclusions about the trend and status of glaucous gull in Kongsfjorden. Long-term time series are needed.

Miljøeffekt/miljøgevinst av tiltaket/prosjektet, sluttvurdering

A long-term monitoring of glaucous gulls in Bjørnøya and Kongsfjorden done in synergy with ongoing studies of contaminants (G.W. Gabrielsen, NPI and J.O. Bustnes, NINA) and winter ecology and migration (B. Moe, NINA) will give important insight about the demographic and environmental drivers of glaucous gull population dynamics in Svalbard. The 2012 monitoring in Kongsfjorden was only the first step of this work.

Studies on pollutant levels in glaucous gulls breeding in Kongsfjorden have started some years ago and are part of a long-term monitoring. The value of such a contaminant monitoring greatly increases if the consequences of pollution at the individual and population levels are understood and quantified. This is the objective of implementing a long-term population and demographic monitoring of glaucous gulls breeding in Kongsfjorden in parallel to the long term work done on Bjørnøya led by Hallvard Strøm, NPI.

Forslag til tiltak

Bjørnøya and Kongsfjorden are characterized by very different environments. Therefore, one can likely not easily extrapolate results found on Bjørnøya (for a given species) to another locality on Svalbard. Status and trends of seabirds in general, and glaucous gulls in particular,

may vary between breeding locations. Monitoring the status and trend of glaucous gulls breeding at these two localities is thus needed and this monitoring should be done annually over several years. In practice, this means to have a dedicated team in early June at both places to (i) count the total number of breeding pairs early in the season and (ii) capture and ring adults. This is needed to estimate body condition of birds and then estimate their survival rates. Then, in late June and July, glaucous gull nests should be monitored and chicks ringed. With such a framework, the main demographic parameters of glaucous gulls could be estimated and their population trend assessed and understood.

photo credit: S. Descamps

Introduction

Little is known about the trend of glaucous gulls *Larus hyperboreus* in Svalbard. The population on Bjørnøya has shown a steep decline since 1980 (total of 2000 breeding pairs in 1980 versus 650 in 2006, Strøm 2007 ; see also *Fig. 1*) and glaucous gull is now on the Norwegian red-list (near threatened status). A similar trend seems to occur on Hopen, where >1000 breeding pairs have been found in 1988 but less than 250 during the 2012 survey. However, on Spitsbergen, glaucous gull trend is unclear. Indeed, no monitoring data on glaucous gulls exists in Spitsbergen, so that no conclusion regarding their trend and status can be drawn for this part of Svalbard archipelago.

Svalbard is an important sink for anthropogenic chemicals transported via atmospheric and oceanic currents from distant sites of production. Since the early 1970s, high levels of organochlorine pollutants such as PCBs and DDE have been found in seabirds in the European Arctic, especially in the glaucous gull (Verreault et al. 2010). Glaucous gulls stand on top of the food chain and feeds mainly on benthic animals and fish, as well as carrion, eggs and chicks of other seabirds. Since organic pollutants increase with trophic position, glaucous gulls accumulate high levels of organic contaminants, especially in birds that specialized in preying on eggs and chicks of other seabirds (Bustnes et al. 2000). Organic contaminants affect gull reproduction and survival (Bustnes et al. 2001, Bustnes et al. 2003, Bustnes et al. 2005, Erikstad et al. 2011), and are likely a key factor driving glaucous gull population dynamics and thus being, at least partly, responsible of the population decline in Bjørnøya (Erikstad and Strøm 2012).

