EARLY SPRING WRECK OF BLACK-LEGGED KITTIWAKES *RISSA TRIDACTYLA* IN NORTH NORWAY, APRIL 2003

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Barrett, R.T., Josefsen, T.D. & Polder, A. 2004. Early spring wreck of Black-legged Kittiwakes *Rissa tridactyla* in North Norway, April 2003. Atlantic Seabirds 6(2): 33-45. *Large numbers of dead Black-legged Kittiwakes* Rissa tridactyla *were washed ashore in North Norway in late April 2003. Inspection of 51 corpses indicated that they had died of starvation. More than 90% of those collected were males. Coincidental with the wreck were reports of many of the large colonies in the region being temporarily abandoned at a time when birds would normally be starting to breed. It seems that North Norwegian Black-legged Kittiwakes are dependent on the annual spring spawning migration of Capelin* Mallotus villosus *along the coast of Finnmark. In 2003, however, the stock was low and spawning took place exceptionally far west, forcing the birds to leave their colonies in their search for food. When small amounts of Capelin appeared along the Finnmark coast in mid-May the kittiwakes returned to their colonies and breeding proceeded as normal. This episode was unusual as the victims of starvation wrecks are usually auks, not kittiwakes.*

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INTRODUCTION

Between 25 and 29 April 2003, reports were received of dead and dying Black-legged Kittiwakes *Rissa tridactyla* on the shore and on the sea at various localities along the coast of Troms, North Norway (Fig. 1). These were accompanied by observations of uncharacteristic behaviour, such as birds with "uncoordinated flight", "tame" birds landing on fishing boats, and of boats steaming through rafts of "sick" kittiwakes. Both the "tame" and "sick" birds were reported as being "easily caught by hand". How many died or were sick is unknown, but one anecdotal report suggested that "thousands" were affected.

The reports of dead and dying birds were soon followed by those of many kittiwake colonies in Finnmark (see Fig. 1), including Eidvågen (3,000 pairs; Strann & Vader 1986), Ranvika (5,000 pairs; Barrett 2003), Sværholt (25-50,000 pairs; Tromsø Museum, unpubl. data) and the largest in the country,

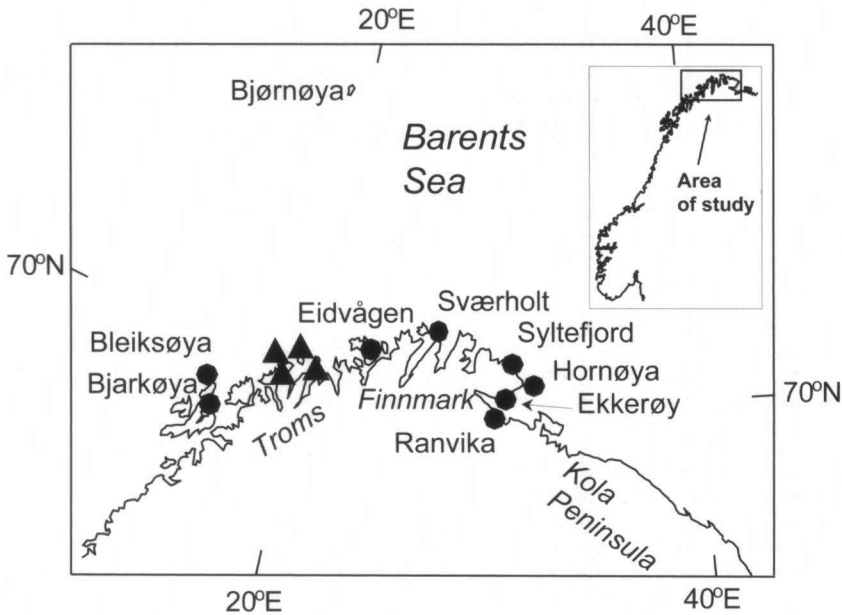

Figure 1. Map of North Norway and the south-west Barents Sea showing seabird colonies mentioned in the text (dots) and sites where dead or sick kittiwakes were seen or collected (triangles, clockwise from top left: Torsvåg, Nord-Fugløy, Badderen, Dåfjord).

