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Studies of Thick-billed Murres on Coats Island, Northwest Territories, in 1981, 1984, 1985, and 1986

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Introduction

Before 1981, the colony of Thick-billed Murres (*Uria lomvia*) situated just west of Cape Pembroke, Coats Island (62°57′N, 82°00′W), had been visited only briefly by biologists, and there was no information available concerning their breeding biology or ecology. In 1981, as part of the Hudson Strait Seabird Project, A.J. Gaston and S.A. Smith spent 10 days there making a preliminary investigation of the colony, including a census of numbers present.

On the basis of their observations, the island was chosen in 1984 for a detailed study of population dynamics to provide information relevant to the management of the winter hunt of Thick-billed Murres in Newfoundland and Labrador. Almost nothing was then known about the population dynamics of Thick-billed Murres, except for measurements of reproductive success at several colonies. The first stage of the study involved the banding of chicks at Coats Island over a period of several years to provide a substantial known-age population on which observations of age of first breeding and age-specific reproductive success could be based.

The Coats Island colony was selected for two principal reasons:

(1) it is relatively small in comparison with other Eastern Arctic Thick-billed Murre colonies, and a high proportion of the chicks could therefore be banded;
(2) the cliffs are easier and safer to climb on than those at other colonies. They are less than 100 m high, composed of firm, nonshattering rock, and include many broad ledges descending in steps that minimize the amount of climbing necessary.

The original plan of the study envisaged four years of relatively brief visits to the colony to carry out chick banding (1984–87), followed by two years of intensive observations of breeding biology (1988–89). However, fewer chicks were banded in 1984 than anticipated, and some of these subsequently lost their colour bands because the diameter used in 1984 was too large. In addition, it appears that only a small proportion of Thick-billed Murres breed in their fourth year (see below). Consequently, we now plan for the intensive observations to be carried out in 1989 and 1990. Although the main results of the study will only be available after 1990, this interim report has been prepared to provide information collected in 1981 and during the first three years of the present project. Because the work is still continuing, we have concentrated on presenting base-line data that may be useful for comparison with Thick-billed Murre biology elsewhere. We have not included any interpretation or synthesis of results, as we await collection of further data in future years.

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Timing of visits and description of work carried out

The visit in 1981 was made from 9 to 18 August. A census of the number of birds present was carried out, the colony was photographed from land and sea, and a sample of chicks was weighed, measured, and banded.

The 1984 field crew, consisting of A.J. Gaston (AJG), R.D. Elliot (RDE), and C. Hyslop, was there from 5 to 18 August. Another photographic inventory was made; chicks were again banded, and some weighed and measured. Adult Thick-billed Murres were also banded and a sample was measured. Observations were made on birds banded with single metal bands—the majority presumably those banded as chicks in 1981.

The procedures followed in subsequent years have been similar to those of 1984. In 1985, the field crew, consisting of RDE, D.G. Noble (DGN), S. Wendt, and A.J. Erskine, remained from 27 July to 11 August. A sample of adult murres was collected for morphometric analysis and a daily count of birds at selected study plots was started. In 1986, the count was continued, and three 24-h watches were made to record feeding frequencies and changes in attendance. The field season extended from 22 July to 10 August. Because the field crew (AJG, DGN, J. Geale and D. Draulans) arrived earlier in 1986 than in the preceding years, they were able to obtain measurements of eggs and chick growth rates. Some observations were also made on birds banded as chicks in 1984.

Banding in 1981 and 1984 was carried out using standard US Fish and Wildlife Service size 5 stainless-steel bands. In 1985, special murre bands designed by the British Trust for Ornithology and manufactured by Lambourne's of Knowle, UK, were introduced. They were engraved with the Canadian Wildlife Service address in St. John's, Newfoundland, in an effort to improve recovery rates. All adults and half the chicks in 1985, and all birds caught in 1986, were banded with the new bands, which are designed so that the numbers on them can be read more easily at a distance than those on the old bands.

In all years, fish found on the breeding ledges were collected, identified, measured, and, if fresh, weighed.

Description and census

The colony at present is divided into two subcolonies about 1 km apart, both situated on the west side of small coves (East and West Colony Coves, Fig. 1). According to C.R. Harington (pers. com. to L.M. Tuck), there was a third subcolony on the east side of West Colony Cove in 1962, but we have never seen birds in that area. There are no real cliffs there, and the spot does not appear to provide suitable breeding sites for murres. It is possible that the birds seen by Harington were non-breeders. However, the disappearance of

birds of any status from that area suggests that the colony may have contracted slightly since 1962.

The western subcolony (the main colony) forms a very dense aggregation extending about 500 m from close to the northern tip of the cove to a deep gully at the south end. The highest sites are about 70 m above sea level, and the lowest just above the splash zone. The cliffs, which descend in a series of broad steps, go right down to the sea; there is no beach. Above the area occupied by murres are steep slopes covered with a thick turf of grasses, mosses, and scurvy grass. Turf also covers the top of the promontory.

The eastern subcolony (the east colony) is similar but is less densely occupied. Ledges are generally smaller and the cliffs steeper, although they are broken by a broad, slanting, grassy ledge halfway up. The rock on the east colony is generally more fragile than that of the main colony, and the birds are harder to see from the land; consequently, practically all research was conducted on the main colony.

We counted the numbers of birds present on the main colony with a 22-power telescope from the opposite side of the cove on 15 August 1981. After a sample count of 7900 birds was made one by one, we estimated the remainder by hundreds and obtained a final estimate of 26 500 birds. Using a conversion factor of 0.7 (Gaston and Nettleship 1981), this suggests a breeding population of about 18 500 pairs. A less exact estimate of 7500 birds for the east colony was obtained from the sea on the same day, counting by hundreds. This suggests about 5200 pairs making a combined total of about 24 000 pairs — slightly larger than the estimate given by Brown *et al.* (1975) based on an aerial survey by D.N. Nettleship in 1972.

Banding and resightings of banded birds

To date, we have banded over 500 adults and nearly 7000 chicks (Table 1). From 1984 on, all adults received two colour bands, a light green band placed above the metal band on the right leg signifying "adult of unknown age," and a year-code colour on the left leg. In 1986, a few birds were banded with the combinations on the opposite leg so as to make it easier to read numbers from a nearby blind or to distinguish members of a mated pair. Chicks banded from 1984 on received one colour band, a year code placed above the metal band on the right leg.