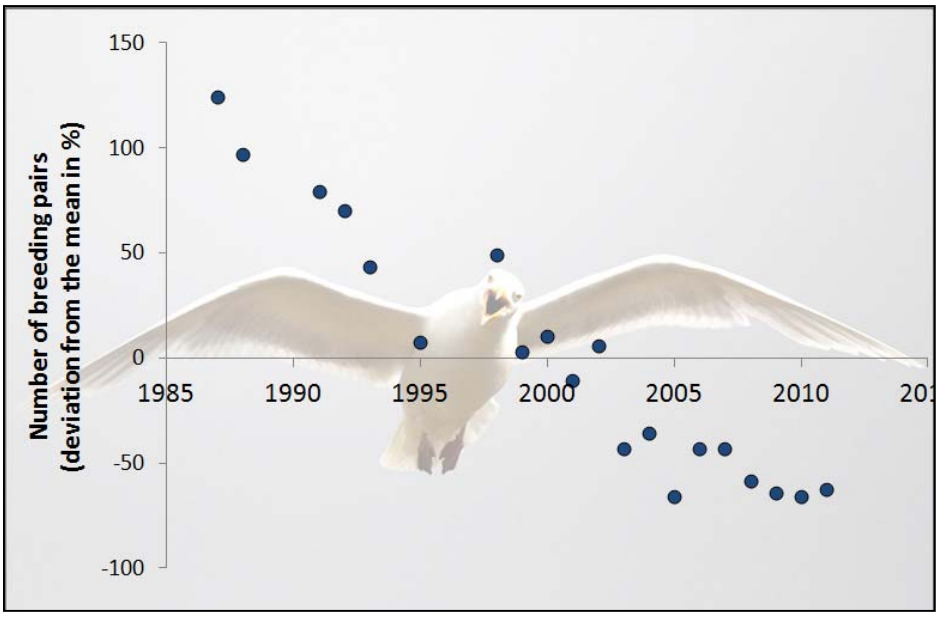

Fig. 1. *Total number of pairs of glaucous gull breeding at Kapp Kolthoff, Bjørnøya (photo credit: S. Descamps)*

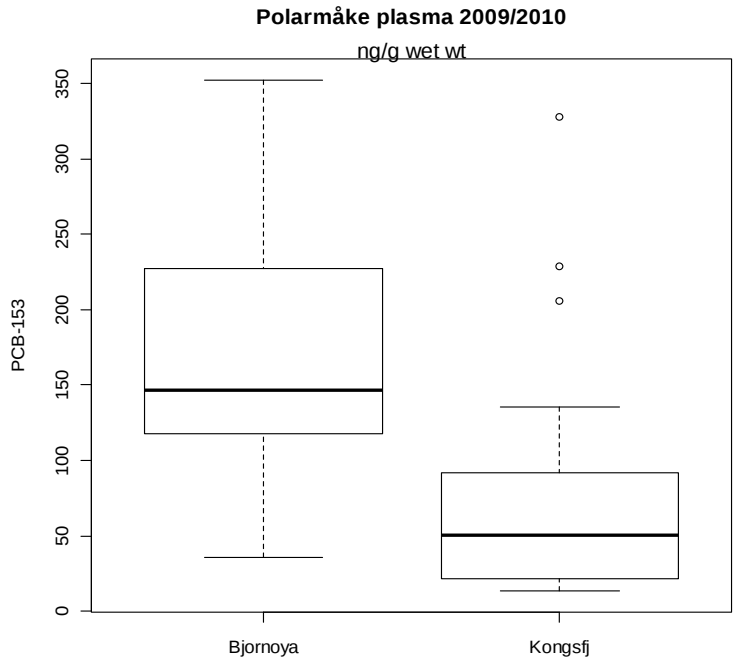

Fig. 2. *Level of PCB in plasma in years 2009 and 2010 for glaucous gulls breeding in Bjørnøya and Kongsfjorden (Sagerup, Gabrielsen and Bustnes, unpubl. results).*

A study on contaminant concentration in glaucous gull breeding in Konsfjorden is already going on (led by G.W. Gabrielsen, NPI). Preliminary results seem to indicate that the level of (some) organic pollutants is lower in Kongsfjorden than on Bjørnøya (*Fig. 2*). However, this may vary with the pollutant and/or year considered. Until 2012, there was no monitoring of the potential effects of organic pollutants on glaucous gull demography and population dynamics in Kongsfjorden. Such a monitoring is urgently needed. It would lead to a better assessment of the status and trend of glaucous gull in Svalbard based on two different sites (Konsfjorden and Bjørnøya).

