Breeding success of black-legged kittiwakes (Rissa tridactyla) at Svalbard in relation to diet and sea surface temperature.

Hekkesuksess hos krykkje (Rissa tridactyla) på Svalbard i forhold til diett og temperatur i havoverflaten.

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ABSTRACT

Seabird and prey interactions are largely influenced by dynamics in marine ecosystems, especially during the breeding season. The availability of prey is affected by oceanographic processes and environmental factors. Black-legged kittiwakes (*Rissa tridactyla*) in Kongsfjorden on Svalbard have experienced a change in available prey species during the last three years. Warm saline Atlantic water has dominated Kongsfjorden since 2005. As a result of the after a large inflow of Atlantic water masses to the western part of Svalbard in 2007 capelin (*Mallotus villosus*) has substituted polar cod (*Boreogadus saida*) in the diet of breeding kittiwakes. Diet data from the field season of 2009 has been compared with diet data from 1997, 1998 and 2004-2008. The diet samples has been analysed to classify the prey species to the nearest possible taxon. Hatching date, body condition, amount of fish in the diet and sea surface temperature were used as parameters to determine the effect availability of fish had on the birds breeding success (chicks per active nest). A distinct seasonal variation of capelin and polar cod was found during the incubation and chick-rearing period, respectively, in 2008 and 2009. The hatching date which reflects the body condition of kittiwakes in the period before egg laying was significantly correlated with the breeding success. Also, the body condition during the chick-rearing period was correlated with frequency of fish in the diet. Additionally, there was a tendency for a positive relationship between the frequency of capelin in the diet and sea surface temperature. These findings show that for kittiwakes in Kongsfjorden, fish is the most important prey during the breeding period. Especially the fish availability during the period before the egg laying is assumed to be critical for the outcome of reproduction. The increase of capelins in Kongsfjorden did not affect the breeding success, probably because capelins were first available as prey in mid July (i.e. the chick-rearing period). Kittiwakes are excellent indicators of ecosystem changes, and results from the present thesis support other marine studies: that the ecosystem in Kongsfjorden is changing.

SAMMENDRAG

Sammenhengen mellom sjøfugl og deres byttedyr er i stor grad påvirket av dynamikken i marine økosystemer, spesielt i hekkesesongen. Tilgangen på byttedyr er påvirket av oseaniske prosesser og miljøfaktorer. Krykkjen (*Rissa tridactyla*) i Kongsfjorden på Svalbard har gjennom de siste tre årene opplevd en endring i tilgjengelige arter av byttedyr. Varmt og saltholdig atlantisk vann har dominert Kongsfjorden siden 2005. Som et resultat av stor innstrømning av atlantisk vann på vest siden av Svalbard i 2007, har lodden (*Mallotus villosus*) erstattet polartorsk (*Boreogadus saida*) i diett prøver hos hekkende krykkjer for polartorsk. Diettdata fra feltsesongen i 2009 ble sammenlignet med diettdata fra 1997, 1998 og 2004-2008. Diettprøvene ble analysert og byttedyrene ble klassifisert til nærmeste familie. Hekke dato, kondition og mengden av fisk i dietten i ungeperioden samt havtemperatur ble brukt til å finne ut effekten av tilgjengelig fisk på hekkeksuksessen (unger per aktive reir). Det ble funnet en markant sesongvariasjon i mengde lodde og polartorsk mellom ruge- og ungeperioden i 2008 og 2009. Klekkedato, som reflekterer kondisjonen til hekkende krykkjer i perioden før egglegging, korrelerte signifikant med hekkesuksessen. Kondisjonen i ungeperioden korrelerte også med mengden fisk i dietten. I tillegg ble en trend mellom havtemperaturen og mengde lodde i dietten funnet. Disse resultatene viser at fisk er det viktigste byttedyr for krykkjer i Kongsfjorden i hekkeperioden. Særlig viktig er tilgjengeligheten av fisk i perioden før egglegging for resultatet av reproduksjonen.. Den økte mengden lodde i Kongsfjorden hadde ikke noen påvirkning på hekkesukssen, sannsynligvis fordi lodden først er tilgjengelig som byttedyr i midten av juli (eksempelvis ungeperioden). Krykkjer er en perfekt indikatorart for endringer i et økosystem og resultatene presentert i denne mastergraden støtter konklusjonene hos andre marine studier om at Kongsfjordens økosystem er i endring.

CONTENT

INTRODUCTION

Piscivorous seabirds are central place foragers during the chick-rearing period with restricted distance between their nest site on land and their foraging areas at sea (Welcker et al. 2010). According to optimal foraging theory, a predator will try to maximise its daily energy intake (Krebs & Davies 1978), which depends on both the energy content of the prey and the energy loss connected to foraging (Gabrielsen 2009). Most predators are able to switch between different prey depending on their abundance (Bergerud 1983), or to switch to alternative prey if the abundance of the preferred prey is low (Murdoch 1969). For piscivorous seabirds, primary prey is often distributed in patches and varies both temporally and spatially (Schneider & Piatt 1986). Depth of water constitutes a third challenge (Schneider & Piatt 1986; Ostrand et al. 1998), because prey that seek protection from predators in deep water are not available to surface feeding seabirds. To compensate for reduced availability of surface prey, the birds can either intensify search effort in the given foraging area or increase their foraging range. In any case, the primary goal is to obtain sufficient amount of prey within the time frame that allows successful breeding (Suryan et al. 2000). High-latitude seabirds have an additional challenge because the time frame during which conditions are suitable for reproduction is short and has to match the seasonal peak in food abundance. The timing of reproduction and the abundance of key prey species are essential for the reproductive investment and the fitness of adults and chicks (Suryan et al. 2000; Shultz et al. 2009).

On the west coast of Svalbard, a large number of seabirds breed during the short arctic summer. Here, warm, saline Atlantic water and cold, relatively fresh Arctic water masses meet and mix on the shelf outside Kongsfjorden-Krossfjorden fjord system (Mehlum 1997; Svendsen et al. 2002). Because Kongsfjorden-Krossfjorden is an open sub-Arctic glacial fjord system with no sill at the entrance, the exchange of water masses makes the outer fjord heavily influenced by the mix of Atlantic and Arctic water, while the inner fjord is more influenced by freshwater from glaciers around the fjord (Hop et al. 2002; Svendsen et al. 2002; Gabrielsen & Hop 2009). The inflow of Atlantic water into Kongsfjorden through the deep water column is common during winter and spring (Tverberg & Nøst 2009). At the shelf where the water masses mixes, it creates an upwelling area of pelagic invertebrates and fish. This constitutes a good food basis for breeding seabirds (Mehlum & Gabrielsen 1993; Loeng et al. 1997; Hop et al. 2002) and marine mammals, such as ringed seals (*Phoca hispida*) (Lydersen et al. 1985) and bearded seals (*Erignathus barbatus*) (Hjelset et al. 1999).

Seabirds are important components of the marine ecosystems. Their consumption of marine prey at sea also results in a large return of nutrients to the terrestrial ecosystem as excrements at their nest sites. This flow of nutrients, energy and material from one ecosystem to another is especially important in polar areas to get high productivity in terrestrial coastal ecosystems (Mehlum & Gabrielsen 1995; Mehlum 1997; Stempniewicz et al. 2007). As top predators, seabirds will detect changes in fish stock and oceanographic conditions at an early stage (Montevecchi 2007), thus they are well suited as bioindicators for short- and long-term variations in the marine environment and fish populations (Cairns 1987; Barrett et al. 2007; Montevecchi 2007; Piatt et al. 2007; Wanless et al. 2007; Shultz et al. 2009).

Black-legged kittiwake (*Rissa tridactyla*), hereafter referred to as kittiwake, is an easily accessible, long-lived, conspicuous surface-feeding seabird that breeds in large colonies, and has a restricted foraging range. Their breeding success depends on the adults' body condition, which in turn depend on prey availability (Fig. 1). Therefore the breeding success is often used to investigate relationships between trophic and physical conditions within a defined ocean region (Cairns 1987; Wanless et al. 2007). Kittiwakes have been studied for many years and the occurrence of different prey species in their diet has often been associated with reproductive success (Furness & Barrett 1991; Barrett & Krasnov 1996; Lewis et al. 2001; Carscadden et al. 2002; Jodice et al. 2006; Barrett 2007). Even though kittiwakes are capable of capturing many species of vertebrate and invertebrate prey (Furness & Monaghan 1987), one prey type often dominates the kittiwake diet. Decline in this prey type can cause reduced reproductive success (Cairns 1987; Lønne & Gabrielsen 1992; Barrett 1996; Barrett & Krasnov 1996; Harris & Wanless 1997; Lewis et al. 2001).

In recent time, polar cod (*Boreogadus saida*) and capelin (*Mallotus villosus*) has been the two major prey species for kittiwakes in Kongsfjorden. The polar cod is a pelagic small-sized, cold-water fish species (Falk-Petersen et al. 1986). It is present in Kongsfjorden all years and monitored as a key species in the Arctic marine food web (Stiansen & Høines 2009). Capelin on the other hand is a small, pelagic and short-lived schooling fish that migrate long distances between spawning areas outside the coast of Norway in March to the oceanic Polar Front near the ice-edge during sum. It then reaches their maximum northern extension in September-October (Jonsson & Semb-Johansson 1992; Barrett & Tertitski 2000; Gjøsæter 2009; Stiansen & Høines 2009).

The aim of this present master thesis was to examine the importance of availability of fish and various fish species for the breeding success of kittiwakes in Kongsfjorden, Svalbard, based on an existing time series (1997-1998 and 2004-2007) on breeding success, hatching date, adult body condition and diet during the chick rearing period. At the end of this period, capelin substituted polar cod as the major fish species in the diet, presumably because of increased sea temperatures. Hence from 2008 and 2009, diet data were collected from both the incubation and chick rearing period, in order to be able to test for seasonal changes in the occurrence of the two fish species in the diet. My predictions are (1) that the breeding success will depend on food availability prior to egg-laying, which is reflected by the time of egg laying and thus hatching date (Frederiksen et al. 2004a; Wanless et al. 2007; Fig. 1), (2) that the adult body condition and breeding success also will be positively related to the proportion of fish, which have a higher fat content than invertebrates (Gabrielsen 2009) in the diet during the chick-rearing period (Fig. 1), (3) that capelin are more profitable than polar cod due to a higher fat content (Jangaard 1974; Brekke & Gabrielsen 1994), and (4) that the occurrence of capelin in the diet is positively related to sea surface temperatures.

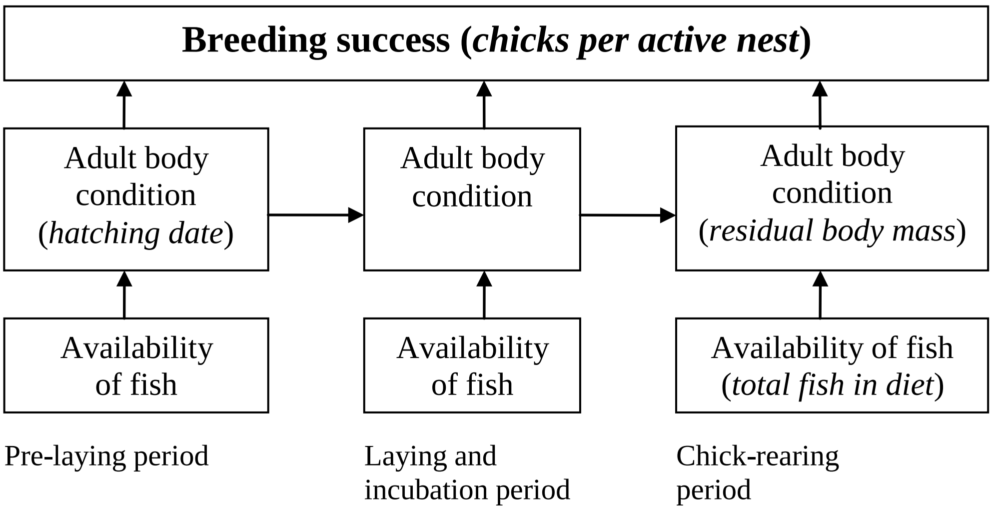

Fig. 1 The breeding success of kittiwakes depends on the adults´ body condition. The adults´ body condition in the pre-laying period affects the condition during laying and incubation which, further affects the condition of adults in the chick-rearing period. To analyse the effect of available prey on the breeding success, different indices (chicks per active nest, hatching date, residual body mass and total fish in diet) were used. Chicks per active nest is used as an index for breeding success, hatching date is used as an index on adult body condition in the pre-laying period, total fish in the diet during the chick-rearing period is used as a measure of available fish during this period while residual body mass is used as an index for the adult body condition in the chick-rearing period.

MATERIAL AND METHOD

Study area and period

The study area is located in Kongsfjorden (79º 01´N, 11º 33´E) on the west coast of Spitsbergen, Svalbard. Kongsfjorden is a 20 km long south-east oriented fjord. The width varies from 4 to 10 km and the inner fjord has relatively shallow water (less than 100 meter deep) (Svendsen et al. 2002). Kongsfjorden is an open glacial fjord (Hop et al. 2002) and one of the largest on the West-Spitsbergen coast. The area has a high-arctic climate and a mean summer temperature of 4-5º celsius (Mehlum & Gabrielsen 1993). In 2009 the mean summer air temperature was 4.0º celcius which is not different from previous years (Meteologisk Insitute 2010). The mean sea surface temperature (SST) in Kongsfjorden during July-August has been measured by the Norwegian Polar Institute for long periods and the sea surface temperature has increased during the period (Fig. 2).

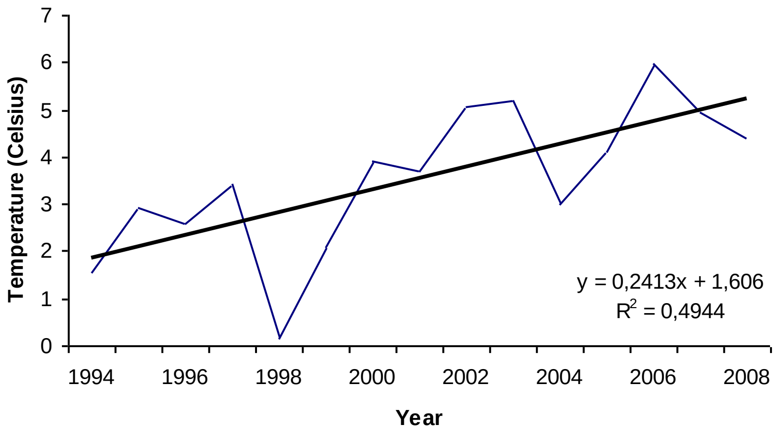

Fig. 2 Mean sea surface temperature (< 50m) in July-August in Kongsfjorden from 1994-2008. Data from 2005-2006 is based on August measurements only, and data from 2009 is not available.

Kittiwakes were studied in three different colonies in Kongsfjorden: Krykkjefjellet, Observationsholmen and Blomstrand. The three colonies are all located within a 10 km range from Ny-Ålesund, an international research station on the south side of Kongsfjorden. Collection of diet samples from the three kittiwake colonies has been conducted during the chick-rearing period in 1997, 1998 and 2004–2007. In the years 2008 and 2009, data were collected for the present master thesis and includes samples from both incubation and chick-rearing periods. The diet data from

2008 and 2009 were compared with previous collected diet data in order to analyse for seasonal- and inter-annual variation in diet composition.