In 1984, many banded birds, presumably those banded as chicks in 1981, were present on the main colony, but none appeared to be breeding, and most acted as though prospecting rather than holding sites. In 1985, one banded bird was seen brooding a chick. The band number could not be read, but it may have been one of 14 banded as adults in 1981. No birds banded as chicks in 1984 were seen.

In 1986, three birds banded with single metal bands were caught while brooding chicks, and all proved to have been banded as chicks in 1981. Another three banded birds with chicks could not be caught. Many birds banded as chicks in 1984 were seen, all behaving as though prospecting, but none banded as chicks in 1985 were present.

In summary, it appears that few, if any, Thick-billed Murres bred at four years old, but that some did at five years old. We do not know what proportion of the 1981 cohort still surviving in 1986 was actually breeding. These observations concur with similar observations at Digges Island in 1985, where some five-year-olds were seen breeding but no three-year-olds (RDE, DGN unpubl.). First-year birds clearly do not visit the colony, an observation also supported by observations at Digges Island in 1981 and 1982 (AJG, DGN unpubl.).

Adult measurements and weight

Adult murres caught on the cliffs were weighed and inspected for the presence of a brood patch, and a sample of them was measured. The measurements taken were wing (maximum chord), tarsus, and four bill dimensions: culmen, nostril-to-tip, gape (length of white line), and depth at the gonys (see Gaston *et al.* 1983 for details). In addition, the minimum external interorbital width (EIW) was measured by pressing a pair of calipers gently but firmly into the tops of the orbital cavities and closing them until they encountered resistance from the supra-orbital ridges at their narrowest constriction. This procedure requires care and some practice. Internal interorbital width (measured on the skull) provides a good method for discriminating first-year from older Thick-billed Murres in winter (Gaston 1984). More recently, RDE (unpubl.) has found that the external measurement, as described, is also effective in distinguishing first-year birds.

A comparison of samples measured in 1984, 1985, and 1986 suggests that, despite changes in personnel, it was possible to maintain reasonable consistency in measurements (Table 2). Significant inter-year variation occurred only in tarsus and bill depth, presumably reflecting variation in techniques employed, although bill depth varied between the sexes more than other measurements, and the inter-year differences may be partly explained by differences in sex ratio within the samples measured.

In 1985, we collected 26 adults at sea, about 1 km from the colony, which were sexed by dissection. Significant differences between the sexes were found in tarsus, culmen, and nostril-to-tip measurements (Table 3). When the sexes were pooled, the collected sample differed significantly from the unsexed sample measured on the cliffs in tarsus, nostril-to-tip, and bill depth measurements (Table 4). These differences may be related, in part, to the unbalanced sex ratio of the collected sample (17 females : 9 males).

Timing of breeding

We obtained approximate estimates of timing of hatching by aging samples of chicks on the basis of their wing length. At least one hundred chicks were measured each year. In 1986, additional observations were made of the timing of pipping and hatching of eggs not already hatched at the time of our arrival. For eggs not beginning to pip, we estimated the number of days they had been incubated by their density index (weight/(length × breadth^2)) (Gaston *et al.* 1985), and used this to estimate probable hatch dates.

All of our samples are probably biased somewhat by the higher rate of loss of late-laid eggs typical of Thick-billed Murres (Gaston and Nettleship 1981, Gaston *et al.* 1985). However, the dates of earliest laying should not be affected, and the effect on median laying date is probably small. We estimated median hatching as 27 July in 1981, 22 July in 1984 and 1985, and 26 July in 1986, with significant variation among years ($Chi^2_{30} = 267.5$, $P < 0.01$, Fig. 2). These correspond to median laying dates of 25, 20, and 24 June, respectively, assuming an incubation period of 32 days (Gaston and Nettleship 1981).

Both first and median laying dates are the earliest recorded for a Thick-billed Murre colony north of 60°N. Apparently, laying is normally earlier at Coats Island than at Digges Island, 300 km to the east (Table 5). In all years we estimate that 50% of eggs were laid within eight days or less during the peak of laying. The overall spread of laying dates (30–40 days) is similar to that recorded elsewhere (Gaston and Nettleship 1981, Birkhead and Nettleship 1981, Gaston *et al.* 1985).

Egg size

Egg volume indices (length × breadth^2) measured in 1986 ranged from 153.1 to 253.0 cm^3. The mean for pipping eggs measured from 23 to 25 July, all of which would have hatched in the central 50% of hatching, was 217.1 ± 15.7 cm^3 (N = 36). The mean for all eggs not pipping on the same dates, and hence hatching later, was 201.0 ± 16.8 cm^3 (N = 66). A plot of egg volume index on egg density index (weight/length × breadth^2) suggests a fairly constant decline in volume index over the period when unhatched eggs were laid, approximately the last 75% of laying (Fig. 3).

Egg volume indices found at Coats Island were comparable to those found on Digges Island in 1980–1982, where they declined from about 210 cm^3 in the first half of the season to about 190 cm^3 towards the end (Gaston *et al.* 1985). If anything, the Coats Island eggs appear to be slightly larger than those measured at Digges Island, making them the largest laid by any Thick-billed Murre population in the Eastern Arctic. However, as a proportion of adult weight, they are similar to those laid elsewhere (Table 6).

Chick growth

In 1986, growth in weight and wing length was monitored for a sample of chicks measured at three-day intervals. No measurements were made after 5 August because of bad weather; consequently, chicks for which date of hatching was known could only be measured to 10 days old. However, measurements on this sample were used to estimate the age of chicks that had already hatched when we arrived at the colony, and this additional sample allowed us to estimate growth curves for wing length up to 19 days old (Fig. 4). We used the observed wing lengths of our known-age sample to estimate the age of chicks weighed in earlier years, and this was the basis for our information on timing of breeding.

In 1986, seven chicks weighed at hatching, while still wet, averaged 71.8 ± 3.5 g. Weights of chicks less than 48 h old averaged 73.4 ± 8.1 g (N = 21), and wing lengths averaged 26.0 ± 0.74 mm (N = 21). Rates of growth during the first 14 days were similar to those observed elsewhere, with chicks reaching 180–200 g (Fig. 5). Older chicks continued to increase in weight in all years up to at least 21 days, and in 1981 to at least 25 days. However, ages beyond 19 days are based on extrapolations of wing length, assuming that the rate of growth observed over 14–19 days continues. At Prince Leopold Island in 1977, increase in wing length slowed slightly after 19 days; consequently, estimated ages used here may be slightly too low.