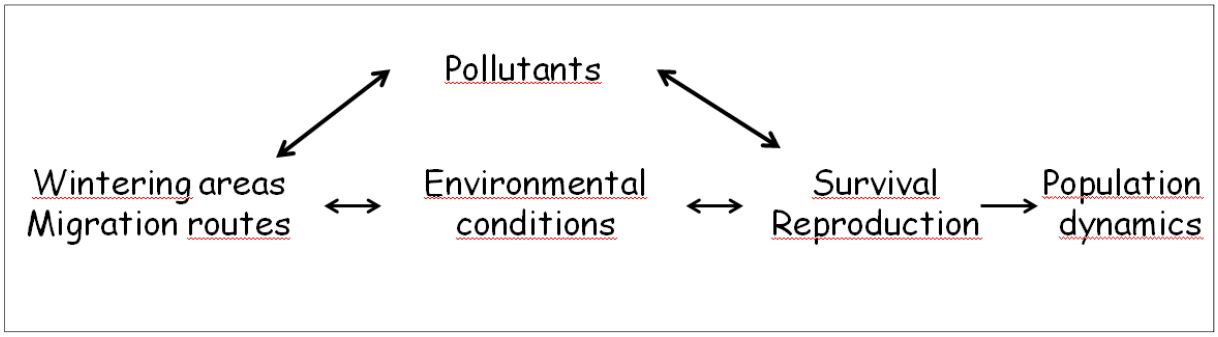

Fig. 3 *Framework of the research on glaucous gull in Kongsfjorden*

In this project, we have initiated a detailed demographic study of glaucous gull in Kongsfjorden. This monitoring included a survey of population size, breeding success,

survival, body condition and chick growth rate of glaucous gulls breeding in Kongsfjorden (from Ossian sarsfjellet to Kongsfjordhallet). It was based on the nest monitoring and capture/ringing of breeding adults as well as capture of chicks. This demographic study of glaucous gulls in Kongsfjorden was done in synergy with the organic contaminant monitoring led by Geir Wing Gabrielsen (NPI) and the study of glaucous gull winter ecology led by Børge Moe (NINA). Combining researches on demography, organic pollutants and migration strategies will lead to a unique integrative study (Fig. 3). It will give important insights on the glaucous gull population status in Svalbard and about the links between their wintering areas, pollutant concentration and population dynamics.

The present report shows results from the 2012 breeding season and compares several demographic parameters from the Bjørnøya and Kongsfjorden glaucous gull populations. Such comparisons are not necessarily meaningful when based on a single year. Long-term data are needed to provide reliable results and conclusions about potential differences, or similarities, in the demography and population dynamics of glaucous gulls breeding at Bjørnøya and in Kongsfjorden. However, this report mainly aims at showing what kind of data and results we can expect in the future if such long-term monitoring activities are to be continued. It aims at showing the potential behind this monitoring in Bjørnøya and Kongsfjorden to understand glaucous gull status and trend in Svalbard.

Methods

Study species and site

The glaucous gull is a large gull that weighs approx. 1.3-2.2 kg. It has a circumpolar, high arctic, breeding distribution. In the north-east Atlantic it occurs in Greenland, Iceland, Jan Mayen, Svalbard, Franz Josef Land and Novaya Zemlya. The glaucous gull breeds throughout most of Svalbard, either as single pairs or in small colonies. Their breeding areas are most often situated close to colonies of other seabirds. Glaucous gulls can also breed on small islets together with colonies of common eiders and geese. Most glaucous gulls leave Svalbard in September-October and spend winter dispersed through the North Atlantic. The birds return gradually to their breeding colonies in March and April (Strøm 2006).

Fig.4 *Glaucous gull with chicks in Kongsfjorden (photo credit: S. Descamps)*

The glaucous gull is one of the largest gulls breeding in the Arctic and has the same ecological role as the birds of prey in more southern latitudes. The glaucous gull is a generalist predator and scavenger that feeds on a wide variety of preys. Birds breeding in or close to bird colonies are often specialized in preying upon eggs, chicks, and adult birds of other seabird species (Strøm 2006).

Glaucous gulls lay 1 to 3 eggs that are incubated by both sexes for 27–28 days. The chicks remain for a few days at the nest after hatching, but roam around the nest site area as they get older. They are fed by both parents and fledge approximately seven weeks after hatching. Breeding pairs are highly philopatric to previous nest sites if they have been successful at rearing young. Birds that survive their first few years usually return to their natal colonies when they are three or four years old and will attempt to establish a territory in the area (Strøm 2006).

In Kongsfjorden (Spitsbergen, Svalbard), between 50 and 60 pairs of glaucous gulls breed essentially on small islands scattered in the fjord. Most of those pairs are close to eider or goose colonies, or for a few of them within the Ossian sarsfjellet guillemot/kittiwake colony.