Kittiwakes

The black-legged kittiwake is a small gull and the most numerous species of Laridae in the world (Barrett 1996). In general, it has a circumpolar distribution and breeds in the boreal and arctic zone (Barrett 2007), throughout most of the northern hemisphere (Barrett & Tertitski 2000). The world population counts approx 6-8 million pairs (Lloyd 1991). Half of these breeds in the Barents Sea, on Iceland and the Faeroe Islands (Barrett 1978). Around 900 000 pairs breed in the Barents Sea area, with the largest colony at Syltefjord in east Finnmark, Norway. On Svalbard, around 270 000 pairs are breeding (Lloyd 1991) distributed in 200 colonies (Barrett 1996; Barrett & Tertitski 2000). The kittiwakes arrive at the breeding areas in March/early April and breed in colonies on steep, often high cliffs very close to the sea. They normally lay two or three eggs in the first half of June and both sexes incubate the eggs for about 27 days. Often only one of the chicks survives to fledging at five or six weeks of age. After fledging the birds leave the breeding areas in early September (Barrett 1996). Outside the breeding season and as immature birds are they pelagic, and disperse widely over most of the North Atlantic. Many immature birds do not return to natal areas until their third summer (Barrett & Tertitski 2000). The main predators on kittiwakes are great skua (*Catharacta skua*), glaucous gull (*Larus hyperboreus*) and arctic fox (*Alopex lagopus*). They chiefly eat kittiwake eggs and chicks, but especially the great skua can also kill adult kittiwakes (Malling Olsen & Larsson 1997).

Kittiwakes are surface-feeders (Carscadden et al. 2002) and feed in flocks (Lønne & Gabrielsen 1992). Their normal foraging area when breeding stretches up to a distance of 50 to 100 km from the nest (Barrett 2007). Invertebrates and fish (up to ca. 15-20 cm) are their main food-choice (Barrett & Tertitski 2000; Gabrielsen 2009). Polar cod (*Boreogadus saida*) and capelin (*Mallotus villosus*) are found to be the two most dominating fish species in the diet of kittiwake in the Barents Sea (Mehlum & Gjertz 1984; Lønne & Gabrielsen 1992; Mehlum & Gabrielsen 1993; Mehlum & Gabrielsen 1995; Barrett & Krasnov 1996; Barrett & Tertitski 2000). Polar cod has dominated the diet on Svalbard (Lønne & Gabrielsen 1992; Barrett & Krasnov 1996; Carscadden et al. 2002; Barrett 2007; this study).

Sampling

The same sampling method was used throughout all years of the data collection and the same method is used in other studies on kittiwakes (Barrett et al. 2007). In total 504 diet samples were collected during the 9 years of research (1997, 1998, 2004-2009). Because kittiwakes often spontaneously regurgitate when handled, food samples were collected from all team members during the field season in 2008 and 2009 when ever a bird was captured for handling. Food samples were most often collected from birds on nest, and usually when they returned from the sea. The kittiwakes were captured while lying on their nests using a telescopic fishing rod with a nylon snare fitted to its end. The nylon wire was placed around the neck and the bird was brought to the ground and handled by the team members. Regurgitations were collected and stored in plastic bags. The bags were labelled with area, date, birdnumber (if marked) and the person handling the bird. It was then stored at -20ºC until further analysis. The analysis of diet samples took place at the Norwegian Polar Institute in Tromsø and at the University of Life Sciences, Ås. Body measurements from almost all kittiwakes, which include body mass, wing length, beak length and head length, were measured for all birds that regurgitated. Body mass was measured with a spring balances 500 g (± 5 g). The wing length (maximum flattened chord) was measured with a stopped ruler from the carpal joint to the tip of the longest primary. The length of the headbill was measured to the nearest 1 mm with a sliding calliper from the back of the head to the tip of the bill.

Laboratory work

The analysis of food samples was carried out in the same way during all years and periods. The samples were thawed and each individual food sample was weighed to the nearest 0.1 g before the sample was teased apart in a petri dish. Food items were identified to species level using primarily otoliths or morphological characteristics under a binocular microscope and available keys (Breiby 1985). Otoliths were often extracted from the skulls of fish or if digestion of the food was more advanced, otoliths were found free in the sample. Wear of the otoliths was not a significant problem and did not lead to a bias in the data. The mass of each species from all regurgitation was recorded. All otoliths were counted and their lengths were measured to the nearest 0.1 mm using a measuring ocular in a binocular microscope. Crustaceans and polychaeta were identified by exoskeletons to the lowest possible taxon using identification keys (Klekowski & Weslawski 1991) (Appendix I).

Diet description

The different taxa in the food samples were grouped in the following categories to simplify analysis and illustration; “Crustaceans” includes all *Themisto libellula*, *Themisto abyssorum*, *Thysanoessa longicaudata* and *Thysanoessa inermis*, “Polychaeta” includes only *Nereis*. The category “Other fish” includes other fish found in the diet, as well as unidentified fish. The reason why we were sometimes unable to identify taxa in the samples was that the sample included no otoliths or because the fish was too digested to identify any morphological characteristics. “Polar cod” includes only polar cods and “Capelin” includes only capelins.

Fish length measurements

Capelin and polar cod lengths (snout to end of tail) were calculated based on the length of the otoliths (Appendix I).

Capelin (Barrett 1996):

$$\textit{Fish length} = \textit{otolith length} * 48.0 + 25.8$$

Polar cod (Lønne & Gabrielsen 1992):

$$\textit{Fish length} = 16.4 + 21.8 * \textit{otolith length}$$

Additional parameters

All data concerning hatching date, breeding success and body condition are collected by the kittiwake-team at the Norwegian Polar Institute over the years.

Hatching date

Hatching date was determined from mean hatching date in the colony (Appendix II). Visual inspections of nests were obtained every second day during the breeding season from June to August in all years from 1997 to 2009. Observations were done with a mirror on a stick reaching the nest sites and conducted counts of eggs and chicks were done from the ground under the colony. The same method for determine breeding success was used in all years of the study. No inspections to determine hatching date were obtained in 2001. The incubation and chick-rearing period was determined from mean hatching date. The hatching dates varied from year to year depending on when the adults produced eggs.

Breeding success

The measurement of breeding success is an estimation based on regular visual inspections of nests every second day during the breeding season from June to August during all years in the period 1997-2009. The number of active nests was counted to determine the total number of breeding pairs. Active nests were defined at any site where at least one egg was laid. During the breeding season all eggs and chicks were counted until the end of the field season in early August. Due to late hatching in some years, breeding success became an estimation of numbers of chicks per active nest more than 12 days old per active nest (Appendix II). Breeding success was measured from different colonies in different years, and therefore only shows an indication on the total breeding success in Kongsfjorden.

Body condition

The body mass of breeding kittiwakes decreases during the chick-rearing period (Moe et al. 2002). Measured body mass data were correlated for this seasonal trend, in order to compare between years. This was done by fitting a least-square linear regression of body mass on chick age, and taking the residuals of this regression as an index of corrected body mass (hereafter referred to as ‘residual body mass’). As a result mean residual body mass is thus independent of between-year differences in when birds were measured in relation to chick age. Only birds captured during the chick rearing period were used for the measurement. As body mass varies between the sexes, residual body mass was calculated separately for females and males. The residual body mass is further used in this thesis as an index of body condition for breeding kittiwakes (J. Welcker pers. comm. 2009).

Analysis and statistical tests

To compare the frequency of prey species in kittiwake diet over the years and periods. The frequency of each prey species is calculated from wet mass in grams. Each prey category is a percentage of the total wet mass for the whole year or period (incubation or chick-rearing). Only chick-rearing samples were used for inter-annual analysis because there were no collections of food samples in the incubation period in 1997, 1998 or in 2004-2007. The collected data did not contain sufficient information to do statistical test for comparison between years.

To test the probability of a diet sample containing capelin, polar cod and crustaceans during incubation or chick-rearing period and years, a likelihood ratio test in a logistic regression model in JMP, version 8, was done.

Nonparametric correlation Spearman’s tests in JMP-version 8 were used to test for relationships between breeding success and hatching date, breeding success and diet, sea surface temperature and capelin abundance in the diet and between body condition and frequency of total amount of fish in the diet. Nonparametric test were used because the amount of data material was too small for linear regression tests. Results were considered significant at $\alpha = 0.05$.

RESULTS

Diet

Inter-annual variation

Between 2004 and 2009, at least 16 different prey species occurred in the diet (Table 1). Some rare species, such as haddock (*Melanegrammus aeglefinus*), shakeblenny (*Lumpenus lampretaeformis*) and *Themisto abyssorum*, were only observed in 2006 when there was a peak in the mean sea surface temperature (Fig. 2). The species diversity declined after 2006 and in 2007-2009 there were around 8 different species in the diet per year (Table 1).

Table 1 Species diversity in diet samples from kittiwakes in 2004-2009 in Kongsfjorden, Svalbard.

Species	**Year**					
	2004	**2005**	**2006**	**2007**	**2008**	**2009**
Polar cod (*Boreogadus saida*)	X	X	X	X	X	X
Capelin (*Mallotus villosus*)		X	X	X	X	X
Cod (*Gadus morhua*)			X	X		X
Daubed shanny (*Leptoclinus maculatus*)	X	X	X			X
Shakeblenny (*Lumpenus lampretaeformis*)			X			
Haddock (*Melanogrammus aeglefinus*)			X			
Glacier laternfish (*Benthosema glacial*)	X	X	X	X		
”Mysterious fish”		X	X		X	X
Thysanoessa inermis	X	X	X	X	X	X
Thysanoessa longicaudata			X		X	
Themisto libellula	X	X	X		X	X
Themisto abyssorum			X			
Neris	X	X	X	X	X	X
Scrimp	X		X		X	X
Sagitta elegans (*Chaetognatha*)		X				
Limnica nelicina		X	X	X		

From 1997 to 2006 polar cod dominated the diet of adult kittiwakes in the chick-rearing period, whereas capelin dominated in and after 2007 (Fig. 3). Crustaceans and polychaeta replaced fish in the diet when fish was rare.

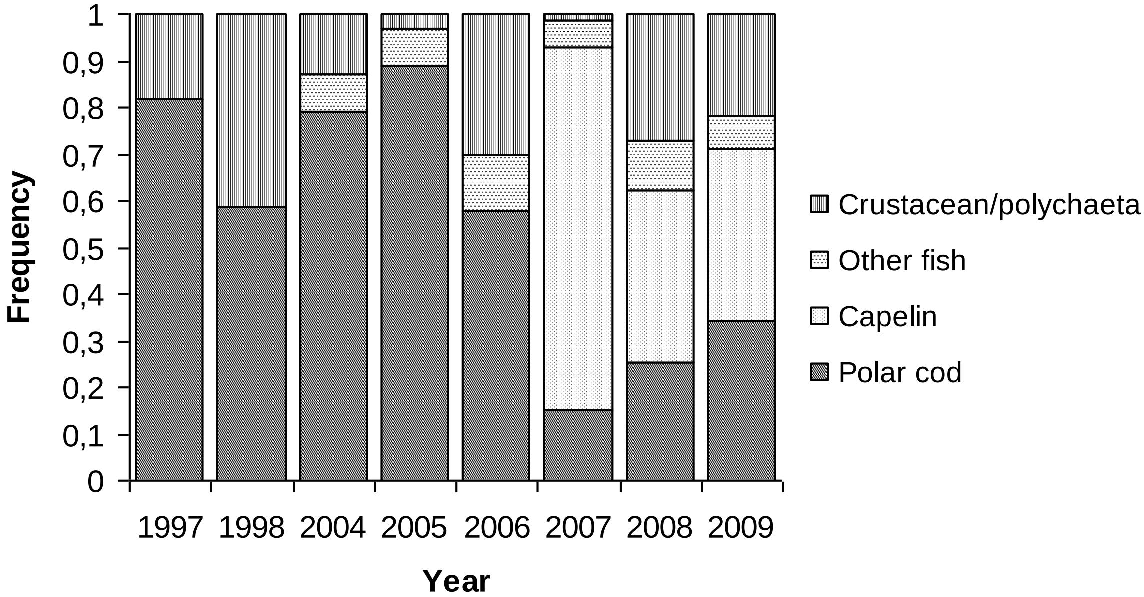

Fig. 3 Annual frequency of prey (polar cod, capelin, other fish and crustacean/polychaeta) in adult kittiwake diet in Kongsfjorden during the chick-rearing period in 1997, 1998 and 2004-2009. (1997 n=29, 1998 n=12, 2004 n=37, 2005 n=145, 2006 n=103, 2007 n=60, 2008 n=53, 2009 n=65). n=number of diet samples investigated.

The mean length of polar cods in the regurgitations was rather stable throughout 2004, 2005, 2006, 2008 and 2009 (Fig. 4). In 2007, the polar cods were much smaller than usually. They were even smaller than the capelins represented in the diet. Capelins from 2008 were larger than capelins from 2007 and 2009, and of the same size as the polar cods from 2008. In contrast capelins from 2009 were smaller than the polar cods (Fig. 4). The greatest variation in length of polar cods was found in 2007, while capelins varied most in 2009 (Fig. 4).

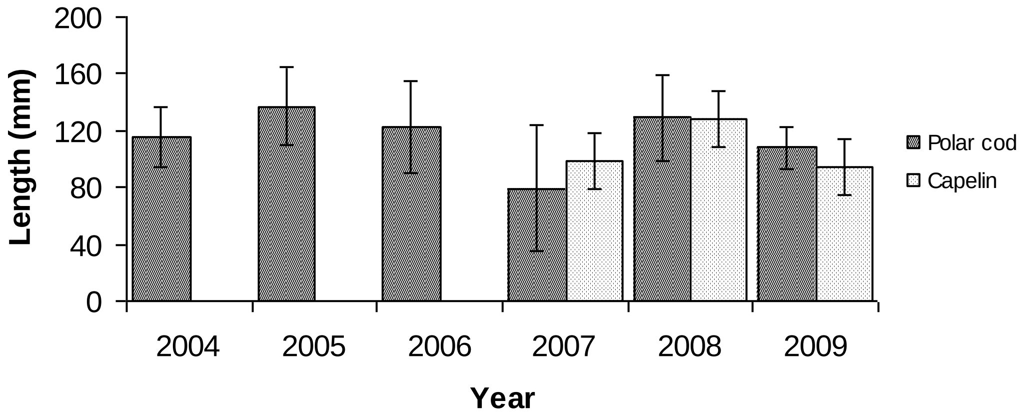

Fig. 4 The length of polar cod and capelin found in regurgitations from kittiwakes in Kongsfjorden from 2004-2009. (2004 n=33 SE=0.7, 2005 n=190 SE=27.0, 2006 n=57 SE=32.2, 2007 n=15/89 SE=44.0/11.7, 2008 n=14/9 SE=29.8/11.8, 2009 n=33/42 SE=14.9/19.9). n=number of calculated fish samples polar cod/capelin, SE=the standard deviation from polar cod/capelin.

Seasonal variation

During the incubation periods in 2008 and 2009, polar cod dominated the kittiwake diet constituting 37% in 2008 and 81% in 2009 (Fig. 5). In the chick-rearing periods capelin dominated the diet as it constituting 37% in 2008 and 41% in 2009. The probability that a diet sample contained capelin was significantly lower during incubation than during chick-rearing ($\chi^2 = 8.27$, $p = 0.04$, $n = 113$), whereas the opposite was true for polar cod ($\chi^2 = 14.20$, $p = 0.017$, $n = 113$). Crustaceans were found in both periods, but was not significant ($\chi^2 = 0.340$, $p = 0.56$, $n = 113$) between incubation and chick rearing period. Polychaeta constituted a very small percentage of the diet and it was found only during incubation in 2008 and in chick-rearing in 2009. There were no effects of year (2008 and 2009) in these models.