In 1981, mean weights at 21 days, the normal age of fledging at most other colonies, ranged from 229 to 242 g and at 25 days chicks averaged 256.5 g. Although we have no information on fledging weights, it is clear that the majority of chicks must have fledged at well over 200 g in all years. This weight is heavier than at any of the other Hudson Strait colonies (Gaston *et al.* 1983), but similar to fledging weights at Prince Leopold Island (Gaston and Nettleship 1981).

Chick diet

All fish found on the breeding ledges that appeared fresh and complete were collected for identification. They were weighed to the nearest 0.1 g on a digital electronic balance, fork lengths were measured to the nearest millimetre, and they were then preserved in 70% isopropyl alcohol. The fish were identified by the staff of the National Museum of Natural History in 1981 and 1984 and by DGN with the assistance of museum staff in the later years.

Fish delivered to chicks were recorded when observed during the course of other work on the colony. However, certain groups were impossible to identify to species except in the hand, and these were classified simply as "blennies," "sculpins," and "sand lance."

Thick-billed Murres, unlike Common Murres (*Uria aalge*), do not use fish in courtship behaviour (Birkhead 1985); consequently, all fish found on the ledges had probably been intended as chick meals. They may have been dropped accidentally, delivered before the chick had hatched, or discarded by the chick as being too difficult to handle or too large to swallow. In any case, they are unlikely to be a completely unbiased sample. However, proportions of species collected and observed did not differ significantly in any year. We have therefore assumed that any biases involved were relatively small and we have combined our collected and observed samples for inter-year comparison.

The most common species in all years was the Arctic cod (*Boreogadus saida*), which made up 32–47% of fish recorded, based on the collected and observed samples combined. In 1981 and 1986, sculpins (*Cottidae*) were the next most common category, while in 1984 and 1985 capelin (*Mallotus villosus*) were in second place. Blennies (*Blennioidea*) ranked third in 1985 and 1986 and fourth in the earlier years (Fig. 6). Species richness was highest in 1984, when 13 taxa were identified in the chick diet (Table 7).

To estimate the contribution by weight of different fish to the chick diet we multiplied the number of each identified taxon by the mean weight of collected specimens. On this basis, Arctic cod again ranked first in all years, composing 42 of chick diet by weight. Sculpin ranked second in all

years except 1985, when blennies were second, and capelin, which generally weighed less than the other fish, ranked fourth in all years except 1984 (Table 8). If we assume that the majority of Arctic cod and capelin were caught in mid-water, and that most blennies and sculpin were taken on the bottom, then Thick-billed Murre chicks received approximately one-third benthic fishes and two-thirds mid-water fishes by weight.

There was some variation among years in the proportions of different species detected in chick diets. However, the general picture of a diet consisting of one-half Arctic cod with the remainder made up of a mixture of capelin, blennies, and sculpins was true for all years. Species richness was higher in all years than in any of three years at Prince Leopold Island (Gaston and Nettleship 1981) and one year at Coburg Island and Cape Hay, Bylot Island (Birkhead and Nettleship 1981). This supports the analysis of Gaston (1985), who found that chick diets at Low Arctic Thick-billed Murre colonies tend to be more diverse than those at High Arctic colonies.

Conclusions

We have found, based on the four years of data collected so far, that conditions for Thick-billed Murre reproduction at Coats Island are good and relatively stable from year to year. Both early laying dates and rapid growth of chicks provide evidence that food is more readily available at Coats Island than at the nearest colony, Digges Sound. Egg size, though large, seems to be related chiefly to the size of adult birds, which is also comparatively large.

Although major results from the banding programme will not be available for several years, we have already demonstrated that first-year Thick-billed Murres do not visit the breeding colony, but that second-year birds do so in quite large numbers. We also know that few, if any, birds breed in their fourth year, but some, perhaps a substantial proportion, do so in their fifth year. As second-year birds do not remain long in one place, we assume that at this age their time is mainly devoted to prospecting. Presumably, sites are acquired and defended in the third and fourth years. Information on the time spent by different age cohorts in the vicinity of the colony will enable us to make more accurate predictions about the possible effect of catastrophic mortality from oil spills near a colony.

As well as providing information on population dynamics, the project should answer a variety of questions about age-related aspects of behaviour and the acquisition and maintenance of breeding sites. Many of these questions are peripheral to the aims of CWS, but are of general scientific interest and have the potential to attract academic research. In due course we hope to collaborate with university departments so that such opportunities are not wasted.

Acknowledgements

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References

Birkhead, T.R. 1985. Coloniality and social behaviour in the Atlantic Alcidae. Pages 355–383 *in* Nettleship, D.N.; Birkhead, T.R. eds. The Atlantic Alcidae. Academic Press, London.

Birkhead, T.R.; Nettleship, D.N. 1981. Reproductive biology of Thick-billed Murres *Uria lomvia*: an inter-colony comparison. Auk 98: 258–269.

Brown, R.G.B.; Nettleship, D.N.; Germain, P.; Tull, C.E.; Davis, T. 1975. Atlas of eastern Canadian seabirds. Can. Wildl. Serv. 220 pp.

Gaston, A.J. 1984. How to distinguish first-year murres, *Uria* spp., from older birds in winter. Can. Field-Nat. 98: 52–55.

Gaston, A.J. 1985. The diet of Thick-billed Murre chicks in the eastern Canadian arctic. Auk 102: 727–734.

Gaston, A.J.; Cairns, D.K.; Elliot, R.D.; Noble, D.G. 1985. A natural history of Digges Sound. Can. Wildl. Serv. Rep. Ser. No. 46. 63 pp.

Gaston, A.J.; Chapdelaine, G.; Noble, D.G. 1983. The growth of Thick-billed Murre chicks at colonies in Hudson Strait: inter- and intra-colony variation. Can. J. Zool. 61: 2465–2475.

Gaston, A.J.; Chapdelaine, G.; Noble, D.G. 1984. Phenotypic variation among Thick-billed Murres from colonies in Hudson Strait. Arctic 37: 284–287.