Figuur 1. Kaart van Noord-Noorwegen en de zuidwestelijke Barenstzee met de kolonies die in de tekst genoemd worden (stippen) en plaatsen waar dode of zieke Drieteenmeeuwen werden gezien of verzameld (driehoeken,vanaf linksboven met de klok mee: Torsvåg, Nord-Fugløy, Badderen, Dåfjord).

Syltefjordstauran (140,000 pairs; Stougie *et al.* 1989) being abandoned in late April-early May. The captain of one of the coastal steamers that daily travels the whole coastline reported on 29 April that seabirds had "deserted" the coast of Finnmark and he, and the harbourmaster at Vardø, reported a complete lack of the usual hectic fishing activity among seabirds in the region. In a colony on Hornøya, East Finnmark, where daily observations began on 16 April, numbers of kittiwakes on the cliffs dropped from "normal" (the colony is estimated to number 15-20,000 pairs, *pers. obs.*) on the first day to no birds between 18 and 28 April, none to "few" between 29 April and 15 May, and "normal" again from 16 May (Vincent Staszewski, *pers. comm.*). Common Guillemots *Uria aalge* and Atlantic Puffins *Fratercula arctica* also abandoned the colony between 19

and 25 April and again on 4-5 May. At Ekkerøy and Eidvågen, kittiwakes were reported as having returned on 2 and 3 May respectively.

This study aims to determine the cause of the mass mortality of kittiwakes, the cause of the temporary abandonment of the colonies, and the provenance of the dead birds (i.e. where they would have bred).

METHODS

Collection and examination of corpses Soon after the first reports of dead kittiwakes were received, a plea was made via the media for birds to be collected and delivered to Tromsø Museum or the National Veterinary Institute, Tromsø. This resulted in a sample of 51 birds, six of which were collected at Torsvåg and five at Dåfjord (including three that were shot) on 28 April; a further three were collected at Badderen on 30 April. These 14 birds underwent a complete autopsy at the National Veterinary Institute, including external measurements and weighing, macroscopic inspection of internal organs, search for gastrointestinal parasites, histological examination of liver, heart, lungs, brain and skeletal muscle, and cultivation of bacteria from liver, lungs and kidney. Levels of PCB, HCB and pp-DDE residues in the brain of the six Torsvåg individuals were measured at the accredited laboratory (Norwegian Standard NS-EN and ISO/IEC guide 17025, test 051) at the Norwegian School of Veterinary Science, Oslo, using standard methods.

The remaining 37 corpses were collected at Torsvåg on 4 May and brought to Tromsø Museum where external body measurements and weights were taken before they were deep frozen. The birds were later skinned, their sex determined by gonad inspection, and the subcutaneous and body cavity fat deposits scored (on a scale of 0 = no fat to 3 = much fat; Jones *et al.* 1982).

External measurements included wing length (maximum flattened chord ± 0.5 mm using a stopped ruler), culmen length and gonys depth (± 0.1 mm using Vernier callipers), and total head length (head + bill ± 0.5 mm using callipers described by Coulson *et al.* 1983). Corpses (excluding waterlogged specimens) were weighed to the nearest 1 g using an electronic balance.

Origin of the birds Because Black-legged Kittiwakes vary in size across their breeding range with a general increase in size with increasing latitude (Sluys 1982, Barrett *et al.* 1985, Weir *et al.* 1996), the measurements of birds collected during the incident were compared with those of birds collected at various colonies and sites in North Norway and the Barents Sea. This was supplemented by the data from one ringed bird found among the wrecked specimens.

Table 1. Mean mass and body measurements of adult Black-legged Kittiwakes wrecked in North Norway, April-May 2003.

Tabel 1. Gemiddeld gewicht en lichaamsmaten van adulte Drieteenmeeuwen die april-mei 2003 in Noord-Noorwegen waren gestrand.

		Males	Females	All
Mass (g)[1]	mean	279.1	250.6	275.5
	SD	19.7	23.2	22.0
	N	35	5	40
Wing (mm)	mean	324.1	313.7	322.7
	SD	7.0	5.9	7.6
	N	41	6	48
Culmen (mm)	mean	37.7	35.6	37.3
	SD	1.1	2.1	1.5
	N	41	7	49
Gonys (mm)	mean	11.7	11.3	11.7
	SD	0.6	0.2	0.6
	N	31	5	36
Head + bill (mm)	mean	94.0	89.1	93.2
	SD	2.2	19.7	2.8
	N	41	7	49

[1]Excluding juvenile, shot or waterlogged birds.