Fig.5 *Lovenøyane in Kongsfjorden where several glaucous gull pairs breed (photo credit: K. Sagerup)*

Capture of adult glaucous gulls

Capture and ringing of glaucous gulls have started in 2009 as part of research programs on contaminants and winter ecology. Between 2009 and 2012, 62 adult glaucous gulls have been ringed (9 in 2009, 26 in 2010, 9 in 2011 and 18 in 2012). Captures have been done during incubation (from late May to late June) either with a trap put on the nest (Fig.6) or with a net gun.

Fig.6 *Trap deployed on a glaucous gull nest. The trap consists in a nylon loop triggered at a distance and that tightens up around the adult legs when it comes back onto the eggs. During capture, eggs are replaced by fake eggs.*

No injury or nest desertion have been reported since 2009 with those methods of capture. When being caught with a net propelled by a net gun, birds generally land onto the water and are immediately retrieved with the zodiac.

Fig.7 *Captured glaucous gull ready for being processed (ringing, measurements, blood sampling, GLS deployment)* *(photo credit: S. Descamps)*

Nest monitoring and chick captures

In 2012, 70% of the nests in Kongsfjorden have been regularly visited to estimate glaucous gull breeding success. Those nests have, on average, been visited 8 times from mid-May to mid-July. The time spent at each nest by field workers was extremely short (<1 minute) and most of the nests were close to the shore and accessible by zodiac. Consequently, disturbance for eiders and/or geese breeding around glaucous gull nests was minimal.

In 2012, 36 chicks have been captured and ringed (handling of chicks was done either on the shore or in the zodiac, as far as possible from eider and goose nests). Those chicks belonged to 20 different nests. Chicks were on average captured and measured twice within the season (range 1-3) between age 1 (hatching day) and age 20 (only 3 chicks were capture after age 13). Hatching dates, and thus chick age, were determined ±2 days on average.

Fig.8 *Capture of glaucous gull chicks for ringing and measurements* *(photo credit: S. Descamps)*

Statistical analyses

Survival analyses were carried out using capture–mark–recapture methods (Lebreton et al. 1992), implemented in software M-SURGE 1.7 (Choquet et al. 2004, Choquet et al. 2005). Our dataset consisted of 33 breeding birds ringed (with metal and plastic color rings) between 2009 and 2011 and monitored from 2009 to 2012. Birds ringed in 2012 can obviously not be used to estimate annual survival rates before 2012. Only birds ringed with a plastic ring with an individual code (allowing band reading at a distance) have been included in this analysis. Model selection was based on the Akaike's criterion corrected for small sample (AICc, Burnham and Anderson 2002).

Glaucous gull breeding success was estimated with nest survival analyses (Rotella et al. 2004). We used program MARK (White and Burnham 1999) to estimate daily nest survival. We also used an information theoretic approach based on the AICc to evaluate the performance of different models (Burnham and Anderson 2002).

Comparison between adult condition or chick growth rate in Kongsfjorden and Bjørnøya were performed with ANOVA and/or ANCOVA implemented in software R (R Development Core Team 2010).

Results

Population size

We found 55 active nests in Kongsfjorden in 2012 (Fig.9). An active nest was defined as a nest where eggs have been laid. Some of those nests were in inaccessible places like in the middle of the cliff within the Ossian sarsfjellet guillemot colony. Others were in areas where eider and goose densities were very high like on Kapp Guissez (8 glaucous gull nests).

Monitoring those nests would have created to much disturbance and nest desertion for eiders and geese and we thus decided not to monitor them. At the end, a total of 38 nests out of these 55 have been monitored to estimate breeding success in 2012. Data were sufficient for 35 of these 38 nests to estimate nest survival. In 28 of these nests, there was at least one ringed parent.