Gaston, A.J.; Nettleship, D.N. 1981. The Thick-billed Murres of Prince Leopold Island. Can. Wildl. Serv. Monogr. No. 6, 350 pp.

Tuck, L.M. 1961. The murres. Can. Wildl. Serv. Monogr. No. 1, 260 pp.

Figure 1
Map showing the position of localities mentioned in the text

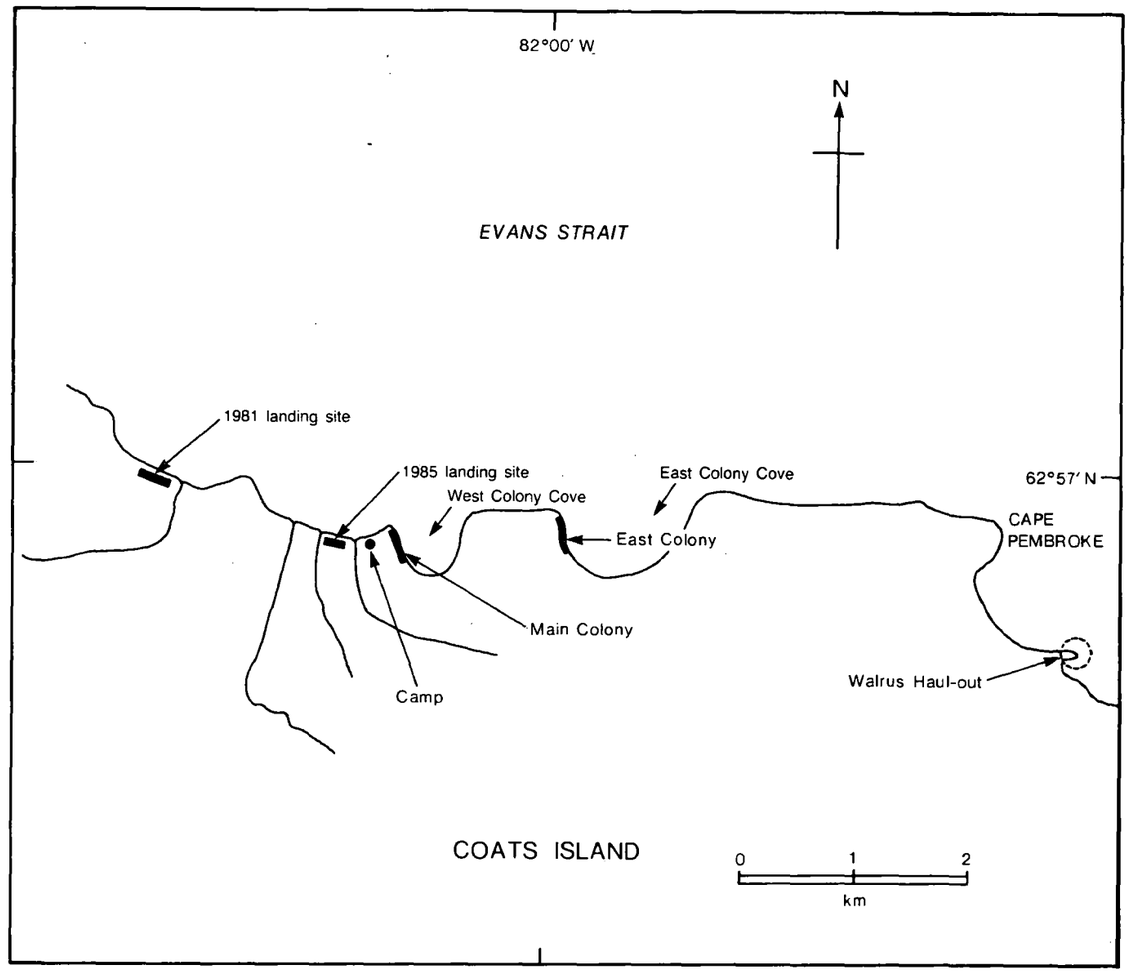


Figure 2
Timing of hatching for Thick-billed Murres at Coats Island in four years