Table 2. Levels (ppb or µg/kg wet weight) of five PCB congeners, HCB and pp-DDE and % fat in the brains of six Black-legged Kittiwakes found dead in North Norway on 28 April 2003.

Tabel 2. Gehalte (ppb of µg/kg nat gewicht) van vijf PCB-typen, HCB en pp-DDE en vetpercentage in de hersens van zes Drieteenmeeuwen die op 28 april 2003 in Noord-Noorwegen dood waren gevonden.

	Bird no.							
	252	253	254	255	256	257	Mean	SD
PCB-118	134.1	168.2	138.5	294.1	174.4	203.3	185.4	59.0
PCB-153	633.2	734.8	450.0	1428.9	416.9	578.0	707.0	373.0
PCB-138	362.8	443.2	295.4	934.9	293.7	387.7	453.0	242.9
PCB-180	182.5	189.1	116.8	347.6	93.3	135.8	177.5	91.2
PCB-170	59.9	72.4	40.5	145.2	37.2	51.1	67.7	40.1
ΣPCB	1372.6	1607.8	1041.1	3150.7	1015.5	1355.9	1591.0	796
HCB	201.4	157.3	153.4	199.5	187.0	189.1	181.3	20.9
pp-DDE	43.4	120.6	82.7	296.0	235.5	126.2	150.7	95.9
% fat	5.0	7.8	7.7	7.4	7.6	7.1	7.1	1.1

RESULTS

Age and sex All but two of the birds were in adult plumage. The exceptions were immature birds. Of 50 birds whose sex was determined, 43 (86 %) were males and 7 (14 %) were females.

Body condition The mean body mass of 40 individuals was 275.5 ± 22.1 g (range 220-346 g, Table 1).
With the exception of the three shot birds, the 11 that underwent a complete autopsy were extremely emaciated with very little subcutaneous and no body cavity fat. There were no food remains in any of the alimentary canals, and the breast muscles were very atrophied, dark and dry. Gastrointestinal parasites were absent in nine, present in small numbers in four and present in moderate numbers in one of the autopsied birds. Bacterial cultivation from liver, lungs and kidneys was negative. Histological examination of liver, kidney, heart, lungs and brain revealed no abnormalities apart from relatively large amounts of haemosiderin (a pigment composed of colloidal ferric oxide formed by the breakdown of haemoglobin and indicative of muscle atrophy) in the liver. The body masses of the three shot birds were 309 g, 392 g, and 366 g.

The mean subcutaneous and body cavity fat scores of the remaining 37 birds were 1.0 ± 0.2 and 0.1 ± 0.5 respectively.

Organochlorine residues Relatively high levels of residues of five PCB congeners (PCB 118, 138, 153, 170 and 180), HCB and pp-DDE were found in the brains of six birds (means = 1591.0 ± 796.0, 181.3 ± 20.9 and 150.7 ± 95.9 µg/kg wet weight respectively, Table 2).

Origin of the birds Only male birds were used in the analyses due to the low numbers of females in the sample of wrecked birds. The mean head lengths of the wrecked birds were similar to those of males measured on Bleiksøya and Hornøya during the breeding season, but shorter than those of birds caught east of Bjørnøya soon after the breeding season (ANOVA, $F_{3,127} = 3.4$, $P = 0.02$, Fisher's pairwise comparison, Fig. 2). There were no differences in their mean wing lengths (ANOVA, $F_{3,132} = 1.5$, $P = 0.21$). The recovery of a bird ringed as a breeding adult on Hornøya in 2002 again suggests strongly that the dead birds were breeding birds from Finnmark.