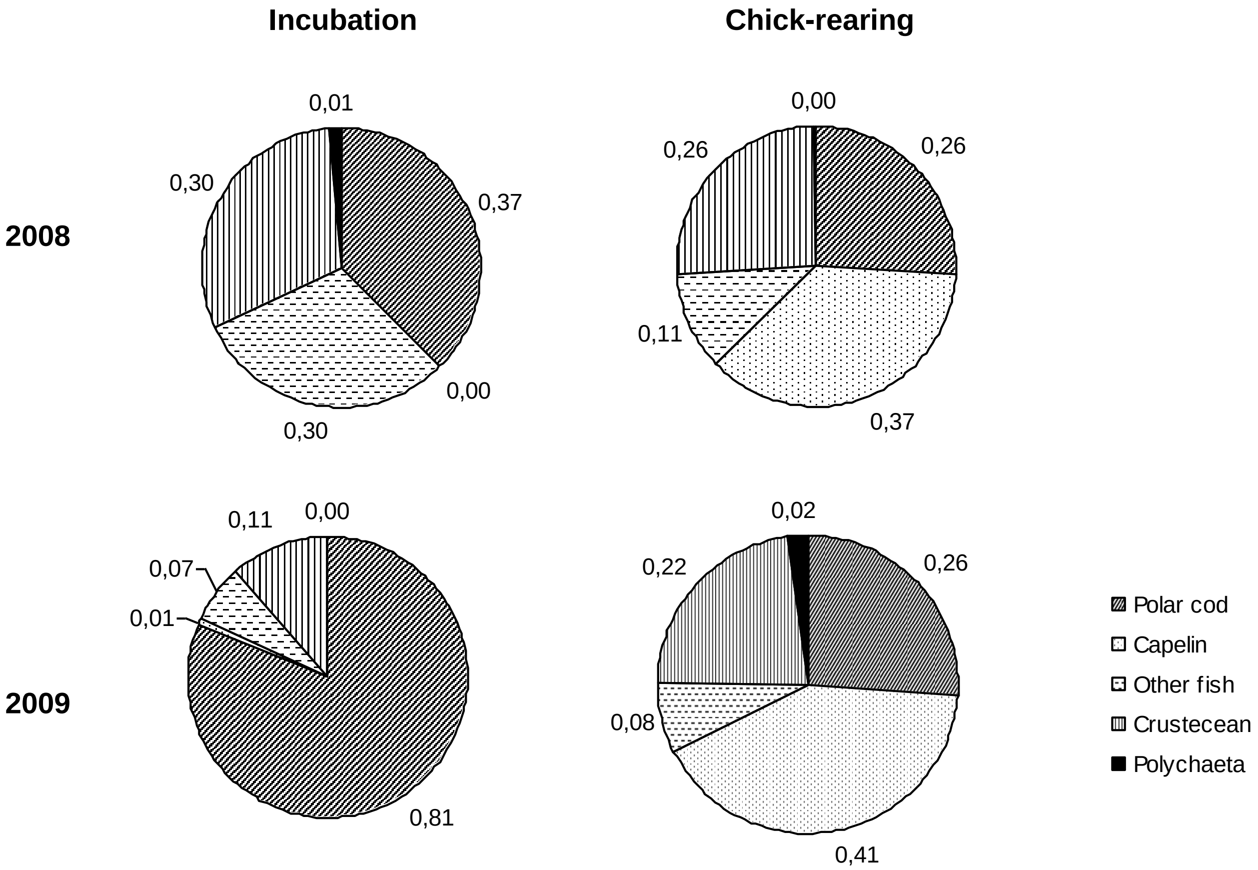

Fig. 5 Seasonally occurrence of primary prey species in diet of kittiwakes in Kongfjorden in 2008 and 2009 (2008 n=50, 2009=63). n=number of diet samples investigated.

Breeding success in relation to hatching date

Breeding success (chick per active nest) was significantly correlated with hatching date (Spearman's ρ = -0.58, p = 0.047) in the colonies (Fig. 6). In years with late hatching date, such as 2002 (25th of July) and 2003 (18th of July) the breeding success was poor, with 0 and 0.25 chicks per nest, respectively. In years with early hatching, such as 1998, 2000 and 2008 (8th, 9th and 8th of July), the breeding success was very good, with 0.94, 1.02 and 0.98 chicks per nest, respectively (Appendix II).

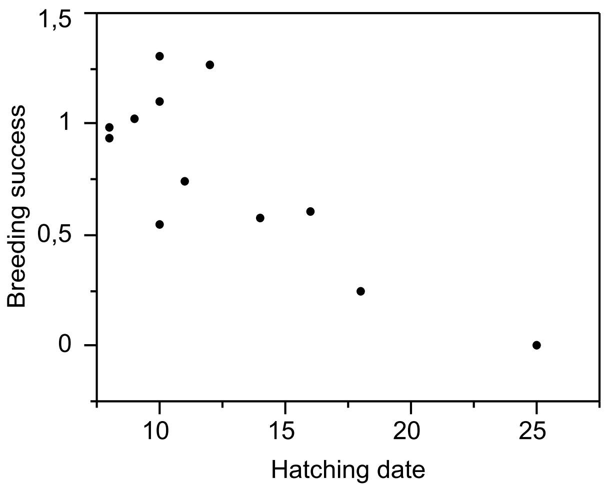

Fig. 6 Breeding success (chicks per active nest > 12 days) in relation to hatching date in July for kittiwakes in Kongsfjorden from 1997-2009, (n=12). n=number of years.

Body condition in relation to diet

During the chick-rearing period, there was a positive and significant relationship between the mean body condition of adult kittiwakes and the frequency of fish in the diet (Spearman's $\rho = 0.81$, $p = 0.015$) (Fig. 7).

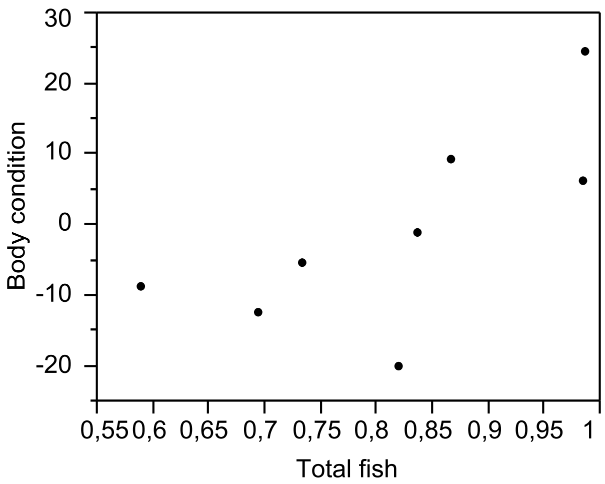

Fig. 7 Mean body condition for kittiwakes in Kongfjorden (1997, 1998, 2004-2009) in relation to the total proportion of fish in the diet, (n=8). n=number of years.

Breeding success in relation to diet and body condition

The breeding success (chicks per active nest) for kittiwakes in Kongsfjorden did not show a significant correlation with the total amount of fish (Spearman's ρ =0.59, p=0.119), the amount of polar cod (Spearman's ρ =0.07, p =0.866) or the amount of capelin (Spearman's ρ = 0.36, p = 0.372) in the diet. Neither was there a significant correlation between the breeding success and the mean body condition of adult kittiwakes in the chick rearing period. However, the two years with the highest breeding success 2005 and 2007 (Fig. 6) had the highest proportion of fish in the diet (Fig. 3).

Mean sea surface temperature in relation to capelin in diet and breeding success

Capelins were recorded in the kittiwakes' diet in 2007, 2008 and 2009, with the highest amount in 2007. There was a tendency for a positive connection between the amount of capelin in the diet and mean sea surface temperature in July-August (Spearman's ρ = 0.74, p= 0.056; Fig. 8). Breeding success did not reveal a connection with mean sea surface temperature (Spearman's ρ = -0.32, p = 0.340).

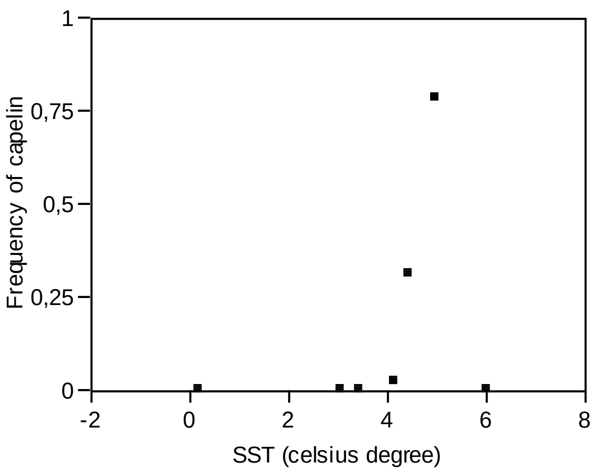

Fig. 8 Sea surface temperature (SST) in degree celsius in Kongsfjorden and the proportion of capelin in the diet in 1997, 1998 and 2004-2008, (n=8). n= number of years.

DISCUSSION

In this study, we found both annual and seasonal variations in kittiwakes' diet in Kongsfjorden. From 2004-2006 to 2007-2009, the diet during the chick-rearing period changed from a dominance of polar cod to a dominance of capelin. In 2008 and 2009, the diet was mainly dominated by polar cod during incubation, but changed to a dominance of capelin in the chick-rearing period. In accordance with prediction (1), the breeding success was negatively related to hatching date, which probably reflects the body condition of the birds prior to egg laying. A positive relation was found between the amount of fish in the diet and the body condition of the kittiwakes during breeding, supporting prediction (2). This confirms that fish is the most important prey type for kittiwakes. Prediction (4) was supported as we saw a tendency for a correspondence between the occurrence of capelins in the diet and sea surface temperature. Together with the new species found in 2006, this could indicate capelin to follow the Atlantic water masses on the western coat of Svalbard into Kongsfjorden. Contrary to prediction (3) however, the occurrence of capelins did not seem to affect kittiwakes' body mass or breeding success. By this, the relative proportion of polar cod and capelin as prey indicates to be the most important factor.

Diet

Fish were more important than invertebrates in kittiwakes' diet in Kongsfjorden. Polar cod predominated the diet until a change happened in 2007 (Mehlum & Gabrielsen 1993; this study). After 2007 the diet was no longer dominated by two year old polar cods but by capelin. Additionally, new prey species occurred in 2006 and a tendency for a positive relationship between sea surface temperature and the frequency of capelins in the diet was found. Capelin is associated with warm water (Mehlum 1997) and follows the currents of Atlantic water along the west cost of western Spitsbergen from the Barents Sea (Gjøsæter 2009). When a large amount of warm Atlantic water entered Kongsfjorden in 2007 (Tverberg & Nøst 2009), it is possible to assume that capelins followed the Atlantic water into the fjord giving central breeding birds the opportunity to forage on capelins, as well as polar cods.

Earlier studies from Hornsund and at Franz Josefs Land never confirmed that kittiwakes captured capelins (Lydersen et al. 1985; Mehlum & Gabrielsen 1993). Lønne & Gabrielsen (1992) only once documented the appearance of capelin in the diet in northern Svalbard. Nor was capelin noticed in nine historical studies of birds breeding on Svalbard by Løvenskiold (1963). Barrett (1996) was the first to find that capelin was a main part of kittiwake diet at Hopen. He explained the occurrence by the fact that Hopen is located so far to the south. One explanation to the occurrence of capelin in diet samples in Kongsfjorden before 2007 could come from non-breeding birds foraging other places (Baird 1991). The Institute of Marine Research has registered capelin outside western Svalbard since 2004 (Anon. 2004; Anon. 2005; Anon. 2006; Anon. 2007; Anon. 2009; H. Gjøsæter pers. comm), where one could assume non-breeding birds could forage, since breeding birds have a foraging range up to 100 km from their nest (Barrett 2007).

The distinct change in kittiwake-diet detected in 2007 is an interesting supplement to the knowledge of kittiwake diet on Svalbard and could indicate a shift in the Kongsfjorden ecosystem in general. The greater species diversity in 2006 also supports indications of changes in the ecosystem. Fish species, such as haddock, cod (*Gadus morhua*) and shakeblenny found in diet samples from 2006 have never been registered in earlier kittiwake diet samples from Kongsfjorden. Both cod and haddock are abundant in the southern Barents Sea outside the coast of Finnmark, Norway and are normally found in warmer waters during the summer (Gjøsæter 2009).

Jangaard (1974) found that capelins in the Barents Sea had a fat content of 12% of the total mass in July/August, whereas Brekke & Gabrielsen (1994) found that polar cod in the same period had a fat content of 5% of the total mass. Kittiwakes' daily consumption of fish, if they stick to one fish species, was estimated to be 130 g capelin/day and 215 g polar cod/day (Brekke & Gabrielsen 1994). Since capelin is a more energy-rich species than polar cod, kittiwakes should choose to eat capelins if they are able to find both species. However, the switch from a dominance of polar cod to capelin in kittiwakes' diet during the chick rearing period after 2007 did not improve adult body condition or breeding success. The most likely explanation is that capelins arrived too late in summer to have a significant effect on kittiwakes. There is also the possibility that the profitability does not differ much between the two fish species because capelins might be more difficult to capture than polar cod. However, more research is required in order to get a better understanding of catchability of capelin and polar cod and the time spend on prey source and the energy content of prey.

In most other studies of kittiwakes and other seabirds, one prey species has dominated (Galbraith 1983; Furness & Barrett 1985; Barrett & Furness 1990; Baird 1991; Krasnov & Barrett 1995; Mehlum 1997; Lewis et al. 2001; Carscadden et al. 2002; Jodice et al. 2006; Krasnov et al. 2007), and a change in diet has often affected the breeding success negatively (Carscadden et al. 2002; Barrett 2007). In the North Sea, kittiwakes feed predominately on the lesser sand eel (*Ammodytes marinus*) and only when these are unavailable they switch to alternative prey (Lewis et al. 2001). In Prince William Sound, Alaska, kittiwakes depend on herrings (Jodice et al. 2006), and in Newfoundland and Labrador, Canada, they depend on capelins (Carscadden et al. 2002). Similarly, in Norway, especially in the southern part of the Barents Sea (Mehlum 1997), capelins are the most important food source during the breeding season (Furness & Barrett 1985; Krasnov & Barrett 1995; Barrett & Krasnov 1996; Barrett 2007).

In 2008 and 2009, there was a change in the kittiwakes' diet from polar cod during the incubation period to capelin during chick-rearing. Two possible explanations have been used to explain seasonal variation in the diet of seabirds. Firstly, birds may respond to a change in available prey species by taking the easiest available prey at any time throughout the season. Secondly, breeding birds may choose prey species according to the nutrient requirements for chick growth (the selective prey choice hypothesis; Quillfeldt 2002). Le Corre et al. (2003) found a seasonal variation in the diet for the red-tailed tropicbird (*Phaethon rubricauda*) on Europa Island, Indian Ocean. The seasonal variation was a result of an appearance of dolphin-fish (*Coryphaenidae*) during the chick-rearing period. This appearance was explained by variation in sea surface temperatures in the Mozambique Channel and the change in migration patterns of dolphin-fish was explained by a change in the sea surface temperature. On the other hand, Quillfeldt (2002) explained the increase of fish in the diet of Wilson'storm-petrels on King George Island, South Shetland Islands, as a cause of selective choice of breeding birds. Similarly, Creet et al. (1994) found non-breeding and incubating Cape petrels (*Daption capense*) to have more crustaceans in the diet than chick-feeding birds.

In the present study, the switch from polar cods during incubation to capelins during the chick-rearing period was significant and rather outstanding. The energy demand during the chick-rearing period is greater than during the incubation period (Gabrielsen 2009), and thus the kittiwakes may increase their foraging area to include more profitable prey. Data from incubation has not been available from earlier years, but kittiwakes raised their chicks successfully on polar cod before the capelin became dominant in 2007. The lack of correspondence between the occurrence of capelin in the diet and adult body condition or breeding success does not support the selective prey choice hypothesis. The fact that there was a tendency between the occurrence of capelin in the diet and sea surface temperature in the time series indicate that the relative proportions of capelin and polar cod as food prey is the most important factor. In conclusion, the most likely explanation is that capelins are not present in Kongsfjorden until the chick rearing period. Capelins migrate from spawning areas outside the coast of Norway in spring to the oceanic Polar Front near the ice-edge in autumn (Gjøsæter 2009). Their occurrence in western Svalbard could match in time with the occurrence of capelins in kittiwakes' diet (H. Gjøsæter pers. comm.). However, to test which hypothesis diet choice by kittiwakes in Kongsfjorden support, diet material from non-breeding birds in the chick rearing period is needed.