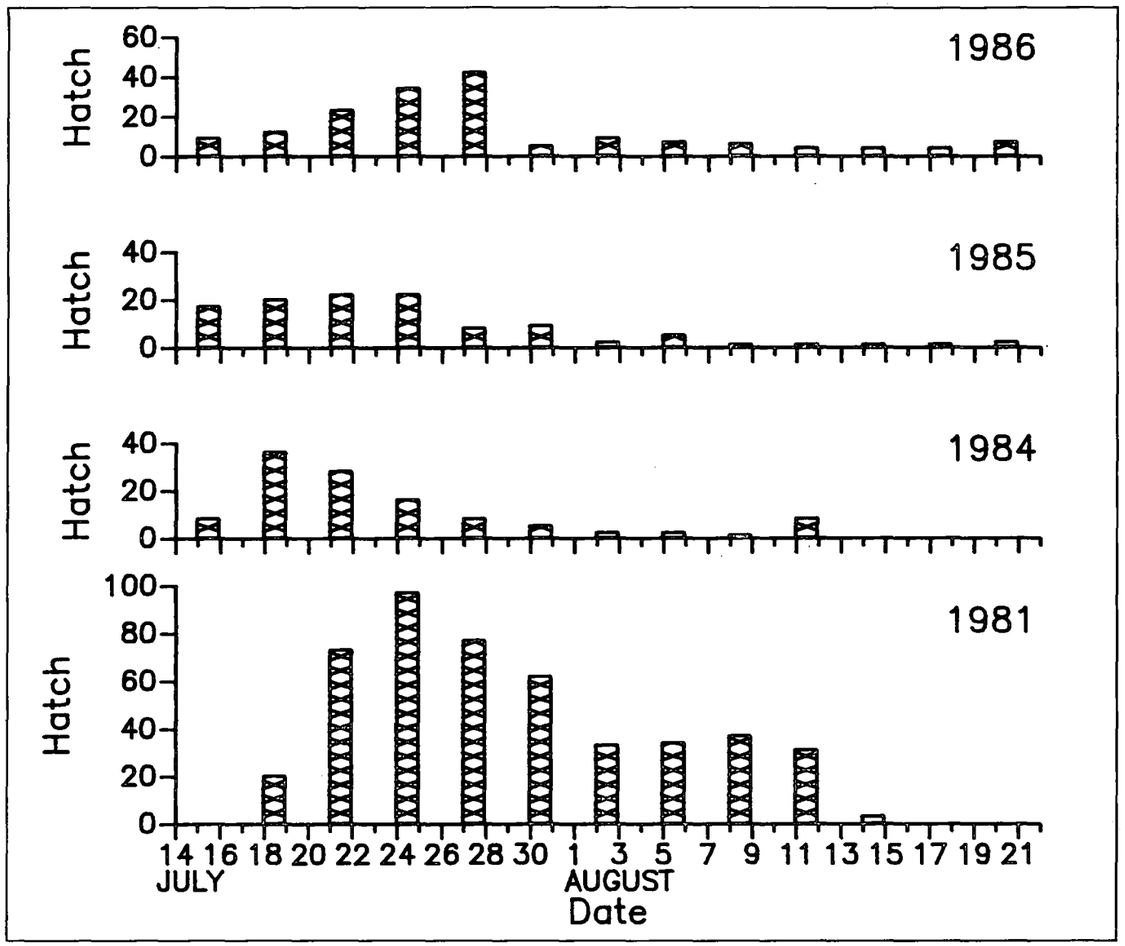


Figure 3
Volume indices of Thick-billed Murre eggs in relation to density indices on 24–25 July 1986

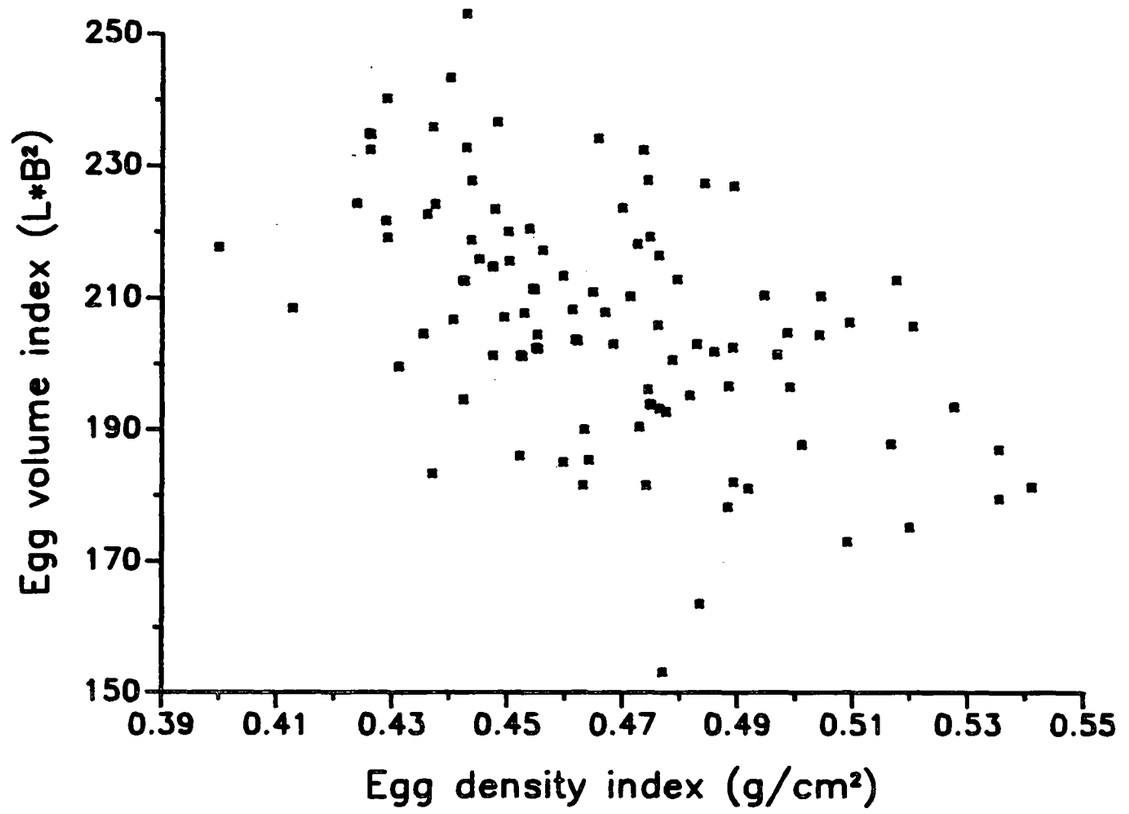


Figure 4
Wing length of Thick-billed Murre chicks in relation to age (day of hatching = day 1)