DISCUSSION

How did the kittiwakes die? It is most likley that the birds died of starvation. The mean body mass of the birds found (275.5 g) was only *ca.* 60% of that of

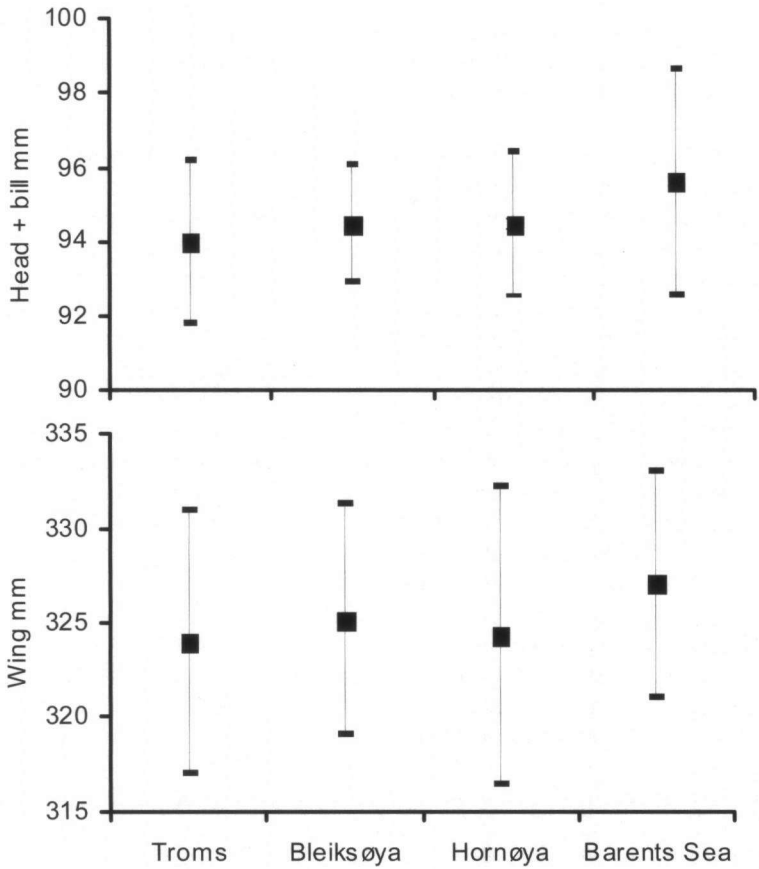

*Figure 2. Mean (± 1 SD) body measurements of 41 male Black-legged Kittiwakes found dead in Troms in April-early May 2003 compared with those of male birds measured in colonies in North Norway (Bleiksøya (*n *= 20), Hornøya (n = 32-35) or collected in the Barents Sea (east of Bjørnøya between 74-75° N, 23-29° E,* n *= 40-42) during or soon after the breeding season (Source: RTB, unpublished data).*

*Figuur 2. Gemiddelde lichaamsmaten (± 1 SD) van 41 mannelijke Drieteenmeeuwen die april-mei 2003 in Troms dood waren gevonden, vergeleken met maten van mannetjes die tijdens of vlak na het broedseizoen waren gemeten in Noord-Noorwegen (Bleiksøya (*n *= 20), Hornøya (*n *= 32-35) of in de Barentszee (*n *= 40-42) op zee ten oosten van Bjørnøya tussen 74-75° N, 23-29° E. (Bron: RTB, ongepubl. data).*

Black-legged Kittiwakes weighed in the region at the same time of year (when birds are building up body reserves prior to breeding, e.g. at Bleiksøya 465.0 ± 41.6 g, *n*=24, and at Hornøya 456.2 ± 38.2 g, *n*=29; RTB unpublished data). Furthermore, the almost complete lack of fat deposits was in sharp contrast to the condition of apparently healthy birds shot off Bleiksøya in mid-April 1986. These birds had mean subcutaneous and body cavity fat scores of 2.6 ± 0.6 and 1.8 ± 0.1 respectively (RTB unpublished data). The low parasite burden and the absence of bacterial pathogens exclude parasitic and bacterial diseases as contributing causes of death.