Effects of diet

The breeding success was correlated with hatching date. This supports the hypothesis that factors affecting energy demand and prey availability, such as spring air temperature, rain, sea ice cover, winter condition and prey number, are especially important during the early phase of the breeding (Perrins 1970; Cairns 1987; Baird 1990; Moe et al. 2009). These environmental factors could chiefly affect the adult birds' body condition and in turn the time of egg laying. In the Canadian high Arctic, low sea ice cover and early sea ice break up, were positively related to early breeding of Brünnich’s guillemots (*Uria lomvia*) (Gaston et al. 2009). In Kongsfjorden, sea ice cover has been reduced since 2006 (Gabrielsen & Hop 2009). This may have decreased the abundance of preferred prey, such as polar cod, early in the season, since polar cods are associated with sea ice water on or below 0ºC (Gjøsæter 2009). Breeding birds may then be forced to extend their foraging range and thereby delay the time of egg laying (Moline et al. 2008). With rising temperatures however, alternative prey may also become available.

At their arrival to the breeding grounds in spring, seabirds have to adjust the timing of breeding to match the peak in food availability (Moe et al. 2009). In order to make an optimal choice, they have to rely on environmental cues (Frederiksen et al. 2004a). In the high Arctic where food availability is highly seasonal and reproduction is possible only during a short period, failure in the timing hatching may have great consequences (Moe et al. 2009). Hence, the relationship between hatching date and breeding success may not only reflect adult body condition prior to breeding, but also how well the period of the highest food demand of the offspring matched the period of the highest food availability.

The breeding success of kittiwakes did not correlate with the amount of fish in their diet. However, the two years with highest amount of fish were also peak years with regard to reproduction. There was also a decline in breeding success when fish were rare. During the breeding season, food supplies are assumed to be richer than at any other time of the year (Perrins 1970). The diet of seabirds is thought to reflect prey availability and affect the breeding success (Cairns 1987; Baird 1990; Lewis et al. 2001). However, my results may also have been influenced by direct effects of physical factors on the breeding success. In Sitkalidak Strait, Alaska, unfavourable weather, such as storms and freezing temperatures, during the hatching period had a negative effect on the breeding success of several seabirds (Baird 1990). Predation may enhance negative effects of weather and sea ice cover. Because of an increase in the foraging time adult seabirds will leave the eggs and chicks unprotected for longer periods (Jangaard 1974; Baird 1990).

The relationship between adult body condition and the frequency of fish in the diet during the chick-rearing period confirms that fish is the most important prey for kittiwakes in Kongsfjorden. The body condition change during the breeding season. The first part of the chick-rearing period is energetically most demanding (Moe et al. 2002). Body mass reduction in adult kittiwakes during breeding is explained by Moe et al. (2002) as a cost of reproduction. The parent birds need to maintain their own body condition in as well as feed their chicks (Gabrielsen 2009). To maintain body condition, available prey has to contain enough energy. The energy content of fish and crustaceans differs. Fish contain more energy because of the fat content (Gabrielsen 2009). Hence, it is possible to assume that a diet based on fish will give better reproduction success than a diet based on crustaceans.

Kittiwakes as an indicator species

The results from Kongsfjorden, presented in this thesis, indicate a change in the marine ecosystem. Although the breeding success was not affected by change in prey species composition, the pronounced change in the diet in 2007 indicates a change in Kongsfjorden ecosystem. Not only did the diet change in 2007 the capelin also dominated the diet of kittiwakes in 2008 and 2009. Seabirds all over the world are used as indicators of changes in the marine ecosystems (Cairns 1987; Lewis et al. 2001; Quillfeldt 2002; Le Corre et al. 2003; Frederiksen et al. 2004a; Frederiksen et al. 2004b; Frederiksen et al. 2005; Montevecchi 2007; Piatt et al. 2007). They are excellent contributors in regard to both biological (Piatt et al. 2007) and biophysical data (Montevecchi 2007). To obtain information on food supply a variety of parameters can be used at different levels of availability. Some of the parameters used are: adult survivorship, breeding success, chick growth and fledging weight, colony attendance and activity budget (Cairns 1987; Piatt et al. 2007; Wanless et al. 2007). These data indicates temporal availability of food supply in an area rather than absolute abundance of prey species. On the other hand, availability is assumed to be related to absolute prey abundance, because of the ease which seabirds can locate and capture prey (Cairns 1987). Kittiwakes in the UK feed on lesser sandlance (*Ammodytes matinus*) and have been used as sensitive and reliable indicators of the North Sea ecosystem. Breeding success was used as a parameter to reflect the availability of sandlance during the breeding period, when birds were associated with the colony (Wanless et al. 2007). Montevecchi (2007) used seabirds and prey interactions to exploit oceanographically changes in the North West Atlantic. Data from kittiwakes in this thesis has a rather short time series, but the results can contribute to discover and clarify changes in the marine ecosystem in Kongsfjorden. More samples from breeding birds, chicks and non breeding birds should be obtained in the years to come to provide further information on annual and seasonal variations in kittiwakes' diet in Kongsfjorden. Such studies may reveal effects of climate change, such as rising ocean temperatures and changing ocean currents.

CONCLUSION

This study builds on diet samples from kittiwakes in Kongsfjorden collected by the Norwegian Polar Institute (1997, 1998 and 2004-2009), and provides answers to questions raised about diet change and the effects on breeding success on kittiwakes in Kongsfjorden. Most important is the availability of fish species during the egg-laying period. Capelin did not improve the breeding success, sow the relative proportion of polar cod and capelin as food prey seem to be more important than the actual prey species. Although, the time series in this study is rather short, the data indicated a change in the ecosystem, further research is needed to get a better understanding of kittiwakes´ diet choice and the impact of prey composition on the breeding success. It would be interesting in the future to collect samples from non-breeding birds and thereby provide valuable additional knowledge about the diet choice. Kittiwakes are a species well suited as indicators of the status of the marine ecosystem. They are very useful as a study species because they are easy accessible from the ground and simple to handled, in addition to be good indicators for a changing ecosystem. I would suggest continuing the research on kittiwakes in Kongsfjorden in the future, because the data collected so far could be a good beginning of a long term data set. With a longer data series, more precise predictions and conclusions can be drawn and one can maybe predict the future for kittiwakes if the climate changes.

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1997

Dato	Kjønn	Polar cod	Other fish	Parathemisto	Krill	Polychaeta	snail (L.helicini)	Item mass
97.07.11	1,E-felt				11,88			11,88
97.07.12	4,E-FELT						2	
97.07.12	2 ,E-FELT	37,82						37,82
97.07.12	3,E-FELT	10,53			1,57			12,1
97.07.15	5,F-FELT				11,1			11,1
97.07.16	7,E-felt	41,35		0,5				41,85
97.07.16	6,F-FELT	2,06		1,02	5,35	0,88		9,31
97.07.17	E14,HANN				17,39			17,39
97.07.17	E25 HANN	92,5	2,5					95
97.07.18	E14,HANN	24,24						24,24
97.07.19	A38	12,07						12,07
97.07.19	A19	11,5						11,5
97.07.22	A46	15,86						15,86
97.07.24	B72,HUNN						8	8
97.07.25	E29 HANN	17,12						17,12
97.07.25	E33 HANN	20,11						20,11
97.07.25	E5,HUNN	52,87						52,87
97.07.26	E6,HANN	25,86						25,86
97.07.26	F5,HANN						5,5	5,5
97.07.30	E20, HANN	12,26						12,26
97.07.30	E26,HANN	25,13						25,13
97.08.05	A-FELT	10,345			2,4			12,745
97.08.07	A-FELT	19,14						19,14
97.08.08	A-FELT	27,98						27,98
97.08.08	A22					20,54		20,54
97.08.09	E2,HUNN			15,97				15,97
97.08.10	E33 HANN	43,37						43,37
97.08.11	E32,HUNN	31,05						31,05

1998

Dato	Ringnr	Reir	Kjønn	polar cod	other fish	Parathemisto	Krill	Polychaeta	snail (L.helicini)	Total item
1998		E18	female				38,7777			38,7777
1998	6176956	E35	male	5,3676						5,3676
1998	959						31,6233			31,6233
1998		e22	male	49,1164						49,1164
1998	6176853	E08	male	22,741						22,741
1998	6176947	E21	female	8,9439			38,7569	11,9252		59,626
1998	6176943	E29	male	11,7873						11,7873
1998	unge	E20	unge				27,0113			27,0113
1998	unge	E21		14			1,1603			15,1603
1998	unge	E12		62,98						62,98
1998		e14	male	38,7661						38,7661

2004

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth 1	Comment
1	2004	KB52		7,77	polar cod	7,77	1	4,8/4,8	2,3/2,3	
2	2004	SQ40		12,10	Thyssanoessa	12,10	c.80			Thyssanoessa inermis
3	2004	KB49		24,11	polar cod	24,11	1?	4,3	2	
4	2004	KB32		12,95	polar cod	12,95	1			no otoliths
5	2004	KB35		5,42	polar cod	4,17	1			no otoliths
					Thyssanoessa	1,25	c.10			Thyssanoessa inermis
6	2004	SQ4		9,26	polar cod	8,99				no otoliths
					Nereis	0,27				
7	31-07-2004	CSK05	BJP	3,68	polar cod?	3,68				only soup, no otoliths
8	2004	?		6,27	polar cod	6,27	1	4,5/4,5	2,3/2,3	
9	2004	CHKB01		17,41	Themisto	17,41	many			Themisto libellula
10	2004	KB73		20,24	polar cod	20,24	2-3	5,1/5,1	2,2/2,3	
11	2004	KB40		10,40	polar cod	9,60	1	4,5	2,2	
					Nereis	0,80	1-2			
12	2004	KB60		23,58	polar cod	23,58	?	4,4/4,5	1,9/2,0	
13	2004	KB08		15,95	polar cod	15,95	?			no otoliths
14	2004	KB33		18,92	Thyssanoessa	2,05	many			Thyssanoessa inermis
					Langebarn	4,96	1	3,1/3,0	1,9/2,0	Tverrhalet Langebarn
					polar cod	11,91	3	4,3/4,2	2,0/1,9	
								3,8/3,7	1,8/1,8	
									2,3	only one broken otolith
15	2004	CHKB02		18,43	polar cod	9,22	?	3,5	1,3	item mass estimated (50%)
								3,0/2,9	1,1/1,0	
					Lysprikkfisk	9,21	?	2,1/2,1	1,7/1,8	item mass estimated (50%)
16	2004	KB48		18,64	polar cod	14,33	2	4,5/4,5	2,1/2,1	
								4,1/4,2	1,9/1,8	
					Nereis	4,31	7-8			
17	2004	KB59		18,43	polar cod	18,43	2	5,6/5,7	2,4/2,4	
								4,4/4,5	2,2/2,2	
18	2004	CHKB09		5,94	polar cod	5,94	1	6,1/6,1	2,6/2,5	
19	2004	KB41		11,09	polar cod	11,09				no otoliths
20	2004	RKB25		7,98	Nereis	7,98	6-8?			

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth 1	Comment
21	2004	KB31		20,94	polar cod	20,94	c.2			no otoliths
22	2004	KB23		3,66	polar cod	3,29	1			no otoliths
					Nereis	0,37	1			
23	2004	E14	BCD	16,46	polar cod	16,46	c.2	4,5/4,4	2,2/2,1	
								3,9	1,8	
24	2004	KB03		8,08	unident.fish	8,08				impossible to identify
25	2004	KB11		7,44	polar cod	7,44	1	4,1/4,0	1,8/1,8	
26	2004	KB13		27,12	polar cod	27,12	2	8,2/8,2	3,2/3,0	
27	2004	KB09		17,94	polar cod	16,27	1-2			no otoliths
					Nereis	1,54	?			
					Themisto	0,13	?			
28	2004	KB55		33,88	polar cod	33,88	6	4,6/4,5	2,2/2,1	
								4,1/4,0	1,9/2,0	
								4,1/4,0	1,9/1,9	
								3,9	1,9	
29	2004	EA01		9,04	polar cod	9,04	1			no otoliths
30	2004	?		16,04	Nereis	15,09	?			
					Thyssanoessa	0,95	?			
31	2004	KB06		6,06	polar cod	6,06	1	4,2	1,9	
32	2004	KB77		22,23	polar cod	22,23	2-3	4,3/4,3	2,1/2,1	
33	2004	KB07		23,47	polar cod	23,47	3	4,6/4,5	2,2/2,1	
								4,4/4,6	2,1/2,1	
								4,9	2,1	
34	2004	KB17		5,34	polar cod	5,34	1-2	5,3	2,2	
35	2004	CHKB04		9,84	Lysprikkfisk	7,76	1-2			no otoliths
					Themisto	1,37	c.15			Themisto libellula
					Pandalus	0,71	2-3			Pandalus borealis
36	2004	?		9,45	Lysprikkfisk	9,45	?	1,7	2,2	
37	2004	CHKB21		12,55	polar cod	12,55	3	4,4/4,5	2,0/2,1	
								4,2	2,1	
								4,7	2,1	
								4,3	2,1	

2005

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
1	26-07 2005	KF18	m	36,19	polar cod	36,19	2	6,7/6,8	2,8/2,8	otoliths of one fish
2	25-07 2005	BG48	m	19,39	polar cod	19,39	1	7,1/7,2	2,8/2,9	
3	26-07-2005	B10	m	32,00	polar cod	32,00	2	6,6/6,7	2,5/2,5	
								3,9/4,0	1,9/1,9	
4	18-07-2005	B2	f	7,37	polar cod	7,37	1			no otoliths
5	25-07-2005	BG44	m	53,33	polar cod	53,33	4	7,5/7,6	2,8/2,8	
								4,7/4,8	2,2/2,2	
								4,4/4,2	1,9/1,7	
								3,9/4,0	1,9/2,0	
6	18-07-2005	A5	m	17,54	polar cod	17,54	1	6,5/6,5	2,5/2,6	
7	25-07-2005	BG44	m	22,11	polar cod	22,11	1-2			no otoliths
8	25-07-2005	BG54	m	20,37	polar cod	20,37	4	4,6/4,7	2,1/2,2	
								4,5/4,6	2,1/2,0	
								3,9/3,9	1,9/2,0	
								5,6	2,5	
9	18-07-2005	A9	m	30,70	polar cod	30,70	?	6,5	2,4	only one otolith
10	18-07-2005	B4	f	47,97	polar cod	47,97	3	6,2/6,3	2,9/3,0	
								5,9/6,1	2,7/2,7	
								4,6	2,1	
11	25-07-2005	BG55	f	50,73	polar cod	50,73	2-4	6,2/6,2	2,9/2,8	
								4,2/4,2	2,0/2,0	
12	12-07-2005	B4	m	25,33	polar cod	25,33	?			no otoliths
13	25-07-2005	BG19	m	44,73	polar cod	44,32	3	5,8/5,8	2,7/2,7	
								5,9/6,0	2,4/2,5	
								3,6/3,5	1,5/1,4	
14	25-07-2005	BG24	m	26,98	polar cod	26,98	2-3	6,1/6,2	2,8/2,8	
15	25-07-2005	BG45	f	87,32	Lysprikkfisk	87,32	many	2,2/2,2	1,6/1,6	Glacier lanternfish (Benthosema glaciale)
								2,0/2,1	1,6/1,6	
16	13-07-2005	B15	f	16,06	polar cod	16,06	1	4,6/4,6	2,2/2,2	
17	13-07-2005	A26	m	3,74	polar cod	3,74	1			no otoliths