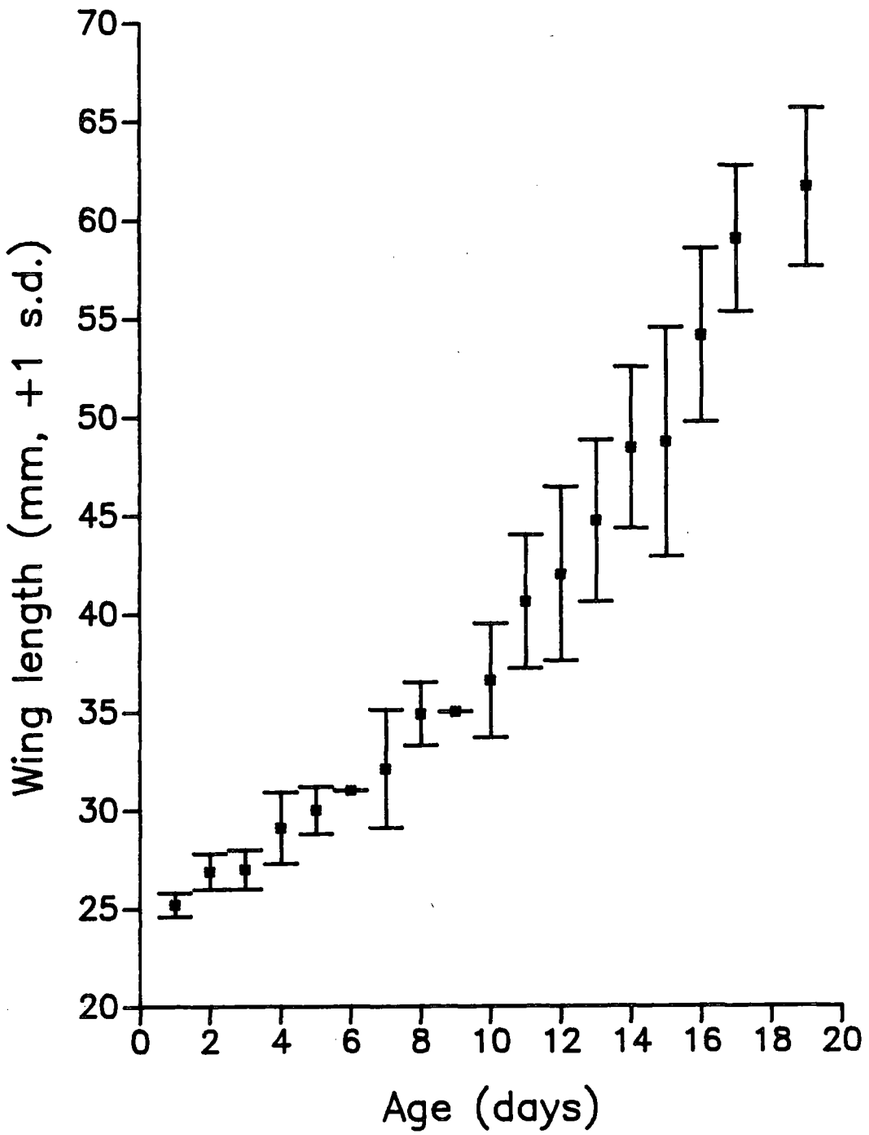
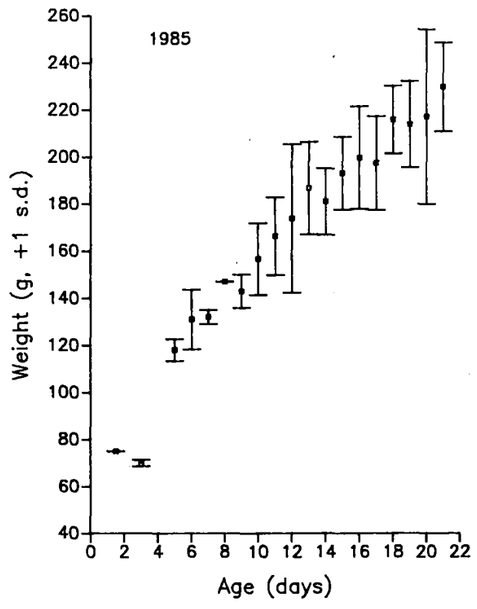
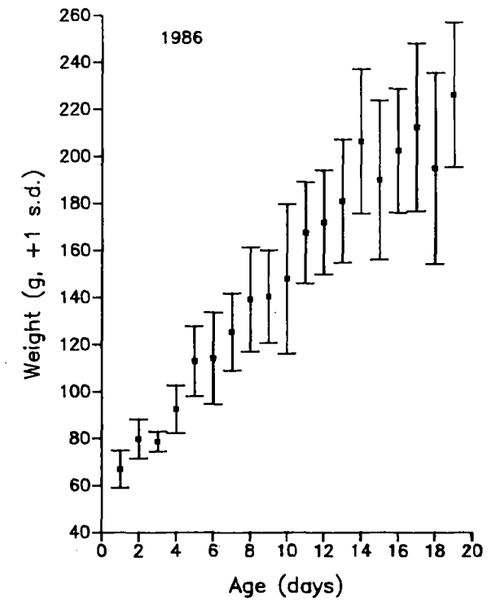
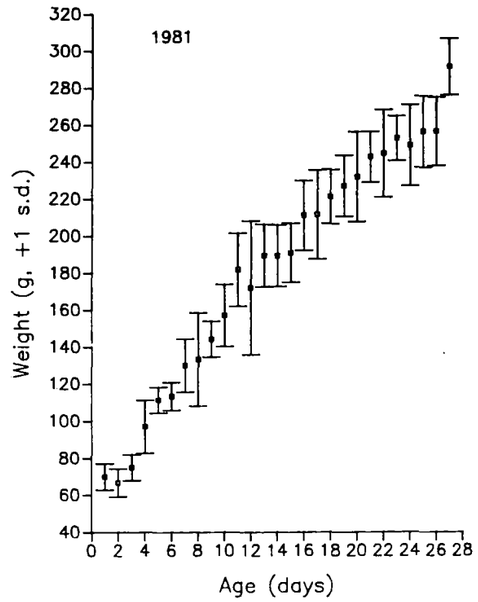


Figure 5
Weight of Thick-billed Murre chicks in relation to age for four years







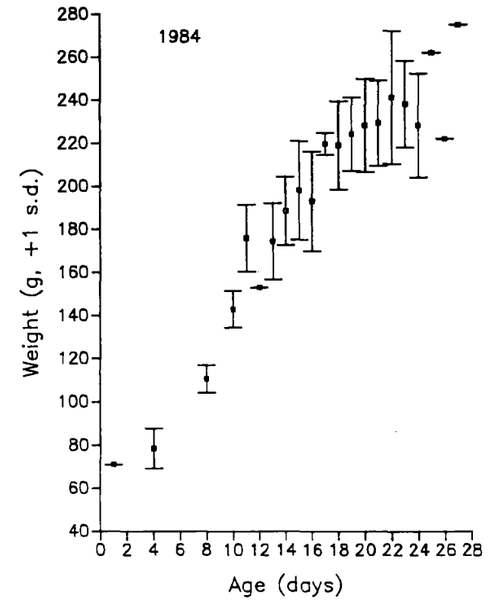


Figure 6
Proportions of different taxa in the diet of Thick-billed Murre chicks over four years