The levels of organochlorine residues in the brains of six birds were 10-20 times higher than those previously found in brains of apparently healthy North Norwegian kittiwakes (*ca.* 50-170 µg/kg for ΣPCB and *ca.* 8 µg/kg for HCB; Savinova *et al.* 1995, Henriksen *et al.* 1996). Although the redistribution of organochlorines as a result of the mobilization of fat during the period of starvation might contribute to impaired viability (Ingebrigtsen *et al.* 1984, Henriksen *et al.* 1996), the levels recorded here were much lower than those associated with illness or death found in other studies. For example, Gabrielsen *et al.* (1995) recorded much higher levels of ΣPCB, HCB and pp-DDE (means = 14 800 ± 10 000, 655 ± 388 and 2798 ± 1633 µg/kg respectively) in the brains of 12 dead Glaucous Gulls *Larus hyperboreus* on Bjørnøya, but concluded that the PCBs only may have contributed to their death. Similarly, approximately the same levels of PCB and DDE (mean = 2020, maximum 60 000, and mean = 470, maximum 9700 µg/kg, respectively) in the brains of 37 dead Great Northern Divers *Gavia immer* were not associated with their death (Stone & Okoniewski 2001). Furthermore, Dahlgren *et al.* (1972), Sileo *et al.* (1977) and Stickel *et al.* (1984) suggest that lethal brain levels are as high as 300 000 µg/kg for both ΣPCB and DDE, i.e. at levels several orders of magnitude higher than found here.

Origin of the birds It is unlikely that the desertion of the colonies in Finnmark at the same time as the wreck was coincidental; based on body measurements and the recovery of a Hornøya bird, it seems that most of the wrecked birds originated from colonies in Finnmark. Of the nearly 1,000,000 pairs of Black-legged Kittiwakes that breed in the Barents Sea region, approximately 50% breed in Finnmark (Barrett & Tertitski 2000). Outside the breeding season, they disperse over the whole North Atlantic and some into the Mediterranean Sea (Barrett & Bakken 1997, Nikolaeva *et al.* 1997, Bakken *et al.* 2003) but return and occupy the breeding colonies in late March-early April. An observation on *ca.* 28 April, i.e. at the time of the wreck, of a fully occupied colony (*ca.* 2,000 pairs) on Bjarkøy (Fig. 1), with no dead birds in the neighbourhood, suggests that only the northerly populations were involved.

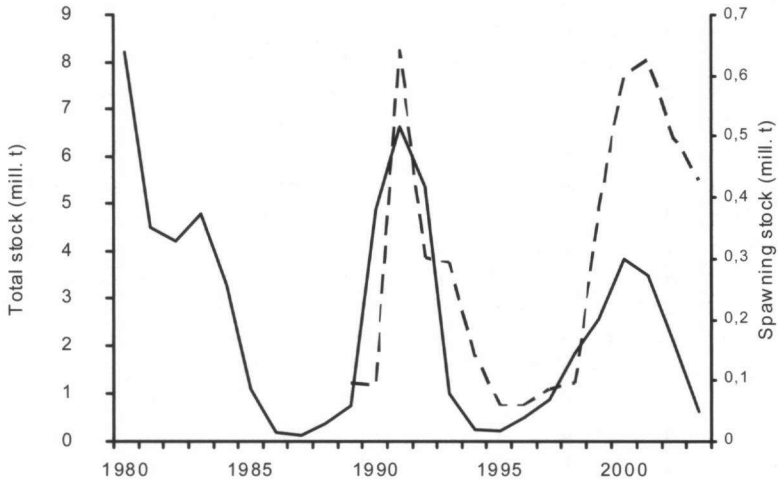

Figure 3.Estimates of total biomass (solid line) and median value of the modelled stochastic spawning stock (broken line) of capelin in the Barents Sea, 1980-2003. (Source: ICES 2003).

Figuur 3.Schatting van de totale biomassa (doorlopende lijn) en mediane waarde van de gemodelleerde stochastische populatie (onderbroken lijn) van Lodde in de Barents Sea, 1980-2003. (Bron: ICES 2003).

Why did the birds starve? There are many reports of seabird wrecks from the North Sea and one recent one (March/April 2002) from central Norway, but in most instances the victims have usually been auks *Alcidae* (Underwood & Stowe 1984, Weir *et al.* 1996, Anker-Nilssen *et al.* 2003). The main cause of death in all cases was starvation, generally as a result of poor weather preventing birds feeding.