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
18	25-07-2005	BG19	m	27,83	polar cod	27,83	6-7	5,4/5,3	2,2/2,3	
								4,0/4,1	2,0/2,1	
								4,5/4,5	2,1/2,1	
								5,1	2,2	
								4,2	2	
								4,6	2,1	
									2,8	broken otolith
19	12-07-2005	B19	f	17,78	polar cod	17,78	1	6,3/6,2	2,5/2,5	
20	12-07-2005	A20	f	6,56	polar cod	6,56	1			no otoliths
21	12-07-2005	B5	f	8,53	polar cod	8,53	1			no otoliths
22	12-07-2005	B12	f	8,62	polar cod	8,62	1			no otoliths
23	25-07-2005	BG35 A	ch	6,69	polar cod?	6,69	?			no otoliths
24	08-07-2005	A11	m	14,84	capelin	14,84	4	2,3	1,7	only one otolith
25	12-07-2005	B2		14,22	polar cod	14,22	3-5	7	2,7	
								6,2	2,6	
								7,1	2,8	
26	12-07-2005	B20	m	17,63	polar cod	12,88	1	6,5	2,7	
					Thyssanoe ssa	4,75				Th. inermis
27	12-07-2005	A14	f	16,36	polar cod	16,36	2?			no otoliths
28	29-07-2005	D19	f	35,71	polar cod	35,71	2-3	8,3/8,5	3,0/3,2	
								4,6/4,6	2,2/2,2	
29	09-07-2005	B3	m	13,56	polar cod	13,56	2	6,1	2,5	
								6,3	2,6	
30	09-07-2005	B1	f	4,42	polar cod	4,42	?			no otoliths
31	09-07-2005	B4	f	0,88	polar cod?	0,88	?			pieces of broken otoliths
32	09-07-2005	B9	f	10,24	polar cod	10,24	1-2			no otoliths
33	09-07-2005	B6	m	6,10	polar cod	6,10	?			no otoliths
34	09-07-2005	A8	m	18,06	polar cod	18,06	1-2	5,6/5,6	2,6/2,6	
35	10-07-2005	A5	m	12,99	polar cod	12,99	3?	4,8/4,9	2,1/2,1	
36	10-07-2005	A7	m	7,23	polar cod	7,23	1-2	4,7/4,6	2,0/2,1	
37	10-07-2005	B1	m	6,49	polar cod	6,49	1			no otoliths
38	10-07-2005	A6	m	9,29	polar cod	9,29	?			no otoliths
39	10-07-2005	B11	f	14,91	polar cod	14,91	2?	4,7/4,6	2,1/2,1	
40	30-07-2005	A	?	10,80	polar cod	10,80	2			no otoliths

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
41	24-07-2005	B20	m	18,79	polar cod	18,79	2-3			no otoliths
42	15-07-2005	A12	f	10,32	polar cod	10,32	1			no otoliths
43	26-07-2005	KF20	m	17,44	polar cod	3,25	3	6,1/5,5	2,5/2,5	item mass estimated (20% of fish)
								3,6	1,6	
									3,6	broken otolith
					Lysprikkfisk	12,99	3?			no otoliths, item mass estimated (80% of fish)
					Pandalus	1,20				Pandalus borealis
44	27-07-2005	B10	ch	2,52	polar cod	2,52	?			no otoliths
45	23-07-2005	BG37	f	35,05	polar cod	14,96	2	4,1/4,1	2,0/2,0	
								4,7/4,8	2,1/2,1	
					Nereis	4,92	6			
					Lysprikkfisk	14,67	1	1,7/1,7	1,4/1,3	
					Pandalus	0,50	1			Pandalus borealis
46	23-07-2005	BG43	m	21,97	polar cod	21,97	2	6,4/6,4	2,8/2,8	
								4,6/4,5	2,1/2,1	
47	23-07-2005	BG36	?	35,85	Lysprikkfisk	35,85	4?			no otoliths
48	23-07-2005	BG44	m	5,77	polar cod	5,77	2	4,2/4,1	1,9/1,9	
								3,2/3,1	1,7/1,6	
49	31-07-2005	D9	m	23,09	polar cod	23,09	2	7,2/7,3	2,7/2,8	plus one broken otolith
50	23-07-2005	BG44	m	4,10	Lysprikkfisk	4,10	1			no otoliths
51	24-07-2005	B8	ch	0,50	polar cod	0,50	1			no otoliths
52	18-07-2005	B5	f	6,88	Lysprikkfisk	6,88	2			no otoliths
53	18-07-2005	A9	f	16,66	polar cod	16,66	1-2	4,7/4,8	2,1/2,1	
54	18-07-2005	B6	f	12,11	polar cod	12,11	1			no otoliths
55	18-07-2005	A16	f	9,79	polar cod	9,79	?			soup, no otoliths
56	21-07-2005	KF6	?	10,58	polar cod	10,58	1-2	4,2	2	
57	21-07-2005	KF8	f	16,05	polar cod	8,03	1	6,4	2,9	item mass estimated (50%)
					Lysprikkfisk	8,02	1	2,2/2,3	2,5/2,6	item mass estimated (50%)
58	21-07-2005	KF8	ch	15,44	polar cod	12,45	1-2			no otoliths
					Langebarn	2,99	1	2,8/2,8	1,8/1,8	Tverrhalet Langebarn
59	27-07-2005	BG44	f	44,08	polar cod	44,08	4	5,9/6,0	2,5/2,5	
								5,6/5,6	2,5/2,4	
								4,9/5,0	2,4/2,3	
								8,6	3,5	

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
60	20-07-2005	A17	ch	7,40	polar cod?	7,40				mostly fishbones, no otoliths
61	20-07-2005	B6	?	6,17	polar cod	6,17	1?	3,9/3,8	1,8/1,8	
62	19-07-2005	A14	f	22,24	polar cod	21,49	2-3	4,4/4,4	2,1/2,0	
								4,1/4,1	2,0/2,0	
					Thyssanoe ssa	0,75				Th. inermis
63	19-07-2005	A16	f	8,77	polar cod	8,77	1			no otoliths
64	19-07-2005	A17	m	3,73	polar cod	1,87	?			no otoliths, item mass estimated (50%)
					Nereis	1,86				item mass estimated (50%)
65	19-07-2005	A19	m	22,65	polar cod	22,65	1-2	6,1	2,6	
66	18-07-2005	B1	f	22,36	polar cod	22,36	3-4	6,0/5,9	3,2/3,2	
								2,6/2,6	1,6/1,6	
67	29-07-2005	UB7	m	60,44	polar cod	60,44	3	7,5/7,6	3,0/3,0	two whole fishes + one otolith
								4,5/4,4	2,1/2,2	
								6,3	2,6	
68	22-07-2005	B3	m	11,88	polar cod	11,88	1	6,8/7,0	2,5/2,7	
69	22-07-2005	B18	f	20,09	polar cod	20,09	1-2	6,4/6,4	2,8/2,7	
70	22-07-2005	KF18	m	26,91	polar cod	26,91	?			no otoliths
71	27-07-2005	D2	m	3,85	polar cod	3,85	1			no otoliths
72	28-07-2005	D2	f	15,12	polar cod	14,36	3	3,9/3,8	1,9/1,9	
								4,9	2,3	
					Thyssanoe ssa	0,76	ca.7			Th. inermis
73	28-07-2005	DLW3		28,48	polar cod	28,48	3	6,7/6,7	2,5/2,6	only one head but three fish
74	28-07-2005	DLW2		37,13	polar cod	37,13	1	8,5/8,4	3,0/3,1	one perfect fish, length: 18,0 cm
75	28-07-2005	DLW4		50,83	polar cod	28,33	1	6,6/6,6	2,7/2,7	one almost perfeect fish, length c.15 cm
					Pandalus	0,45	2			Pandalus borealis
					mystery fish	22,05	c.3	3,8/3,7	1,7/1,8	
76	28-07-2005	DLW1		35,41	polar cod	35,21	2	7,2/7,4	3,3/3,3	
					Thyssanoe ssa	0,20	1			
77	02-08-2005	B2	f	29,64	polar cod	29,64	1-2	6,6/6,4	2,7/2,8	
78	02-08-2005	?	?	25,07	polar cod	25,07	4	4,3/4,2	2,0/2,0	
								3,8/3,8	1,9/2,0	

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
								4,4/4,4	2,0/2,0	
								5,2	2,1	
79	29-07-2005	D22	?	25,03	polar cod	25,03	3	4,8/4,7	2,1/2,1	
80	29-07-2005	D37	m?	9,07	polar cod	9,07	1			no otoliths
81	29-07-2005	D2	m?	22,12	polar cod	19,13	2-3	6,1/6,0	2,5/2,5	
								3,6/3,5	1,7/1,7	
					Thyssanoe ssa	2,99	c.35			Th. inermis
82	29-07-2005	D18	m?	35,43	polar cod	35,43	3	5,2/5,3	2,1/2,3	
								4,8/4,7	2,0/2,0	
83	29-07-2005	D21	m?	56,09	polar cod	56,09	7	6,8/6,8	2,8/2,7	
								4,8/4,8	2,1/2,0	
								4,9/5,0	2,3/2,3	
								4,8/4,7	2,1/2,1	
								4,4/4,6	2,1/2,0	
								4,8	2	
									2,7	only one broken otolith
84	01-08-2005	D47	m	46,84	polar cod	46,84	2	6,6/6,5	2,5/2,5	
								6,9/6,9	2,7/2,6	
85	01-08-2005	B8	m	46,30	polar cod	46,30	3	6,7/6,9	2,9/2,7	
								6,7/6,8	2,6/2,7	
								6,8/6,8	2,6/2,8	
86	01-08-2005	B7	m	22,14	polar cod	22,14	1-2	6,3	2,6	
87	01-08-2005	D	?	33,60	polar cod	33,60	1	7,3/7,3	2,6/2,7	One complete Polar cod (guillemot prey?)
88	01-08-2005	A14	m	12,72	polar cod	12,72	1	6,3/6,3	2,7/2,6	
89	01-08-2005	KF12	m	12,95	polar cod	12,95	2?	4,8	2,4	
								5,9	2,6	
90	01-08-2005	A5	f	42,70	polar cod	42,70	2	7,1/7,1	2,7/2,7	
								4,2	1,9	
91	31-07-2005	D28	m	9,39	mystery fish	9,39	?			no otoliths
92	01-08-2005	D44	m	59,13	polar cod	59,13	3	6,5/6,2	2,6/2,6	
								7,4/7,4	2,6/2,7	
93	03-08-2005	BG45	m	45,39	polar cod	45,39	2-3	7,5/7,5	3,073,0	
94	03-08-2005	KF8	m	11,26	polar cod	11,26	1			no otoliths

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
95	09-08-2005	B1	ch	8,39	polar cod	8,39	2	6,8/6,9	2,9/2,8	2 heads
96	12-08-2005	D44	m	20,45	polar cod	20,45	2	7,1/6,9	2,5/2,5	
								3,4	1,7	
97	?	?	?	22,56	polar cod	22,56	1	7,2/7,4	2,6/2,6	
98	12-08-2005	D	?	27,04	polar cod	27,04	1	5,4/6,1	2,5/2,4	from the same head!
99	?	E17	f	20,40	polar cod	20,40	3	7,2/7,4	2,6/2,7	
								7,8	2,8	
100	03-07-2005	E		41,32	capelin	20,32	1	2,4/2,4	1,8/1,8	sample taken from the fjord, length 15 cm
					capelin	21,67	1	2,4/2,4	1,8/1,8	length 15,5 cm
101	12-08-2005	D		16,21	polar cod	16,21	2	4,6	2,1	
102	12-08-2005	D		37,20	polar cod	37,20	3	4,5/4,6	2,2/2,1	
								5,8/5,7	2,7/2,6	
								5,9	2,7	
103	05-08-2005	D22	TDL 5	51,88	polar cod	51,88	3	6,0/5,9	2,2/2,2	
								6,7/6,4	2,7/2,9	
104	30-07-2005	D22	m	76,60	polar cod	76,60	c.3	4,6/4,8	2,2/2,1	
								6,6/6,5	2,9/2,8	
								6,4/6,5	2,7/2,8	
105	03-08-2005	E25	RAW 28	7,80	polar cod	3,90	?	6,4	2,6	item mass estimated (50%)
					Sagitta	3,90	many			Sagitta elegans, item mass estimated (50%)
106	31-07-2005	D2	m	36,23	polar cod	36,23	2	6,4/6,5	2,4/2,4	
107	01-08-2005	E34	AW3 1	14,57	polar cod	14,57	1-2			no otoliths
108	27-07-2005	E	AW2 4	68,41	polar cod	68,41	4	6,5/6,3	2,7/2,6	
								5,3/5,3	2,2/2,3	
								6,4/6,5	2,5/2,6	
								5,8	2,4	
109	09-09-2005			21,33	polar cod	9,38	1	4,8/4,7	2,1/2,0	Trawl-sample out of Kongsfjorden, length: 11,7 cm
						11,95	1	4,5/4,4	2,2/2,2	Trawl-sample out of Kongsfjorden, length: 11,8 cm

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
110	27-07-2005	E	AW25	8,22	polar cod	8,22	1	5,4/5,5	2,4/2,4	
111	30-07-2005	D8	m	11,54	polar cod	11,54	1			no otoliths
112	05-08-2005	E19	AW37	29,04	polar cod	29,04	2	6,8/6,8	3,0/3,1	
113	25,7,5	E	RAW 8	30,80	polar cod	30,80	2-3	5,4	2,3	only one otolith from each fish
								5,6	2,4	
114	30-07-2005	E28	RAW 22	35,50	polar cod	35,50	3	6,9/6,8	2,5/2,5	
								4,8/4,7	1,9/1,9	
								4,7/4,9	2,1/2,1	
115	26-07-2005	E	RAW 12	32,36	polar cod	32,36	3	5,9/5,9	2,5/2,4	
								4,1/4,0	1,7/1,8	
								3,0/3,0	1,5/1,4	
116	26-07-2005	E	RAW 14	39,67	polar cod	39,67	1	7,5/7,9	2,9/2,9	
117	22-07-2005	E	AW2	10,60	polar cod	10,60	1			no otoliths
118	24-07-2005	E	RAW 5	31,06	polar cod	31,06	3	6,5/6,4	2,7/2,7	
								4,2/4,3	2,0/2,0	
119	30-07-2005	D31	m?	7,24	polar cod	7,24	1	4,5	2,1	
120	27-07-2005	E	AW22	36,48	polar cod	36,48	3?	7,1/7,3	2,7/2,7	
121	25-07-2005	E	RAW 7	17,34	capelin	13,87	1?	2,5/2,5	1,8/1,6	item mass estimated (80%)
					Nereis	3,47	?			item mass estimated (20%)
122	24-07-2005	E	RAW 4	7,92	Limnica	5,31	?			Limnica helicina
					Nereis	2,61	?			
123	07-08-2005	E	RAW 32m	32,85	polar cod	32,85	2-3	6,8/6,9	2,8/2,9	
								4,5/4,4	1,9/1,9	
124	29-06-2005			5,98	Calanus spp.					Sample taken from Kongsfjorden
125	29-06-2005			1,80	Thyssanoessa					sample taken from Kongsfjorden, Th. inermis

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
126	29-06-2005			0,69	Calanus glacialis					Sample taken from Kongsfjorden
127	06-08-2005	D21	m	40,98	polar cod	40,98	2	6,7/6,8	2,9/2,9	
128	07-08-2005	KF17	f	2,14	polar cod	2,14	1	7,1/7,2	2,8/2,8	mostly fishbones
129	13-08-2005	D		14,57	polar cod	14,57	1			no otoliths
130	04-08-2005	B12	f	17,73	polar cod	17,73	2			no otoliths
131	04-08-2005	KF8	m	0,75	polar cod	0,75	1			tiny sample
132	05-08-2005	D29	m	41,84	polar cod	41,84	2-3	6,8/6,8	2,6/2,6	
133	13-08-2005	D		24,06	Nereis	24,06	?			
134	12-08-2005	D		19,21	Thyssanoe ssa	13,88	many			
					capelin	5,15	1	2,6/2,6	1,8/1,8	
					Themisto	0,18	2			Themisto libellula
135	08-08-2005	D29	m	33,60	polar cod	26,30	2	4,5/4,4	2,1/2,1	
					Themisto	6,52	many			Themisto libellula
					Nereis	0,78	1			
136	11-08-2005	BG63	chB	9,16	polar cod	9,16	2	6,8/6,9	2,8/2,6	
								4	2	
137	12-08-2005	D		33,96	polar cod	33,96	?	5,7/5,8	2,3/2,5	
138	12-08-2005	D		18,55	polar cod	18,55	3	6,9/6,8	2,8/2,6	
								5,0/5,1	2,0/2,1	
								4,8	2,1	
139	13-08-2005	D		35,90	polar cod	35,90	2	6,1/6,1	2,4/2,5	
								5,1	2,4	
140	30-06-2005			2,34	Limnica					Sample taken from Kongsfjorden, Limnica helicina
141	29-06-2005			1,20	Pandalus					Sample taken from Kongsfjorden, Pandalus borealis
142	07-08-2005	D43	f	56,66	polar cod	56,66	2	6,8/6,7	2,7/2,5	nice, whole fish
								7,6		
143	08-08-2005	KF17	f	4,70	Sagitta	4,70	many			sagitta elegans
144	13-08-2005	D		13,26	polar cod	13,26	1	4,6/4,7	2,1/2,1	
145	09-08-2005	D49	f	8,34	Sagitta	8,34	many			Sagitta elegans
183	27-07-2005	RAW 17		19,85	polar cod	9,75	2-3	4,5/4,7	2,0/2,1	item mass estimated (50% of fish)
								4,6	2,2	