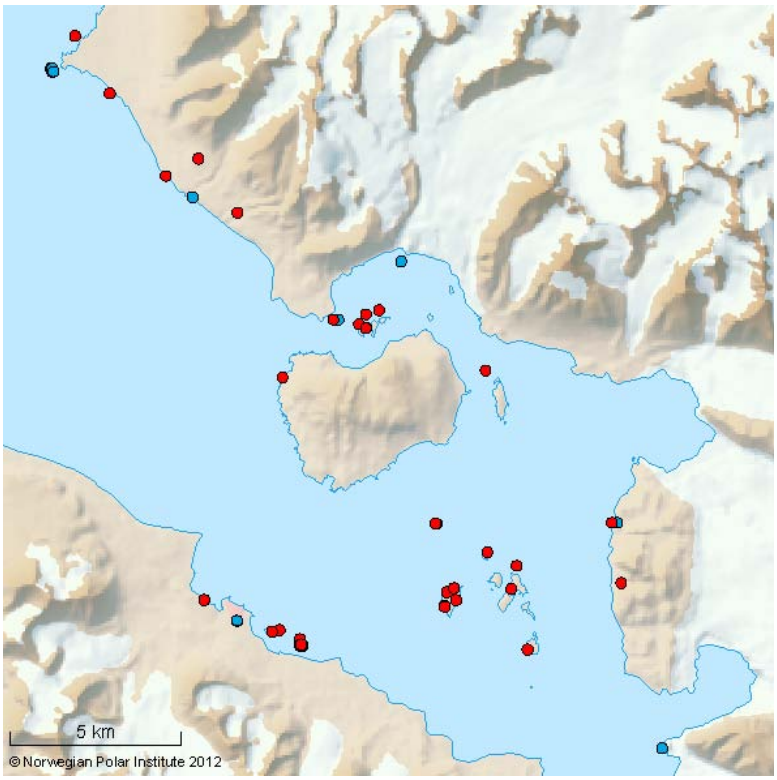

Fig.9 *Distribution of Glaucous gull nests in Kongsfjorden (red: monitored nests in 2012; blue: nest not monitored in 2012)*

Breeding parameters

Clutch size in both localities were similar and averaged 2.7 eggs (±0.09 SE) in Kongsfjorden and 2.6 eggs (±0.1 SE) in Bjørnøya (p-value>0.6).

The average daily nest survival (i.e probability that at least 1 egg or chick survives from one day to the other in a given nest) in Kongsfjorden was estimated at 0.9876% (95% confidence interval: 0.9783-0.9930; estimate based on n= 38 nests; Fig. 10). On Bjørnøya, the average daily nest survival (based on n=23 nests; Fig. 10) was estimated at 0.9915% (95% confidence interval: 0.9812-0.9962). This gives an estimated survival from laying to fledging of 42% in Kongsfjorden (95% confidence interval: 22%-61%) and 55% on Bjørnøya (95% confidence interval: 26%-77%) with the assumption that incubation lasts 28 days and rearing 42 days (Strøm 2006). Nest success on Bjørnøya was thus larger on average than on Kongsfjorden in 2012 but the difference was not significant (Table 3).

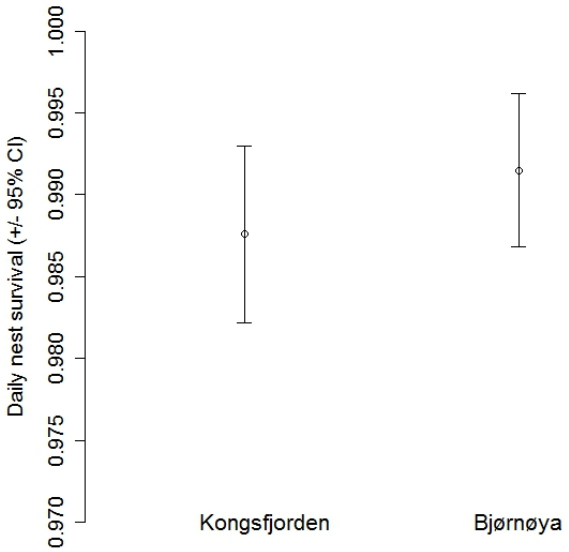

Fig.10 *Average daily nest survival (±95 CI) for glaucous gulls breeding in Kongsfjorden and Bjørnøya in 2012*

Table 3*. Model selection to estimate daily nest survival for glaucous gulls breeding on Bjørnøya and in Kongsfjorden. Data from 2012 (n= 61 nests). Subscript "t" indicates time variation, "g" indicates group, or population (Bjørnøya vs. Kongsfjorde) effect and "." indicates constant models.*

Model	np	AICc	ΔAICc
$S_.$	1	146.139	0.000
S_g	2	147.562	1.423
S_t	54	234.194	88.055

Eggs laid in Kongsfjorden and Bjørnøya had the same length on average (Table 4; p-value>0.1 after adjusting for clutch size) but had different width. Kongsfjorden eggs were wider than Bjørnøya ones (Table 4; p-value<0.01 after adjusting for clutch size) but difference was only around 1 mm. Such a small difference may likely not have any biological meaning but may simply be the consequence of different measurements procedures in both places. This deserves further investigation.