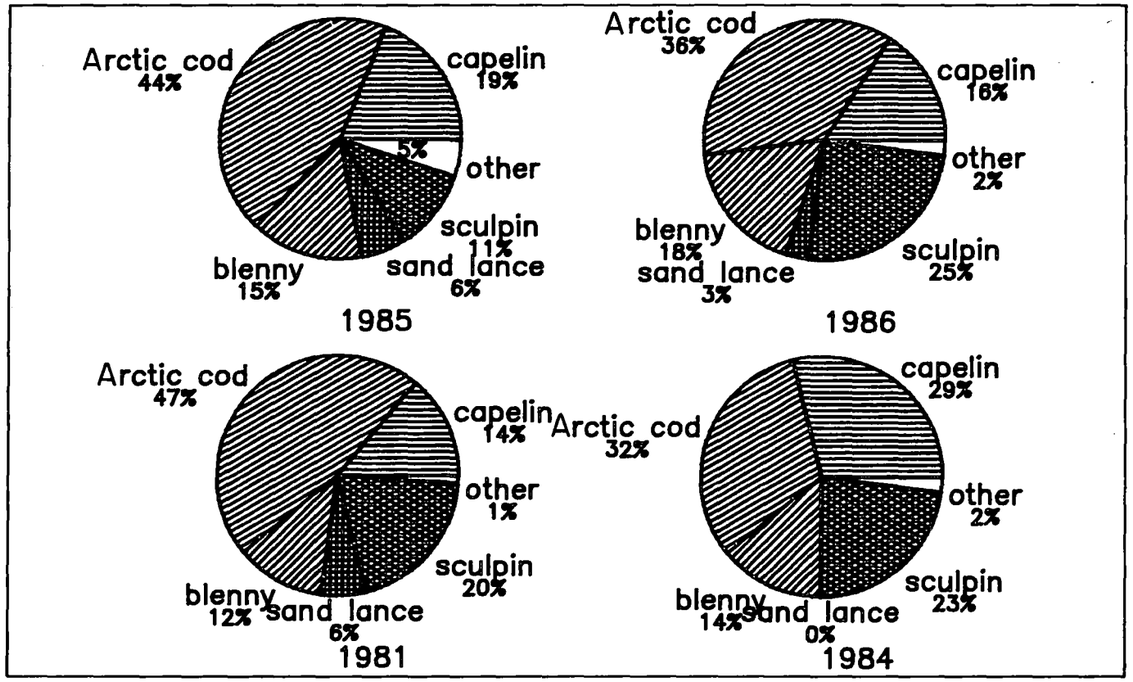


Table 1
Details of banding and controls at Coats Island to date

	Numbers banded		Numbers seen or recaptured from			
Year	Adult	Chicks	1981	1984	1985	Year colour
1981	14	1584	—	—	—	Nil
1984	141	1454	0	—	—	White
1985	134	1619	0	12	—	Yellow
1986	278	2237	3	11	16	Red
Totals	567	6894	3	23	16	

Table 2
Linear measurements (millimetres) of breeding adults captured on the colony

	1984			1985			1986		
Measurement	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N
Wing	218.3	4.9	45	220.3	5.2	18	219.9	5.2	36
Tarsus	37.8	1.7	45	[42.1	4.4	18]	37.9	1.5	36
Bill: culmen	35.7	1.9	45	36.0	2.1	36	35.8	1.5	36
nostril	28.7	1.4	45	29.3	1.8	36	29.1	1.2	36
gape (w. line)	—	—	—	—	—	—	56.9	1.5	36
depth	14.0	0.7	45	14.8	1.1	37	15.1	0.6	36
External interorbital width	16.9	1.1	45	16.8	1.0	37	17.2	0.9	19

Table 3
Measurements of adult Thick-billed Murres sexed by dissection in 1985

	Sex	$\bar{x}$	SD	n	P*
Weight (g)	F	999.9	78.5	17	NS
	M	1006.1	64.2	9	
Wing-length (mm)	F	220.1	6.7	17	NS
	M	219.7	2.7	9	
Tarsus (mm)	F	38.2	1.2	17	P<0.05
	M	39.9	2.0	9	
Culmen (mm)	F	34.5	1.6	15	P<0.05
	M	36.1	1.8	9	
Nostril (mm)	F	27.5	1.9	15	P<0.05
	M	29.0	1.0	9	
Depth (mm)	F	13.9	0.6	17	NS
	M	14.2	1.1	9	
External interorbital width (mm)	F	16.2	1.8	17	NS
	M	16.3	1.8	9	

*Differences compared with two-sample t-test.

Table 4
Measurements of living and dead adult Thick-billed Murres at Coats Island in 1985

		$\bar{x}$	SD	n	P*
Weight (g)	Live	937	73	18	P<0.01
	Dead	1002	73	26	
	Total	975	79	44	
Wing-length (mm)	Live	220.3	5.2	18	NS
	Dead	220.0	5.6	26	
	Total	220.1	5.4	44	
Tarsus (mm)	Live	42.1	4.4	18	P<0.01
	Dead	38.8	1.7	26	
	Total	40.1	3.4	44	
Culmen (mm)	Live	36.0	2.1	36	NS
	Dead	35.1	1.8	24	
	Total	35.7	2.0	60	
Nostril (mm)	Live	29.3	1.8	36	P<0.01
	Dead	28.1	1.7	24	
	Total	28.8	1.9	60	
Depth (mm)	Live	14.8	1.1	37	P<0.001
	Dead	14.0	0.8	26	
	Total	14.5	1.0	63	
External interorbital width (mm)	Live	16.8	1.0	37	NS
	Dead	16.2	1.7	26	
	Total	16.6	1.4	63	

*Differences between samples of live and dead murres compared with two-sample t-test.

Table 5
Hatching dates at Thick-billed Murre colonies in the Eastern Canadian Arctic