Sample	Date	Nest	Bird	Total mass	Item	Item mass	Item no.	O. length 1	O. breadth1	Comment
					Lysprikkfisk	9,75	2-3	1,9/1,9	2,9/2,8	item mass estimated (50% of fish)
								1,5	2	
					Pandalus	0,35	2-3			Pandalus borealis

2006

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
1	08.07. 2006	E3	chick 1	1,95	Nereis	0,34					
1					Polar Cod	1,61					no otoliths
2	09.07. 2006	BG19	ad	16,70	Polar Cod	11,70	5,0	4,9	2,4	2,4	2 ind. Both with otoliths (mixed up?)
2							4,5	2,2			
2					unident. Fish	5,00					Laternfish, capelin or herring?
3	10.07. 2006	C11	ad	2,04	Themisto libellula	0,10					
3					Polar Cod	1,94					no otoliths
4	10.07. 2006	C1	chick	3,32	unident. Crustacea n	1,24					
4					Glacier Laternfish	2,08	1,6	1,1			one otolith
5	10.07. 2006	A6	ad	9,50	Polar Cod	9,50	6,3	2,6	6,2	2,6	2 ind.
5							4,2	1,9		1,9	one otolith broken
6	11.07. 2006	BG41	chick 1	0,84	Polar Cod	0,84					
7	12.07. 2006	C5	chick 1	0,90	Themisto abyssoru m	0,90					
8	12.07. 2006	C15	chick	3,22	Polar Cod	3,22					no otoliths
9	12.07. 2006	E3	chick 1	9,87	Polar Cod?	9,87					no otoliths

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
10	12.07. 2006	E12	ad	3,54	Themisto abyssorum	3,54					
11	12.07. 2006	E17	chick 1	1,30	Thyssanoessa inermis	1,30					
12	12.07. 2006	E25	chick 1	2,60	Themisto libellula	0,60					
14	13.07. 2006	BG59	chick 1	4,73	Polar Cod	4,73	3,3	1,5	3,3	1,5	one ind., 2 otoliths
15	15.07. 2006	BG34	chick 1	0,44	"mystery fish"	0,44	3,6	1,8			one otolith from the same "mystery fish" as last year
16	15.07. 2006	BG38	chick 2	6,13	Thyssanoessa longicauda	6,13					
17	15.07. 2006	BG43	chick 1	12,50	unident. Fish	6,25					glacier laternfish?
17					Polar Cod	6,25					
18	15.07. 2006			5,02	unident. Fish	5,02					Glacier lanternfish, capelin or herring?
19	16.07. 2006	A1	chick	2,23	Nereis	0,23					
19					Polar Cod?	2,00					no otoliths
20	17.07. 2006	BG49	chick 2	13,09	Polar Cod	6,55	2,3	1,0		1,0	very juicy, one otolith broken
20					Nereis	6,54					
21	18.07. 2006	A12	chick 1	8,16	Polar Cod	8,16	2,9	1,3	2,9	1,3	2 otoliths from one ind. + one broken
21								1,5			
22	18.07. 2006	A7	chick	10,84	Polar Cod	10,84					no otoliths
23	18.07. 2006	B2	chick 1	17,30	Polar Cod	17,30					no otoliths

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
24	18.07. 2006	E3	chick 1	0,81	Polar Cod?	0,81					no otoliths
25	18.07. 2006	E12	chick	12,51	Polar Cod	12,51					no otoliths
26	19.07. 2006	B4	chick	9,62	Polar Cod	9,62					no otoliths
27	19.07. 2006	BG58	chick 2	7,67	unident. Crustacea n	0,70					
28	20.07. 2006	B10	chick	2,25	Polar Cod	2,25					no otoliths
29	21.07. 2006	A6	chick	7,87	Polar Cod	7,87					one large ind., no otoliths
30	21.07. 2006	BG45	chick 1	22,15	Polar Cod	15,81	6,4	2,6	6,4	2,6	2 otoliths from one ind.
30					Nereis	1,20					
30					Themisto libellula	5,14					
31	21.07. 2006	BG45	chick 2	5,40	Themisto libellula	0,71					
31							6,6	2,5			
31					Polar Cod	4,69	6,7	2,9			otoliths from 3 individuals, otoliths mixed up
32	21.07. 2006	BG63	chick 1	7,23	Polar Cod	7,23	2,9	1,3	2,9	1,3	one ind., 2 otoliths
33	22.07. 2006			2,82	Polar Cod	2,82					only parts of a head of one large ind. (no otoloiths)
34	23.07. 2006	BG24	chick 1	16,23	Polar Cod	11,36	4,2	2,0			one large ind., one otolith - probably mixed up
34					unident. Fish	4,87					glacier laternfish?
35	23.07. 2006	BG74	chick 1	9,29	Nereis	3,95					
35					Polar Cod	5,34					one ind.,no otoliths

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
37	24.07.2006	BG17	chick 2	11,60	Thyssanoessa inermis	11,10					
37					Themisto libellula	0,50					
38	24.07.2006	BG44	chick 1	7,40	Nereis	0,38					
38					Polar Cod	7,02					
39	25.07.2006	BG16	chick 1	24,62	Thyssanoessa inermis	24,19					
39					Polar Cod	0,43					
40	25.07.2006	BG39	chick 1	23,38	Polar Cod	22,85					
40					Nereis	0,53					
41	25.07.2006	BG72	chick 1	8,05	Polar Cod	8,05	3,8	1,8	3,7	1,9	2 otoliths from one ind.
42	25.07.2006	BG74	chick 1	14,35	Nereis	1,39					
42					Polar Cod	8,44					no otoliths
42					Thyssanoessa inermis	4,52					
43	26.07.2006	BG25	chick 1	12,95	unident. Fish	12,95	6,2	2,7			8 p. cod otoliths although the fish itself is most likely Glacier Laternfish; otoliths mixed up, not necessarily the original otoliths
43							3,5	1,8			
43							5,3	2,4			
43							4,4	2,1			
43							4,3	2,1			
43							4,2	2,0			
43							3,3	1,5			

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
44	26.07. 2006	BG57	chick 1	3,40	Themisto abyssorum	3,40					
45	27.07. 2006	BG34	chick 1	7,24	Polar Cod?	7,24					very juicy, no otoliths
46	28.07. 2006	BG60	ad	16,76	Polar Cod	16,76	4,9	2,3	4,9	2,2	2 large ind.
46							3,8	2,0	3,9	2,0	
47	28.07. 2006	BG72	ad	20,47	Thyssanoessa inermis	20,47					
48	28.07. 2006	A16	chick	23,15	Polar Cod	20,90	8,1	3,0			one otolith
48					Themisto abyssorum	1,21					
48					unident. Crustacean	1,04					
49	29.07. 2006	BG17	chick 2	2,10	Polar Cod	2,10	4,7	2,1			one otolith
50	29.07. 2006	BG32	ad	22,32	Polar Cod	22,02	4,4	2,2	4,3	2,2	min. 2 ind. (one big one without otoloiths)
50							3,2		1,4		mixed up otolith
50					unident. Crustacean	0,30					
51	29.07. 2006	BG72	ad	41,70	Polar Cod	41,70	8,6	2,7			min. 2 large ind.
51							6,3	2,6	6,3	2,6	
52	29.07. 2006	BG71	ad	19,90	Nereis	2,73					
52							3,4	1,6	3,4	1,7	
52					Polar Cod	17,17	3,5	1,8	3,5	1,6	2-3 small indi.

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
53	29.07. 2006	BG51	ad	26,50	unident. Crustacean	0,60					
53							3,9	1,8	3,9	1,8	
53							3,2	1,4			
53					common cod	19,42	3,3	1,6	3,2	1,4	4 small individuals, 3 common cod, one haddock, split mass 75/25
53					haddock	6,48	3,5	1,3	3,5	1,3	
54	31.07. 2006	BG16	chick 1	2,24	Thyssanoessa inermis	2,24					
55	02.08. 2006	BG30	ad	8,35	Polar Cod	8,35	4,9	2,4	4,9	2,2	both otoliths from one ind.
J1	06.08. 2006	UB21	R	0,73	Themisto abyssorum	0,37					
J1					Polar Cod?	0,36					very digested
J2	06.08. 2006	UB47	B	15,95	Themisto libellula	15,95					
J3	05.08. 2006	UB42	B	4,56	Polar Cod	4,56		2,0		2,1	two otolith fragments
J4	06.08. 2006	UB47	R	14,21	Capelin	0,75	1,8	1,3	1,8	1,4	2 otoliths from one ind.
J4					Nereis	13,46					
J5	07.08. 2006	UN42	R	14,70	Nereis	1,18					
J5					Polar Cod	13,52					no otoliths
J6	05.08. 2006	UB46	R	27,18	Nereis	2,76					
J6							5,3	2,5			
J6					Polar Cod	24,42	7,1	2,8	7,0	2,6	two large ind., 2+1 otoliths
J7	29.07. 2006	UB3	B	13,48	unident. Crustacean	1,22					

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
J7					"mystery fish"	12,26	3,6	1,7	3,7	1,8	two otoliths from one ind., two ind. in sample
J8	29.07. 2006	UB31	B	5,90	Thyssano essa inermis	0,25					
J8					Thyssano essa longicaud a	0,25					
J8					Nereis	5,40					
J9	29.07. 2006	UB41	R	12,78	cooked shrimp	2,40					Pandalus borealis, from trawler
J9					Polar Cod	10,38					no otoliths
J10	29.07. 2006	UB21	B	14,55	Thyssano essa inermis	14,55					
J11	30.07. 2006	UB3	R	0,81	Nereis	0,81					
J12	29.07. 2006	UB26	B	6,02	cooked shrimp	3,39					Pandalus borealis, from trawler
J12					Polar Cod	2,63					no otoliths
J13	29.07. 2006	UB50	R	8,22	cooked shrimp	3,15					Pandalus borealis, from trawler
J13					Polar Cod	5,07					no otoliths
J14	29.07. 2006	UB24	R	35,43	Nereis	35,43					
J15	30.07. 2006	UB41	R	17,70	Limnica	17,70					Limnica helicina?
J16	17.07. 2006	UB45	M	3,81	unident. Crustacea n	1,23					
J16					common cod	0,52	6,4	2,3			
J16					Glacier Laternfish	1,55	1,8	1,4	1,9	1,5	
J16					Polar Cod	0,51	4,7	2,1			

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
J17	15.07.2006	UB24	F	3,45	Nereis	3,45					
J18	17.07.2006	UB14	M	8,45	Nereis	0,35					
J18					Polar Cod	8,10	5,5	2,4			only one otolith
J19	16.07.2006	RB4	?	14,97	Polar Cod	3,52	4,2	1,9	4,3	2,0	0ne nind., 2 otoliths
J19					Themisto abyssorum	5,72					
J19					Themisto libellula	5,73					
J20	17.07.2006	UB34	?	9,09	Glacier Laternfish	9,09					no otoliths but ident. by scales
J21	15.07.2006	UB48	M	21,66	unident. Crustacean	1,10					
J21					Glacier Laternfish	10,28	1,8	1,5	1,8	1,5	
J21					Polar Cod	10,28	3,8	1,7			
J22	15.07.2006	RB2	F	18,92	Nereis	1,27					
J22							4,3	2,0	4,4	2,0	
J22					Themisto abyssorum	0,10					
J22					Daubed shanny?	1,23					Leptoclinus maculatus, Tverrhalet Langebarn, no otoliths
J22					Polar Cod	16,32	5,0	2,3	5,0	2,4	2 ind., both otoliths
J23	15.07.2006	RB2	F	10,42	Polar Cod	10,42	3,6	1,8			
J24	18.07.2006	UB17b	F	54,05	Polar Cod	54,05	7,1	2,8	7,4	2,9	2 large individuals, both with otoliths

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
J24							6,9	3,0	6,9	2,9	
J25	12.07. 2006	UB25	F	44,44	Polar Cod	6,38					no otoliths
J25					Nereis	38,06					
J26	12.07. 2006	UB37 b	F	23,07	Polar Cod	5,20					no otoliths
J26					Themisto libellula	17,87					
J27	12.07. 2006	UB25	M	8,44	Thyssano essa inermis	0,72					
J27					Polar Cod	7,72	2,9	1,2	2,8	1,2	
J28	12.07. 2006	UB42	M	7,49	haddock	7,49	9,3	3,8	9,4	3,8	
J29	02.08. 2006	UB26	B	1,49	unident. Crustacea n	0,35					
J29					Glacier Laternfish	1,14	2,2	1,6	2,1	1,6	one ind. Both otoliths
J30	31.07. 2006	UB4	R	11,95	Polar Cod?	0,95					only small bits and pieces
J30					Thyssano essa inermis	11,00					
J31	31.07. 2006	UB24	R	13,25	Nereis	13,25					
J32	02.08. 2006	UB34	B	22,77	Nereis	0,88					
J32							4,7	2,3	4,8	2,2	
J32							4,7	2,1	4,7	2,1	
J32					Polar Cod	21,89	4,1	2,0	4,1	1,9	3 ind., all otoliths
J33	30.07. 2006	UB12 b	R	7,52	Thyssano essa inermis	4,21					

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
J33					Snakeblenny	3,31					Lumpenus lampretaeformis , Langhalet Langebarn, one intact ind., otoliths not found, length 285mm
J34	27.07.2006	UB48	B	0,86	Nereis	0,86					
J35	28.07.2006	UB21	R	19,31	Thyssanoessa inermis	19,31					
J36	27.07.2006	UB15	R	11,74	Nereis	10,57					
J36					Polar Cod	1,17	5,0	2,4			
J37	26.07.2006	UB36	B	15,77	Polar Cod	15,77	4,7	2,3	4,8	2,3	2 ind., all otoliths
J37							4,4	1,9	4,3	2,0	
J38	28.07.2006	UB23		33,79	Polar Cod	33,79	6,8	2,9	6,8	3,0	2 ind., all otoliths
J38							6,4	2,6	6,5	2,5	
J39	28.07.2006	?		9,06	Thyssanoessa inermis	9,06					
J40	28.07.2006	UB26		1,44	Nereis	0,90					
J40					Limnica	0,54					Limnica helicina?
J41	28.07.2006	UB27		6,53	Nereis	6,53					
J42	28.07.2006	?		5,61	Polar Cod?	5,61					4 bits of p.cod otoliths but sample might be not p.cod
K0618	21.07.2006	?		41,85	Polar Cod	41,85	4,4	2,1	4,4	2,1	2 otoliths from one fish, sample most likely 2-3 fish
no No.	30.07.2006	?	chick	9,62	Polar Cod	9,62	6,6	2,9	6,7	2,8	one big fish, 2 otoliths

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	O. length 1	O. breadth 1	O. length 2	O. breadth 2	Comment
K0649	27.07. 2006	?		46,51	Polar Cod	33,41					one big fish
K0649					cooked shrimp	13,10					Pandalus borealis, from trawler
K0611	20.07. 2006	?		39,82	Polar Cod	37,31	7,9	3,2	7,9	3,1	1 complete fish (2 otoliths) + rest of a small one
K0611					Daubed shanny?	2,51					rest of a fish with no otoliths
K0619	22.07. 2006	?		6,77	Polar Cod	6,77	6,6	2,8			very digested, 1 otolith and 2 broken bits
K0619								2,8			
K0619								2,8			
K0608	20.07. 2006	?		39,88	Polar Cod	35,89	4,5	2,1	4,4	2,1	at least 3 whole fish with 2 otoliths each + 2 single otoliths
K0608							4,3	2,0	4,4	2,0	
K0608							4,0	1,8	4,0	1,8	
K0608							5,4	2,5			
K0608							4,0	1,8			
K0608					Capelin	3,99	2,1	1,9	2,1	1,8	one whole fish?