***Table 4**. Average measurements for eggs in Kongsfjorden and Bjørnøya in 2012 (results based on 31 and 12 eggs respectively).*

	Length (mm)		Width (mm)	
	Kongsfjorden	Bjørnøya	Kongsfjorden	Bjørnøya
Mean	77.6	76.4	54.0	53.1
SE	0.6	1.2	0.2	0.2

Survival rates

Average annual survival of glaucous gulls in Kongsfjorden was estimated at 87% (95% confidence interval: [69, 95]; Fig.11). There seemed to be substantial inter-annual variations with survival between 2009 and 2010 being 100% (all individuals ringed in 2009 have been resighted in 2010) but survival between 2010 and 2011 being only 76% (95% confidence interval: [54, 90]). However, those estimates are based on a relatively low sample size so that the confidence intervals are very wide (and model AICc are very similar; Table 1).

We did not detect any significant difference with the average survival on Bjørnøya. Glaucous gulls breeding on Bjørnøya had an average survival of 84% between 2009 and 2012 (95% confidence interval: [72, 92]; Fig.11). Interestingly, survival of Bjørnøya birds was also higher between 2009 and 2010 than between 2010 and 2011 (average of 88% versus 80%, respectively).

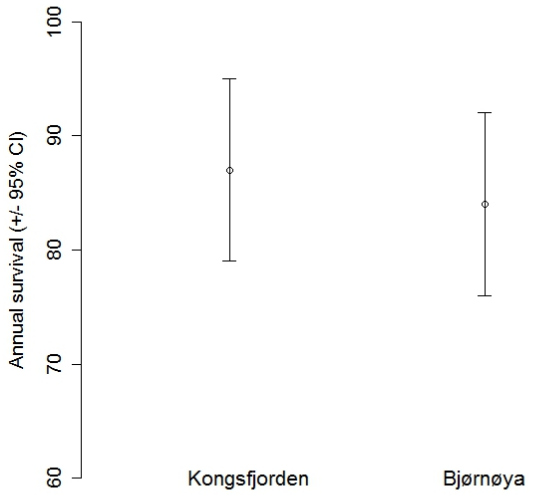

***Fig.11** Average survival (±95 CI) in Kongsfjorden and Bjørnøya for adult glaucous gulls between 2009 and 2012*

***Table 1**. Model selection to estimate survival rates of glaucous gulls breeding on Bjørnøya and in Kongsfjorden. Data from 2009 to 2012 (n= 82 birds). Subscript "t" indicates annual variation, "g" indicates group, or population (Bjørnøya vs. Kongsfjorden) effect and "." indicates constant models. Sign "+" refers to additive effects.*

Model	np	AICc	ΔAICc
$\Phi_{.}\ p_t$	4	217.431	0.000
$\Phi_t\ p_t$	6	219.061	1.630
$\Phi_g\ p_t$	5	219.306	1.875
$\Phi_{t.g}\ p_t$	8	220.325	2.894
$\Phi_{t+g}\ p_t$	7	220.448	3.017
$\Phi_{t.g}\ p_{t.g}$	9	221.271	3.840
$\Phi_{t.g}\ p_{.}$	7	221.898	4.467
$\Phi_{t.g}\ p_{t+g}$	9	222.180	4.749
$\Phi_{t.g}\ p_g$	8	223.330	5.899

Adult body condition

Average body mass of breeders in Kongsfjorden averaged 1570 grams and did not differ significantly from mass of glaucous gulls breeding on Bjørnøya (1563 grams; Table 2; p-value>0.35 after adjusting for date of capture and body size). Body size of birds was similar in both populations (Table 2; no significant difference between Bjørnøya and Kongsfjorden, whatever the body size index considered, *all p-values >0.19*).

***Table 2**. Average body measurements and mass for glaucous gulls breeding in Kongsfjorden and Bjørnøya in 2012 (results based on 28 and 55 birds respectively).*

	Gonys (mm)		**Culmen (mm)**		**Head+Bill (mm)**		**Mass (g)**	
	Kongsfjorden	Bjørnøya	Kongsfjorden	Bjørnøya	Kongsfjorden	Bjørnøya	Kongsfjorden	Bjørnøya
Mean	21.9	22.3	60.0	60.6	137.3	141.5	1570.9	1562.7
SE	0.2	0.2	0.8	0.6	4.7	1.0	31.6	24.7

Chick growth rate

In Kongsfjorden, chicks gained on average 40 grams a day. Measurements on Bjørnøya have been done later in the season than for chicks in Kongsfjorden. As growth rate is likely not linear during the entire season, comparison between Bjørnøya and Kongsfjorden is not statistically valid and we cannot reliably compare growth rate between the two localities. In subsequent years, chick measurements will, if possible, be done at the same ages for both localities so that chick growth rate comparison will be feasible.