As far as we are aware, this episode is only the second known wreck involving kittiwakes alone. The first was on the south-west coast of Britain in January and February 1957, when many birds were found dead or with symptoms very similar to those recorded here ("tame", "tired", "lethargic", etc.; McCartan 1958). *Post-mortem* examinations of the British birds also showed severe starvation as the cause of death but, in contrast to the present episode, this was probably the result of prolonged gales in the North Atlantic carrying the birds away from their regular feeding grounds (McCartan 1958).

Another winter incident in Shetland in 1993 also involved storm-driven birds, but the situation then was exacerbated by oiling from the wreck of the *Braer*, 94% of the recovered birds being reported as oiled (Weir *et al.* 1996).

This is the second seabird wreck due to starvation reported in North Norway. The first was in January 1987 when thousands of dead Common Guillemots, which usually winter in the southern Barents Sea, were reported washed ashore in Finnmark (Vader *et al.* 1990). In common with the present kittiwake wreck, the guillemots were emaciated and their death was attributed to starvation. It was proposed that this was a result of a sudden collapse in 1986/87 in the stock of Barents Sea capelin *Mallotus villosus*, the main food item of the guillemots (Fig. 3).

Of all demographic parameters, adult survival is considered to be the most strongly buffered against effects of food shortage such that significant mortality as reported here and in the Barents Sea in 1987 would occur only when food is extremely scarce or when severe weather prevents the birds from feeding (Hudson 1985, Cairns 1987, Furness & Camphuysen 1997). In both the present case and the guillemot wreck of 1987, weather conditions were not exceptional (*pers. obs.*, http://weather.cs.uit.no) and may be ruled out as the proximate cause of death.

Long-term studies in East Finnmark have suggested that Black-legged Kittiwakes are much more dependent than guillemots and other auks on capelin as a food source during the breeding season (Krasnov & Barrett 1995, Barrett 2003). In April 2003, the total stock of the Barents Sea capelin was very low, and the springtime migration of the spawning stock (which was also declining, Fig. 3) was much further westward than normal, with very few appearing on the traditional spawning grounds along the northern Finnmark coast. Instead, it seems that the majority spawned along the southern coast of Troms and as far west as Bleiksøya (Fig. 1; T. Pedersen, H. Gjøsæter, *pers. comm.*). The large concentration of seabird colonies in Finnmark is probably dependent on the annual movement of capelin to the coast prior to and during the breeding season as a food source (Krasnov & Barrett 1995, Barrett & Krasnov 1996, Gjøsæter 1998). In 2003, the absence of capelin probably caused the birds to temporarily abandon their colonies at the end of April and to forage much further from their breeding sites than usual. This is a time when egg laying has normally started or is about to start, and established sites are rarely left unattended (Barrett 1978, 1989). These birds would probably have remained in the colonies as long as possible but, as their body condition deteriorated, they had to leave in search of food. Observations of the occupied colony with no dead birds at Bjarkøy, which was close to the capelin spawning area, support this possibility. Although the capelin stock was also very low in the mid-1990s (Fig. 3), spawning occurred further north and east in Finnmark and closer to the main breeding colonies, and presumably supported the food demands of the kittiwakes.

The dominance of males among the wrecked birds in this incident is in contrast to the dominance of female (up to 70%) Black-legged Kittiwakes that

died in Shetland in January 1993 (Weir *et al.* 1996), and suggests different behaviour patterns between the sexes early in the breeding season. Gabrielsen (unpublished data, *pers. comm.*) found that male Black-legged Kittiwakes may attend the nest for as long as 5-6 days and twice as long than females just before egg laying. It is possible therefore that the males in Finnmark remained longer than the females in the colonies (to defend their nest sites after the females had left) such that they were in poorer condition when they finally left. It is also possible that females at this time of the season would have built up body reserves prior to egg laying, thereby giving them a better chance of survival.

Unpublished studies suggest that, in the absence of food, adult kittiwakes in normal pre-breeding body condition would exhaust all body reserves within 5-8 days (G.W. Gabrielsen, *pers. comm.*). Those that waited too long in the Finnmark colonies would probably have been too weak to forage efficiently when they finally reached the capelin in Troms, and subsequently succumbed.