2007

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comment
1			AKP	64,01	capelin	64,01	1,7	1,2	broken		at least 7 individuals
							1,7	1,2	1,7	1,4	
							1,7	1,3	1,7	1,2	
							1,6	1,2	1,6	1,2	
							1,6	1,3	1,6	1,3	
							1,8	1,3	1,9	1,4	

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comment
							1,4	1,2	1,4	1,2	
2		E1	AXK	15,22	capelin	15,22	1,7	1,3			
							1,4	1,1			
3				14,36	polar cod	14,36					sample 2, 1-2 fishes, no otoliths
4		BG	DCH	21,17	capelin	21,17	1,4	1,1	1,3	1,1	5-7 small fishes
							0,8	0,7			
							1,4	1,1	1,4	1,1	
							1,4	1,1	1,3	1,1	
5		UB4		30,11	capelin	30,11	1,9	1,5	2,0	1,5	3-4 medium-sized fishes'
							1,6	1,2	1,6	1,2	
							1,7	1,3	1,7	1,3	
6		BG	DCB	15,77	capelin	15,77	1,5	1,1			5-6 small fishes like in other samples
7				24,01	polar cod	24,01	3,5	1,8	3,5	1,8	samples #3,4-5 medium-sized fishes
							3,9	1,8	3,9	1,8	
							4,2	2,0	4,2	2,0	
8		B5	AAC	7,4	capelin	7,4	1,7	1,3	1,6	1,3	well digested
9				21,66	lanternfish?	21,66					sample bag just marked "1" and "2007", no otoliths
10		D4	DSX	11,83	capelin	11,83	1,5	1,1	1,6	1,2	at leat 4-5 fishes
11		D8	DAS	21,97	capelin	21,97	1,6	1,2	1,6	1,2	at leat 4-5 fishes
							1,1	0,9			
							1,4	1,0	1,3	1,0	
12		A4	BZD	21,13	polar cod	10,57	3,2	1,5			estimated 50% p.cod and 50% capelin
					capelin	10,56					
13		C7	DHX	7,26	capelin	7,26	1,6	1,2			
14		A7	DSJ	27,92	capelin	27,92	1,9	1,4	1,9	1,5	at least 6 individuals
							1,5	1,3	1,6	1,2	
							1,9	1,4	2,0	1,5	

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comment
							1,4	1,2	1,3	1,1	
							1,1	0,9	1,1	0,9	
							1,1	0,9	1,1	0,9	
15		D13	DTB	16,6	capelin	16,6	1,8	1,4	1,7	1,4	2-3 fishes
							1,8	1,4	1,7	1,4	
16		D24	DJB	7,7	capelin?	7,7					1-2 fishes, no otoliths
17		A9	ANP	19,72	capelin?	19,72					3-4 fishes, no otoliths
18		A3	7707	6,32	fish	6,32					well digested, no otoliths
19		D16	DBA	7,5	capelin	7,5	1,5	1,1	1,6	1,2	at least 3 fishes
							1,1	1,1	1,1	1,0	
							1,4	1,1	1,4	1,1	
20		B13	86/07	11,9	capelin	11,9	1,4	1,2	1,4	1,1	at least 2 fishes
							1,4	1,2	1,4	1,2	
21		B14(?)	93/07	9,7	capelin	9,7	1,3	1,0	1,3	1,0	several (4-5?) small fishes
							1,5	1,1	1,4	1,1	
							1,2	1,0	1,2	1,0	
							1,3	1,0			
22		C1	89/07	5,3	capelin	5,3					well digested, no otholiths
23		B3	68/07	23,78	capelin	23,78	1,0	0,8	1,0	0,8	at least 6 fishes
							1,2	1,0	1,2	0,9	
							0,9	0,8	0,9	0,8	
							1,5	1,2	1,5	1,2	
							1,0	0,9	1,0	0,8	
							1,2	1,0	1,2	1,0	

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comment
24		UB3	DNS	25,91	capelin	25,91	1,4	1,2	1,4	1,2	several well digested fishes
25		UB	46B	9,4	capelin	9,4					at least 4 small fishes, well digested, no otoliths
26		UB	21R	12,8	capelin	3,7	1,4	1,1			one fish, only one otolith
					Thysanoessa inermis	9,1					
27		UB	46R?	4,99	capelin	4,99					well digested, no otoliths
28		UB	36cB	13,46	capelin	13,46	1,6	1,2	1,6	1,2	at least 4 fishes
							1,7	1,4	1,7	1,3	
							1,4	1,1	1,4	1,1	
							1,4	1,1	1,4	1,1	
29		UB	2R	8,8	capelin	8,8	1,6	1,3	1,6	1,3	at least 2-3 fishes
30		UB	36cR	6,38	capelin	6,38					at lest 2 fishes, no otoliths
31		UB	4R	5,65	polar cod	5,65	1,0	0,6	1,0	0,6	at least 4-5 very small fishes, maybe Polar Cod
							0,8	0,5	0,7	0,5	
32		UB	29R	18,64	capelin	18,64	1,4	1,0	1,4	1,1	at least 5 fishes
							1,7	1,3	1,8	1,4	length of complete fish: 11.0 cm
							1,3	1,0	1,3	1,0	
							1,3	1,0	1,2	1,0	
							1,4	1,0	1,4	1,0	
33		UB	33B	17,25	polar cod	17,25	5,1	2,5	5,0	2,3	one big fish
34		UB	3B	5,2	capelin	5,2					2-3 fishes, well digested, no otoliths
35		UB	17bB	14,71	capelin	14,71	1,3	1,1	1,3	1,0	at least 4 fishes
							1,3	1,1	1,3	1,1	

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comment
							1,6	1,3	1,5	1,2	
							1,6	1,3	1,6	1,3	
36		UB	37R	7,2	capelin	7,2	1,3	1,0	1,3	1,0	at least 2-3 fishes
37		UB	43R	25,8	capelin	25,8	1,8	1,4	2,8	1,4	3 quite big fishes
							1,7	1,3	1,8	1,3	
38		UB	17bR	23,02	capelin	23,02	1,9	1,4	1,8	1,4	2-3 quite big fish
							1,6	1,3	1,6	1,2	
39		UB	13B	10,8	capelin	10,8					2-3 fishes, no otoliths
40		UB	38b	9,83	capelin	9,83	1,6	1,3	1,6	1,2	at least 3-4 fishes
41		UB	46R	5,28	capelin	5,28					1-2 fishes, no otoliths
42		UB	17bR	38,65	capelin	38,65	1,9	1,5	1,9	1,5	at least 6 quite big fishes
							1,6	1,2	1,6	1,2	
							1,6	1,2	1,6	1,2	
							1,5	1,2	1,5	1,2	
							1,6	1,3	1,6	1,2	
							1,9	1,5	1,9	1,5	
43		UB	21B	18,86	capelin	18,86	1,8	1,4	1,8	1,4	at least 3-4 fishes
							1,4	1,1	1,4	1,1	
44		UB	17R	14,06	polar cod	7,03	6,1	2,7	6,1	2,7	1 big fish
					capelin	7,03					c.5 small fish, no otolith
45		UB	45R	39,81	polar cod	39,81	6,2	2,8	6,3	2,8	one big fish
46		UB	3R	13,74	capelin	13,74	1,8	1,3	1,7	1,3	at least 4 fishes
							1,3	1,1	1,3	1,1	
47		UB	12bR	27,16	capelin	27,16	2,0	1,5	2,0	1,5	at least 4 fishes
							1,9	1,4	1,9	1,4	
							1,6	1,2	1,6	1,2	

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comment
							1,5	1,2	1,5	1,2	
48		UB	21B	11,78	capelin	11,78	1,4	1,0	1,3	1,0	at least 2-3 fishes
							1,4	1,1	1,4	1,1	
49		unmarked		5,56	polar cod	5,56	1,0	0,6	1,0	0,6	5-6 very small (about 2.5- 3cm) fish, most likely polar cod
							1,0	0,7	1,0	0,7	
							1,1	0,7	1,1	0,7	
							1,2	0,8	1,2	0,8	
							0,7	0,6			
50		UB	13B	2,27	Thysanoessa inermis	1,71					
					Nereis	0,56					
51		UB	11R	4,51	capelin	4,51					at least 3 fishes, no otoliths
52		UB	12bB	9,57	unid. Fish	9,57					well digested
53		UB	12bB	11,35	polar cod	2	4,3	2,0			one otolith found
					Thysanoessa inermis	0,2					
					polar cod?	9,15					many very small fishes (about 1.5-2 cm), no skulls found (too small)
54		UB	44B	25,29	capelin	12,65	1,8	1,4	1,7	1,4	estimated at 50%, at least one big fish
					unid. Fish	12,64					many very small fishes (about 1.5-2 cm), no skulls found (too small)
55		UB	43B	5,9	capelin	5,9					at least remains of 2-3 fishes, well digested, no otoliths

Sample	Date	Nest	Bird	Total mass [g]	Item	Item mass [g]	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comment
56		UB	1B	14,68	capelin	11,01					estimated at 75%, at least 2 big fishes, no otoliths
					unid. Fish	3,67					some very small fishes (about 1.5-2 cm), no skulls found (too small)
57		UB	45B	27,38	capelin	27,38	1,6	1,1	1,6	1,2	at least 3-4 big fishes
							1,6	1,2	1,6	1,2	
							1,7	1,3	1,7	1,3	
58		UB	15B	13,2	capelin	13,2					at least 3 fishes, no otoliths
59		UB	12bR	8,21	capelin	8,21					at least 2 fishes, no otoliths
60		UB	??	8,94	Artediellus atlanticus		4,3	2,2	4,1	2,3	fish probably not from a Kittiwake but dropped from a Black/Bruennich's Guillemot

2008

Id	Sample	Date	Nest	Bird	Total mass	Item	Item mass	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
1	1	08.07.08	B-koloni		8,18	polar cod	8,18					No otoliths
2	2	08.07.08	A-koloni	CAX	6,88	polar cod	6,88	4,4	2,1	4,3	2,1	2 otoliths
3	3	02.08.08	A13	AVF	40,06	capelin	40,06	2,1	1,6	2,1	1,7	5 fishes, 3 otoliths
4	3	02.08.08						2,2	1,7	0		husk fra samples 3
5	4	01.08.08	BG62	chick, FVD	25,2	Th. inermis	25,2					all inermis, FVD is a chick
6	5	08.08.08	BG58		14,63	Neris	0,26			0		

Id	Sample	Date	Nest	Bird	Total mass	Item	Item mass	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
7	5	08.08.08	BG62			Themisto libellula	14,37			0		
8	7	16.07.08	BG38	BBV	27,45	polar cod	8,37	4,4	2,1	4,5	2	2 otoliths from polar cod and 2 otoliths from cape
9	7	16.07.08	BG25	BBV		Capelin	19,08	2,5	1,7	2,5	1,8	two otoliths fra capelin
10	8	04.08.08	BG38	chick FTL	1,25	Themisto libellula	1,25					
11	9	17.07.08	BG64	CCS	8,7	Th. inermis	7,77					Two kind of thysanoessa
12	9	17.07.08	BG64			th. longicaudata	0,93					
13	10	19.07.08	BG51	CZK	5,76	polar cod	5,76	8,1	3,1			one otolith, front part of a big polar cod
14	11	01.08.08		FVS	14,88	Nereis						10,5 otoliths, very digested foodsample, 8,5 otoliths from polar cod, 2 otoliths from mysterious fis
15	11	01.08.08				Polar cod		5,4	2,3	5,7	2,6	No weigth on different items, to mixed
16	11	01.08.08				polar cod		6,1	2,6	6,1	2,4	
17	11	01.08.08				polar cod		4,9	2,2	3	1,6	
18	11	01.08.08				polar cod		4,5	2	4,4	2,1	
19	11	01.08.08				mysterious fish		3,2	1,5	3,1	1,4	from the mysterious fish
20	12	18.07.08	BG34	BAS	11,41	capelin	2,18	1,6	1,2	1,6	1,3	two fish, 2 otoliths from capelin
21	12	18.07.08				polar cod	9,23					polar cod, no otoliths
22	13	06.07.08	A-koloni	CBS	12,99	themisto libellula	0,97					
23	13	06.07.08				Unidentified fish	12,02					big fish without head/otoliths
24	14	18.07.08	Blomstrand	BLA	5,1	themisto libellula						

Id	Sample	Date	Nest	Bird	Total mass	Item	Item mass	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
25	15	17.08.08	UB12	chick, FZZ	14,31	polar cod	14,31	7,2	2,7	7,2	2,7	3 otoliths
26	15	17.08.08				polar cod		4,7	2,6			
27	16	01.08.08	A-kolonien	FVV	1,85	themisto libellula	1,85					very digested
28	17	27.07.08	BG50	FTX	3,4	uidentified fish						no otoliths and very digested sample
29	18	18.07.08	BG51	CZK	17,45	th. inermis	9,3					
30	18	18.07.08				capelin	8,15	2,2	1,6	2,3	1,6	2 otoliths
31	19	29.06.08	D-koloni		1,3	Themisto libellula	1,3					
32	20	26.06.08	B6 (D-kolonien)		2,02	unidentifie d fish	2,02					very small sample, no otoliths
33	21	02.07.08	Blomstrand	CXH	7,17	polar cod	7	4,1	1,9	4,1	1,9	2 otoliths, very digested
34	21	02.07.08				Neris	0,17					very small sample
35	22	24.06.08	A4	(38-08)	4,94	polar cod	4,94					no otoliths, lange hårlign bein og sølv skjell
36	23	29.06.08	B7, D-kolonien	(78-08)	1,99	Th. inermis	1,99					
37	24	01.06.08	B-kolonien		11,29	polar cod	11,29	5,4	2,5			one otolith
38	25	02.07.08	Blomstrand , øvre	DLL	1,19	unidentifie d fish	1,19					very small sample, kan være en polar cod??
39	26	02.07.08	blomstrand , øvre	FPV	1,03	Neris	1,03					very digested
40	26	02.07.08		FPV		polar cod		2,9	1,6			one otolith, small corner off
41	27	25.05.08	KO837 D-koloni		3,69	Th. inermis	3,69					
42	28	24.05.08	D-koloni K30?		1,09	unidentified fish						very very digested food, just fluid
43	29	17.06.08		FLC	5,27	unidentifie d fish	5,27					no otoliths and very digested food