Discussion

Long-term monitoring potential in Kongsfjorden

The 2012 glaucous gull monitoring in Kongsfjorden was a success. A large number of nests have been monitored with very limited disturbance for eider and goose nesting around. A large number of adults and chicks have also been captured and ringed. Data collected in 2012 allowed us to estimate glaucous gull breeding success, chick growth rate, adult body condition and annual survival rates. Most of those estimates had a relatively good accuracy.

In terms of activities, this monitoring requires approx. 3 weeks of adult captures early in the season (between late-May and mid-June). This means having a dedicated team working exclusively on glaucous gull during this period. Then, when most of hatching has occurred and adults become hardly trappable, the nest monitoring of glaucous gull can be combined with other activities. In 2012, the SEAPOP team working on little auks at Feiringfjellet and Brünnich's guillemots at Ossians sarfjellet was in charge of monitoring the 38 glaucous gull nests from mid-June onwards. This meant, of course, an additional workload for this team but visiting some nests every other day and ringing/measuring some chicks appears, to some extent, compatible with the traditional SEAPOP tasks.

Such a demographic monitoring of Glaucous gull in Kongsfjorden is thus clearly feasible and will allow estimating the main demographic parameters. In parallel to the monitoring on Bjørnøya and to the research on contaminants and on wintering ecology, it should strongly improve our understanding of glaucous gull population dynamics, and consequently, of glaucous gull status and trend in Svalbard.

What should be measured and why?

The demographic parameters described in this report are needed to understand what is going on with glaucous gulls in terms of population dynamics.

For seabirds in general, population growth rate is extremely sensitive to variation in adult survival. In other words, a small decrease in the average adult survival can drastically affect the population growth rate (Sæther and Bakke 2000). However, adult survival is, in general, relatively stable for such long-lived species contrary to breeding success and juvenile survival which can vary a lot. Such large variations in breeding success or juvenile survival have the potential to also greatly affect the growth rate of the population (Gaillard et al. 2000, Gaillard and Yoccoz 2003). Consequently, estimating both adult survival, juvenile survival and breeding success (nest survival) are required to model the overall dynamics of glaucous gulls and to understand the demographic mechanisms behind changes in population size (Caswell 2001). This will then, in a second step, help unraveling the environmental drivers affecting this population dynamics.

Our monitoring also allows us to estimate chick growth rate and adult body condition. Such parameters could tell us about the food availability in the summer period, and again help understanding the environmental determinants of variation in breeding success, recruitment and/or survival.

Results from 2012 and comparison with Bjørnøya

Results from the 2012 season indicate no overall differences between the Kongsfjorden and Bjørnøya population. In the last summer (breeding success, chick growth rate, adult condition) or in the last few years (adult survival), demography was very similar in Kongsfjorden and Bjørnøya. These results also indicate that adult survival in Svalbard was very similar to adult survival in Canada (estimated at 83% for glaucous gull breeding in the low Arctic in the 1990s) (Gaston et al. 2009).

However, as emphasized earlier, this does not mean that the status and trend of both populations (Bjørnøya and Kongsfjorden) are similar. Such conclusions can only be based on long-term data. It is clear that glaucous gulls are sharply declining in Bjørnøya. Recent surveys suggest that situation on Hopen is also worrying (ca. 1,000 breeding pairs counted in the late 80's but only 240 hundreds in 2012). But up to now, we have no evidence that glaucous gulls are declining in Kongsfjorden. We can say that demographic parameters were similar in 2012 in both populations but this is as far as we can get for now. An annual monitoring of the number of breeding pairs in the fjord, annual ringing of adults and chicks and annual monitoring of nest success is what must be implemented to understand glaucous gull population dynamics notably in relation to the long-term research on contaminants. This would allow a rigorous assessment of the biological effects of pollutants in Svalbard and help us understanding, and eventually forecasting, Arctic gull response to environmental changes.

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