At the time of the wreck there were reports of apparently starving kittiwakes ignoring dead capelin that were floating on the sea surface in the area of the wreck. These are fish that die after spawning (Gjøsæter 1998). In subsequent conversations with fishermen, this paradox was corroborated by their reports of gulls *Larus* spp. also avoiding these fish during the capelin spawning season. Why these fish were not eaten is unknown.

Kittiwakes probably survived the capelin shortage in the 1986/87 winter in that the few that were not dispersed outside the Barents Sea were either able to move quickly to richer feeding grounds or survived on, for example, crustaceans that not suitable for auks. The following breeding season, however, was for many species in Finnmark one of complete or very nearly complete breeding failure, again suggesting insufficient movement of capelin into coastal waters in 1987 (Vader *et al.* 1987, Gjøsæter 1998). By 1989, however, when the capelin stock had recovered only slightly and was still very low, breeding success was again normal (Barrett & Furness 1990).

By mid-May 2003, all colonies in Finnmark that had been abandoned were reoccupied, and breeding proceeded, albeit a little late. This coincided with reports of small amounts of capelin spawning in East Finnmark (H. Gjøsæter, *pers. comm.*). On Hornøya, kittiwakes started to lay 2-3 weeks later than usual, around 1 June (RTB, *pers. obs.*), although mean clutch size reached 1.4 eggs/nest (SD = 0.83, n=845 nests), which is normal for the colony (mean for 21 years = 1.4 eggs/nest, RTB. unpublished data). As in 1987, however, fledging success was very low as a result of chick starvation (RTB, *pers. obs*, T. Boulinier, *pers. comm.*). Although not monitored in detail, the 2003 kittiwake breeding season on Bjørnøya was rather poor, with fewer pairs than usual laying eggs, and low breeding success (H. Strøm, *pers. comm.*). Furthermore, there

was a report in June from a whaling vessel operating east of Bjørnøya of kittiwakes in poor condition landing on deck, where some even laid eggs!

Although annual monitoring counts at two colonies in Finnmark, on Bjørnøya and in Svalbard, revealed lower numbers of apparently occupied nests, it is very difficult to attribute this to the wreck as population trends had been declining in all colonies since the mid-1990s (Lorentsen 2003).

This wreck emerges as yet another example of the consequences of the breakdown in the normal trophic interactions between prey fish and seabirds. A strong association between capelin spawning behaviour and seabirds, particularly Black-legged Kittiwakes, has also been reported from Newfoundland, where delays in the capelin spawning movements adversely affected chick production (Massaro *et al.* 2000, Jamieson *et al.* 2000, Carscadden *et al.* 2002, Davoren & Montevecchi 2003).

VOORJAARSSTRANDING VAN DRIETEENMEEUWEN *RISSA TRIDACTYLA* IN NOORD-NOORWEGEN, APRIL 2003

In Noord-Noorwegem spoelden eind april 2003 grote aantallen dode Drieteenmeeuwen *Rissa tridactyla* aan. Onderzoek aan 51 kadavers gaf aan dat deze dieren door voedselgebrek gestorven zijn. Meer dan 90% van de verzamelde kadavers waren mannetjes. Ten tijde van de stranding kwamen ook berichten door dat veel grote kolonies in Noord-Noorwegen tijdelijk verlaten waren en dat in een tijd dat vogels normaliter met broeden zouden beginnen. Het lijkt erop dat Noord-Noorse Drieteenmeeuwen afhankelijk zijn van de jaarlijkse voorjaarstrek gericht op het kuit schieten van Lodde *Mallotus villosus* langs de kust van Finnmarken. In 2003 was de populatie echter klein en kuit schieten vond uitzonderlijk ver in het westen plaats, waardoor vogels in hun zoektocht naar voedsel gedwongen waren om de kolonies te verlaten. Toen kleine aantallen Lodde half mei langs de kust van Finnmarken opdoken keerden Drieteenmeeuwen terug naar hun kolonies en verliep het broedproces verder normaal. De beschreven stranding was uitzonderlijk, omdat alkachtigen gewoonlijk slachtoffer worden van voedselgebrek, geen Drieteenmeeuwen.

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Common Guillemot feeding chick. Zeekoet met voer voor kuiken *(Kees Camphuysen)*