Id	Sample	Date	Nest	Bird	Total mass	Item	Item mass	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
44	30	21.97.08	A4 D-koloni	BZD	25,48	capelin	17,5	2,3	1,6			one otolith, very mixed together sample, difficult to see who must that is cod or capelin
45	30	21.07.08				polar cod	7,98					a half otolith
46	31	10.06.08	C- koloni	BHT	9,29	polar cod	9,29					half an otolith and two spines
47	32	09.06.08	A5 C-koloni	BHX	16,59	Th. inermis	12,25					
48	32	09.06.08				mysterious fish	4,25	3,2	1,5			one otolith
49	33	06.06.08			5,93	unidentified fish	5,93					sample with most eggs
50	34	04.08.08	Blomstrand	FVK	11,26	unidentified fish	8,26					no otoliths
51	34	04.08.08				themisto libellula	1,32					
52	34	04.08.08				unidentified reje?	0,39					
53	35	11.07.08	Krykkjefjellet	HAB	8,59	capelin	5,04	2,2	1,7	2,2	1,7	two otoliths
54	35	11.07.08				Themisto libellula	2,5					
55	35	11.07.08				th. inermis	0,6					
56	36	08.07.08	krykkjefjellet A-kolonien	AHL	6,37	th. inermis	6,37					
57	37	08.07.08	krykkjefjellet B-kolonien	FSC	15,08	capelin	15,08	2	1,5			one otolith
58	38	15.07.08	nedre blomstrand reir 25	BBV	17,25	polar cod	17,25	6,2	2,5	6,2	2,5	two otoliths
59	39	07.07.08	Nedre blomstrand	FSA	8,43	th. inermis	8,43					
60	40	28.07.08	Krykkjefjellet B2	CBX	8,62	unidentified fish	8,62					no otoliths

Id	Sample	Date	Nest	Bird	Total mass	Item	Item mass	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
61	41	02.08.08	Blomstrand	FXA	31,49	capelin	12,99					no otoliths
62	41	02.08.08				Neris	0,72					
63	41	02.08.08				Reje	1,35					
64	41	02.08.08				unidentified	14,45					
65	42	16.07.08	blomstrand	FSK	8,19	polar cod	8,19					no otoliths
66	43	31.07.08	blomstrand	FVP	29,68	capelin	29,68	2,2	1,5			one otolith, but all capelin
67	44	11.07.08	krykkjefjellet	FPP	3,22	th. inermis	1,63					
68	44	11.07.08				themisto libellula	1,62					
69	45	14.07.08	Blomstrand	BBK	5,08	th. inermis	5,08					
70	46	08.07.08	B-kolonien	AND	10,26	themisto libellula	6,24					
71	46					th. inermis	3,72					
72	47	27.07.08	Blomstrand	FTZ	5,94	themisto libellula	5,94					
73	48	22.07.08	D-kolonien	DPF	1,8	unidentified	1,8					very little sample and digested
74	49	27.07.08	blomstrand	FVJ	8,09	unidentified fish	8,09					fish little digested
75	50	08.07.08		DSB	4,87	th. inermis	4,87					
76	51	22.07.08	D-koloni	ANH	3,13	th. inermis	3,13					
77	52	04.08.08	Blomstrand	FTK	3,81	themisto libellula	3,81					
78	53	15.07.08	Blomstrand	BNS	26,48	Neris	0,63					
79	53	15.07.08				polar cod	12,83	4	2,1	4,2	2	two otoliths
80	53	15.07.08				capelin	12,05	2,2	1,7	2,2	1,7	two otoliths

2009

Id	Sample	Date	Nest	Bird	Total mass (g)	Item	Item mass (g)	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
1	1	29.06.09	OB		4,69	polar cod	4,69					No otoliths, but two spine, no otoliths
2	2	29.06.09	OB		5,25	unidentified fish	4,87					two fish, no otoliths
3	2	29.06.09				th. inermis	0,38					
4	3	23.06.09	B11	HCP	29,35	Polar cod	13,02	3,9	1,8	3,8	2	four otoliths
5	3	23.06.09				polar cod		3,8	2	3,7	1,7	
6	3	23.06.09				th. inermis	15,5					
7	4	01.07.09	OB		6,22	polar cod	6,22					no otoliths, mayby a polar cod
8	5	29.06.09	OB		3,5	polar cod	3,5	4,5	1,8	4,3	1,9	2 otoliths, very digested foodsample
9	6	29.06.09	OB		6,45	uidentified fish	6,45					
10	7	24.06.09	KF	DPF	5,06	uidentified fish	4,84					fish and th. inermis
11	7	24.06.09				Th. inermis	0,22					
12	8	29.06.09			5,2	polar cod						no otoliths
13	9	29.06.09	OB		5,58	polar cod	3,66	3,3	1,6	3,4	1,7	2 otoliths
14	9	29.06.09				capelin	1,92					one otolith
15	10	30.06.09			3,96	polar cod	3,5					no otoliths
16	10	30.06.09				Neris	0,46					very digested
17	11	29.06.09			15,51	polar cod	15,51					no otoliths, but two fishes.
18	12	01.07.09	OB		5,6	polar cod	5,6					no otoliths, maybe polar cod,
19	13	23.06.09	KF C3	HCN	7,35	themisto libellula	2,16					
20	13	23.06.09				polar cod	5,11					no otoliths, but looks like a polar cod,

Id	Sample	Date	Nest	Bird	Total mass (g)	Item	Item mass (g)	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
21	14	14.07.09			2,57	Neris	32					
22	14	14.07.09				Themisto libellula	0,53					en enkel - enormt stor
23	14	14.07.09				unidentified fish	1,59					
24	15	11.07.09	KF		11,76	polar cod	11,76					no otoliths
25	16	12.07.09	OB	chick	13,12	polar cod						no otoliths, but three to four spines
26	17	16.07.09	OB		11,37	th. inermis	11,37					no otoliths
27	18	12.07	OB13		8,15	th. inermis	8,15					
28	19	16.07.09	OB koloni D		20,5	polar cod	19,68	4,2	1,9	4,2	1,9	5 otoliths all from polar cod
29	19	16.07.09				polar cod		5	2,3	5,1	2,2	
30	19	16.07.09				polar cod		3,9	1,6			
31	19	16.07.09				Neris	0,54					
32	19	16.07.09				th.inermis	0,22					
33	20	16.07.09	OB B17		21,87	capelin	21,87	1,5	1	1,1	1	8 fish and 13 otoliths two different fish with only one otolith each
34	20	16.07.09				capelin		1	0,9	1,1	0,8	both otoliths from same fish
35	20	16.07.09				capelin		1,3	1	1,3	1	two otoliths from same fish
36	20	16.07.09				capelin		1,1	0,9	1,1	0,9	from same fish
37	20	16.07.09				capelin		1,3	1,1	1,3	1	from same fish
38	20	16.07.09				capelin		1,1	0,9	1,1	0,9	from the same fish
39	20	16.07.09				capelin		1	0,8			from one fish
40	21	16.07.09	OB koloni D		6,22	polar cod		4,8	2,1			one otolith
41	22	15.07.09	OB		20,56	polar cod	20,56	4,9	2,1	4,9	2,1	three fish, six otoliths the same fish

Id	Sample	Date	Nest	Bird	Total mass (g)	Item	Item mass (g)	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
42	22	15.07.09				polar cod		4	1,8	3,9	1,9	from the same fish
43	22	15.07.09				polar cod		4	1,9	4	1,9	from the same fish
44	23	16.07.09	OB kolon i C		27,16	tverrhalet langebarn	3,23	1,1	0,8	1,2	0,8	six otoliths, but two from tverrhalet langebarn, same fish
45	23	16.07.09				polar cod	13,44	4,6	2,2	4,5	2,2	four polar cod otoliths, these two from the same fish
46	23	16.07.09				polar cod		4	1,8	4,1	1,8	from the same fish
47	23	16.07.09				caplin	9,13	2,1	1,7	2,1	1,6	from the same fish
48	24	13.07.09	Blomstrand		CVA	8,12	th. inermis	8,12				
49	25	14.07.09	Blomstrand		18,97	polar cod	18,97	6	2,5	5,9	2,5	two otoliths
50	26	15.07.09	OB		7,61	polar cod	7,61	4,6	2,2	4,5	2,4	two otoliths
51	27	15.07.09	OB		9,24	polar cod	9,24	4	2,1	4,1	2,1	two otoliths
52	28	15.07.09	OB		3,27	unidentifie d	3,27					no otloliths and very digested food
53	29	11.07	OB		17,34	polar cod	17,34					no otoliths
54	30	16.07.09	OB		25,46	polar cod	20,46	3,6	1,6	3,6	1,6	six otoliths from polar cod and two from capelin.
55	30	16.07.09				polar cod		4,6	2	4,8	2	from same fish
56	30	16.07.08				polar cod		3,9	1,8	3,7	1,8	
57	30	16.07.09				capelin	5	1,8	1,3	1,8	1,5	two otoliths from capelin, the same fish
58	31	15.07.09	OB		18,45	polar cod	18,45	4,5	2	4,4	2	4 otoliths, these from same polar cod
59	31	15.07.09				polar cod		4,3	1,9	4,1	1,9	from same polar cod
60	32	29.07.09	OB		6,49	capelin	6,49					no otoliths
61	33	07.07.09	OB		10,18	polar cod	10,18					no otoliths
62	34	07.07.09	blom stran d	CLB	25,08	polar cod	25,08	4,1	2	4	2	four otoliths

Id	Sample	Date	Nest	Bird	Total mass (g)	Item	Item mass (g)	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
63	34	07.07.09				polar cod capelin		4,4	2	4,4	1,9	from same fish seven otoliths, four capelin
64	35	29.07.09	OB		24,26		24,26	1,1	0,8	1	0,8	this is from same fish - lost the one otolith after measuments
65	35	29.07.09				capelin		1,2	0,9	1,1	0,9	from same fish
66	35	29.07.09				capelin		1,2	1	1,2	1	from same fish
67	35	29.07.09				capelin		1,2	1			only one otolith from this fish
68	36	07.07.09	blomstrand	AHJ	27,03	polar cod	27,03	4,2	1,9	4,2	1,8	two otoliths from same fish, but two fishs
69	37	03.07.09	OB reir 4		4,14	polar cod	4,14	3,9	1,9	3,9	1,8	two otoliths from the same fish
70	38	03.07.09	OB reir7		6,54	polar cod	6,54	3,6	1,7	3,5	1,8	two otoliths from same fish
71	39	21.07.09	OB (nr. 82)		12,08	capelin	12,08	1,5	1,2	1,5	1,2	three otoliths
72	39	21.07.09				capelin		1,5	0,9			one otolith from this fish
73	40	21.07.09	OB		20,75	polar cod	13,6	4,5	2	4,5	2,1	two otoliths from same fish
74	40	21.07.09				capelin	7,15	1,9	1,2	1,9	1,3	two otoliths from capelin
75	41	23.07.09	OB		12,96	th. inermis	12,96					
76	42	31.07.09	blomstrand	CSL	3,77	Nereis	3,77					
77	43	01.08.09	Blomstrand	from chick	4,49	tverrhalet langebarn	4,49	2,8	1,9	2,9	1,9	two otoliths from the same fish
78	44	02.08.09	OB		9,26	Nereis	5,14					

Id	Sample	Date	Nest	Bird	Total mass (g)	Item	Item mass (g)	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
79	44	02.08.09				torsk??	4,12	0,5	0,5	0,6	0,5	two otoliths, very small, and look like torsk, but is that possible??
80	45	23.07.09	OB		33,32	capelin	4,21	1	0,8	1	0,7	two otoliths form same fish
81	45	23.07.09				polar cod	20,98	2,5	1,1	2,6	1,1	six otoliths from three fish
82	45	23.07.09				polar cod		3,1	1,5	3,2	1,4	
83	45	23.07.09				polar cod		3,5	1,7	3,7	1,7	
84	45	23.07.09				th. inermis	6,18					
85	45	23.07.09				reke	0,48					
86	46	21.07.09	OB		49,38	capelin	49,38	2	1,5	2	1,4	four otoliths, but at least six fishes
87	46	21.07.09				capelin		2,2	1,3	2,2	1,4	
88	47	02.08.09	OB		3,2	polar cod	3,2					no otoliths
89	48	02.08.09	OB		6,46	Nereis	6,46					
90	49	31.07.09	Blomstrand	CVF	6,89	th. inermis	6,89					
91	50	26.07.09	OB		27,63	Themisto libellula	27,63					
92	51	28.07.09	B19		44,41	th. inermis	44,41					
93	52	26.07.09	OB		17,65	polar cod	8,49	5,6	2,6	5,8	2,6	six otoliths, two from polar cod, two from mysterious fish and two from capelin
94	52	26.07.09				mysterious fish	3,8	2,7	1,5	2,7	1,4	two otoliths
95	52	26.07.09				capelin	4,48	1,1	0,9	1,1	0,9	two otoliths
96	53	KF			20,07	unidentified fish	20,07					no otoliths

Id	Sample	Date	Nest	Bird	Total mass (g)	Item	Item mass (g)	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
97	54	24.07.09	OB		26,83	polar cod	12,12	3,9	1,7	3,9	1,8	two otoliths from polar cod,
98	54	24.07.09				capelin	13,43	1,1	0,9	1,1	0,9	six otoliths from capelin and two from tverrhalet langebarn, these are from same fish
99	54	24.07.09				capelin		1,1	0,9	1,1	0,9	from same fish
100	54	24.07.09				tverrhalet langebarn		1	0,8	1	0,8	same fish
101	54	24.07.09				capelin		1,1	0,8	1,1	0,8	from two different fishes
102	55	24.07.09	OB		26,14	polar cod	26,14					two fishes but no otoliths
103	56	24.07.09	OB		38,13	th. inermis	29,81					
104	56	24.07.09				sild?? Polar cod??	7,86	3,6	1,5	3,5	1,6	two otoliths,same fish, the otoliths looks like polar cod otoliths in the book, wrong?
105	57	02.08.09	OB		53,55	capelin	39,24	1,2	1	1,3	1,1	from same fish
106	57	02.08.09				capelin		1,1	0,8	1,1	0,8	from the same fish
107	57	02.08.09				capelin		1,2	0,9	1,2	0,9	from same fish
108	57	02.08.09				capelin		1,1	0,9	1	0,9	from same fish
109	57	02.08.09				capelin		0,9	0,8	1	0,8	from the same fish
110	57	02.08.09				capelin		0,9	0,8			
111	57	02.08.09				capelin		1,4	1	1,4	1,2	same fish
112	57	02.08.09				capelin		1,3	1	1,4	1,1	same fish
113	57	02.08.09				capelin		1,2	0,9	1,2	1	from same fish
114	57	02.08.09				polar cod	12,46					no otoliths
115	58	26.07.09	(123-09)		3,48	capelin	3,48	1,2	1	1,3	1	two otoliths
116	59	24.07.09	OB	HFC	10,46	unidentified	10,46					two fishes
117	60	23.07.09	OB		17,16	th. inermis	17,16					

Id	Sample	Date	Nest	Bird	Total mass (g)	Item	Item mass (g)	Otolith length 1	Otolith breadth 1	Otolith length 2	Otolith breadth 2	Comments
118	61	24.07.09	OB D4		64,02	capelin	64,02	1,5	1,1	1,5	1,1	from same fish,
119	61	24.07.09				capelin		1,5	1,2	1,5	1,2	from same fish
120	61	24.07.09				capelin		2,1	1,4	2	1,4	from same fish
121	61	24.07.09				capelin		1,9	1,3	1,9	1,4	
122	61	24.07.09				capelin		2,3	1,5	2,1	1,7	from same fish
123	61	24.07.09				capelin		2	1,5	2	1,5	from same fish
124	61	24.07.09				capelin		2	1,5			only one otolith
125	62	24.07.09	OB-D7		49,1	capelin	25,41	2,1	1,5	2,1	1,5	from same fish
126	62	24.07.09				capelin		1,9	1,4	1,9	1,4	from same fish
127	62	24.07.09				polar cod	22,15	4,9	2,3	4,8	2,2	from same fish

APPENDIX II

Year	Breeding success (chicks per active nest)	Hacting date (July)	Sea surface temperature (ºC)
1997	1,10	10	2,98
1998	0,94	8	2,43
1999	0,74	11	2,48
2000	1,02	9	2,94
2001	NA	15	2,71
2002	0,00	25	2,63
2003	0,25	18	3,59
2004	0,58	14	2,90
2005	1,31	10	4,03
2006	0,55	10	3,89
2007	1,27	12	3,49
2008	0,98	8	3,65
2009	0,61	16	NA