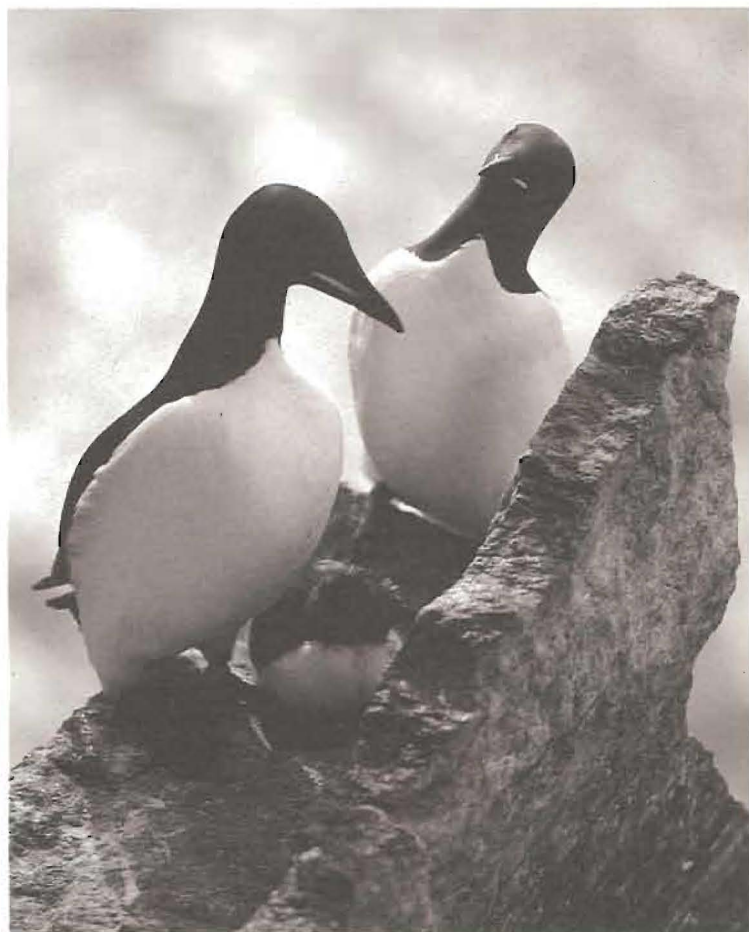


**Anthony J. Gaston
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Monitoring Thick-billed Murre populations at colonies in northern Hudson Bay, 1972-92

**Occasional Paper
Number 80
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Abstract

Direct counts of Thick-billed Murres *Uria lomvia*
present on study plots at Coats and East Digges islands, in
the eastern Canadian Arctic, have been carried out since
1980, and photographic counts are available for Coats Island
for 1972, 1984, and 1990. The Coats Island colony
expanded in area between 1972 and 1984, and the
population of the east subcolony doubled between 1972 and
1990; trends at the west subcolony were probably similar.
Counts of the study plots suggest that this increase may
have ceased about 1989. At the East Digges Island colony,
which is larger than the Coats Island colony by an order of
magnitude, the population may have declined between 1955
and 1980; since then, however, numbers have remained
stable. We speculate that intercolony movements by a small
proportion of birds may exaggerate fluctuations at Coats
Island, the smaller colony.

Résumé

On effectue depuis 1980 des dénombrements directs
des Marmettes de Brünnich *Uria lomvia* présentes sur des
parcelles d'étude des îles Coats et East Digges, dans l'est de
l'Arctique canadien, et il existe des dénombrements
photographiques sur l'île Coats pour les années 1972, 1984
et 1990. La superficie occupée par la colonie de l'île Coats a
augmenté entre 1972 et 1984, et la population de la
sous-colonie de l'est a doublé entre 1972 et 1990; les
tendances étaient probablement similaires pour la
sous-colonie de l'ouest. Les dénombrements effectués aux
parcelles laissent penser que cet accroissement a pu cesser
aux environs de 1989. À la colonie de l'île East Digges, plus
importante que celle de l'île Coats d'un ordre de grandeur,
la population peut avoir baissé entre 1955 et 1980; les
effectifs sont cependant restés stables depuis. On pense que
des mouvements d'une colonie à l'autre d'un petit nombre
d'oiseaux peuvent accentuer les fluctuations connues à la
colonie de l'île Coats, qui est plus petite.

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1. Introduction

The Thick-billed Murre *Uria lomvia* is the most abundant seabird breeding in Canada's eastern Arctic, with approximately 1.5 million pairs distributed among 10 colonies (Nettleship and Evans 1985). A large proportion of the population winters in waters off Newfoundland and Labrador, where it is subject to widespread hunting (Brown 1986; Elliot et al. 1991). Evidence from counts carried out at several colonies suggested that numbers declined between the 1950s and 1970s (Nettleship and Evans 1985). The decline may have been partly due to the heavy mortality of Thick-billed Murres in salmon gill-nets off West Greenland during 1968–76 (Tull et al. 1972; Christensen and Lear 1977).

In 1971, the Canadian Wildlife Service initiated a program designed to monitor the status of seabirds throughout eastern Canada. During 1975–82, baseline studies of the breeding biology of Thick-billed Murres were carried out at several colonies, including daily counts of numbers of birds present on selected study plots. These counts have been repeated subsequently over shorter periods (7–10 days) every few years, using a protocol (Type II) proposed by Birkhead and Nettleship (1980). In addition, oblique aerial photographs were obtained of all colonies during 1972–73 and subsequently when circumstances have permitted. Birds visible on these photographs were counted to provide estimates of total colony size, following techniques outlined by Nettleship (1976) and Birkhead and Nettleship (1980). In this paper, we report on the results of these monitoring observations at two colonies in northern Hudson Bay: East Digges and Coats islands (Fig. 1).