Colony	Hatching date: Year	First	Median	Reference
Prince Leopold Is.	1975	24 July	29 July	Gaston and Nettleship 1981
74°02′N, 90°00′W	1976	20 July	31 July	Gaston and Nettleship 1981
	1977	23 July	5 Aug.	Gaston and Nettleship 1981
	1978	5 Aug.	19 Aug.	Nettleship *et al.* unpubl.
	1984	29 July	10 Aug.	Gaston unpubl.*
Coburg Is.	1979	27 July	3 Aug.	Birkhead and Nettleship 1981
75°48′N, 79°25′W	1981	21 July	4 Aug.	Nettleship unpubl.**
Cape Graham Moore	1954	24 July	—	Tuck 1961
72°56′N, 76°02′W	1957	22 July	—	Tuck 1961
Cape Hay, Bylot Is.	1979	28 July	7 Aug.	Birkhead and Nettleship 1981
73°46′N, 80°23′W				
The Minarets	1985	18 July	24–27 July	Gaston unpubl.*
67°00′N, 62°00′W				
Hantzsch Is.	1982	25 July	6 Aug.	Gaston unpubl.
61°55′N, 65°00′W				
Akpatok Is. – S. colony	1954	1 Aug.	?	Tuck 1961
60°10′N, 68°30′W	1981	2 Aug.	10 Aug.	Gaston unpubl.**
	1982	—	11 Aug.	Gaston *et al.* 1983
Akpatok Is. – N. colony	1983	3 Aug.	—	Gaston unpubl.
60°32′N, 68°00′W				
Digges Is.	1955	17 July	—	Tuck 1961
62°33′N, 77°43′W	1979	—	c. 1 Aug.	Gaston unpubl.**
	1980	20 July	28 July	Gaston *et al.* 1985
	1981	26 July	31 July	Gaston *et al.* 1985
	1982	20 July	4 Aug.	Gaston *et al.* 1985
	1985	19 July	30 July	Elliot and Gaston unpubl.*
Coats Is.	1981	18 July	27 July	This study**
62°57′N, 82°00′W	1984	17 July	24 July	This study**
	1985	14 July	23 July	This study**
	1986	13 July	26 July	This study*/**

*Based on egg density indices.
**Based on chick wing-lengths.
All other records based on direct observations.

Table 6
Egg volume indices, estimated fresh weights, and adult weights for Thick-billed Murres in the Eastern Canadian Arctic

Colony	Years	Egg volume indices* (g/cm^3)	Estimated fresh weight† (g)	Adult weight‡ (g)	Fresh weight / Adult weight %
Prince Leopold Is.	1975–77	189.2 (149)§	99.6	907 (130)	10.98
Coburg Is.	1979	188.9 (65)	99.4	850 (31)	11.69
Cape Hay, Bylot Is.	1979	180.5 (30)	95.3	874 (26)	10.90
Digges Is.	1980–82	205.1 (425)	107.4	962 (148)	11.16
Hantzsch Is.	1982	192.2 (139)	101.0	958 (95)	10.55
Akpatok Is.	1982	192.6 (52)	101.2	831 (22)	12.18
"The Minarets"	1985	200.6 (36)	105.2	985 (101)	10.68
Coats Is.	1986	209.4 (102)	109.5	992 (75)	11.04

*In multi-year studies mean of annual means has been used.
†Estimated by regression; weight = 0.4917 × (volume index) + 6.5327 (Gaston *et al.* 1985).
‡Where sexes were averaged separately, we give the mean of the two values.
§Figures in parentheses give sample sizes.
References: Prince Leopold Island, Gaston and Nettleship (1981) (egg volumes from Table 52, plot S all years); Coburg Is. and Cape Hay, Birkhead and Nettleship (1981); Digges Is., Gaston *et al.* (1985); Hantzsch and Akpatok Islands, Gaston *et al.* (1983); The Minarets, Gaston, unpubl.; Coats Is., this study.

Table 7
Meals fed to Thick-billed Murre chicks

Species	1981	1984	1985	1986
Capelin (*Mallotus villosus*)	5 (7)*	13 (52)	9 (25)	14 (30)
Arctic Cod (*Boreogadus saida*)	11 (24)	12 (57)	32 (58)	35 (67)
Blennioidea				
Fish Doctor (*Gymnelus viridis*)		2	2	4
Four-lined Snake Blenny (*Eumesogrammus praecisus*)		3	2	6
Arctic Shanny (*Stichaeus punctatus*)			2	4
Daubed Shanny (*Leptoclinus maculatus*)		3		4
Slender Eel-Blenny (*Lumpenus fabricii*)		1		
Banded Gunnel (*Pholis fasciata*)			2	
All blennies, including unidentified	2 (6)	9 (25)	9 (19)	19 (34)
Northern sand lance (*Ammodytes dubius*)	2			
Stout sand lance (*A. hexapterus*)				2
All *Ammodytes*, including unidentified	2 (3)		5 (8)	5 (6)
Cottidae				
Arctic Staghorn Sculpin (*Gymnocanthus tricuspis*)		2		
Spatulate Sculpin (*Icelus spatula*)		1		
Shorthorn Sculpin (*Myoxocephalus scorpius*)		4		
Ribbed Sculpin (*Triglops pingeli*)		2	8	10
All sculpins, including unidentified	7 (10)	9 (41)	8 (15)	27 (45)
Lumpsuckers (*Eumicrotremus* spp.)			1 (3)	
Gelatinous snailfish *Liparis fabricii*		(1)		
Greenland halibut (*Reinhardtius hippoglossoides*)	(1)			
Squid (*Gonatus fabricii*)		1 (2)		2 (3)
Crustacea		(2)	2 (3)	
Totals	27 (51)	45 (180)	66 (131)	102 (185)

*First figure is the number collected from ledges. Figures in parentheses are totals for collected and observed samples combined.

Table 8
Proportion of different taxa by weight in the diet of Thick-billed Murre chicks in four years

Taxon	1981 Number	1981 Weight $\bar{x}$ (g)	1981 % by wt.	1984 Number	1984 Weight $\bar{x}$ (g)	1984 % by wt.	1985 Number	1985 Weight $\bar{x}$ (g)	1985 % by wt.	1986 Number	1986 Weight $\bar{x}$ (g)	1986 % by wt.
Capelin	7	(5.0)*	5	52	5.3	14	25	4.8	5	30	6.9	8
Arctic Cod	24	17.6	65	57	18.0	53	58	15.9	65	67	14.4	42
Blenny spp.	6	(5.0)	5	25	9.3	12	19	15.0	17	34	10.7	17
Sand lance spp.	3	(5.0)	2	0	—	—	8	5.0	3	6	8.5	4
Sculpin spp.	10	14.4	22	41	9.6	20	16	8.2	8	45	12.7	29
Snailfish spp.	0	—	—	1	(5.0)	<1	0	—	—	0	—	—
Lumpsucker spp.	0	—	—	0	—	—	3	8.0	1	0	—	—
Squid	0	—	—	2	(2.0)	<1	0	—	—	3	5.5	1
Crustacea	0	—	—	2	(0.2)	<1	3	0.3	<1	0	—	—
Other	1	(5.0)	1	0	—	—	0	—	—	0	—	—

*Weights in parentheses are visual estimates.