2. Methods

2.1 Coats Island

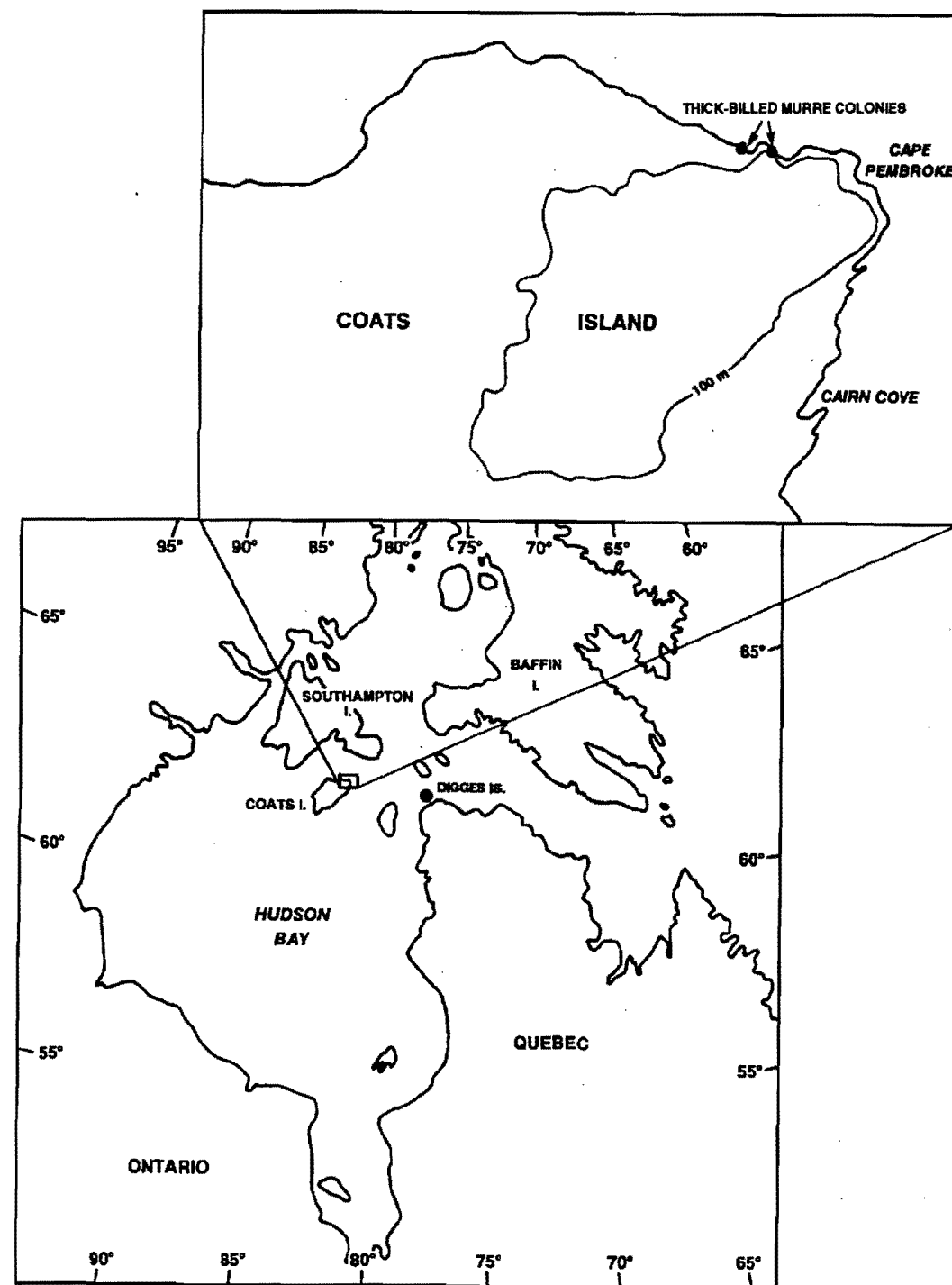
The Thick-billed Murres breeding on Coats Island occupy two small cliffs about 1 km apart just to the west of Cape Pembroke (62°30'N, 83°00'W; Fig. 2). The west subcolony was photographed from the air on 3 August 1971 by G.R. Parker, and both subcolonies were photographed on 16 July 1972 by DNN. Murres in the photographs of the west subcolony in 1972 cannot be counted accurately, but the extent of the breeding area in both subcolonies can be seen. Photographs of both subcolonies were also taken from the sea on 14 August 1984 and 11–13 August 1990. Murres in the 1972 photographs of the east subcolony and the 1984 and 1990 photographs of both subcolonies were counted by similar methods. Birds identified on 10" × 8" or 16" × 11" enlargements using a 10× magnifier were pricked with a pin as counted, either on the photograph or on a transparent overlay.

In 1985, 10 count plots were defined on the west subcolony (Fig. 3). They were chosen principally for their visibility from the cliff top; where choice was available, however, they were also selected to cover all heights above the sea and all types of ledge. Nevertheless, five plots included the uppermost part of the occupied area. Plots were recorded on photographs and counted daily from 1 to 10 August 1985. Daily counts of these plots have been carried out annually since then for varying periods, with 1–7 August covered in every year (Type II counts). Since 1986, the position of breeding sites at plot D has been mapped annually. Photographs of this plot were taken on 12 August 1981 and 10 August 1984, and these were used to map the boundary of the occupied area in those years. Studies of breeding biology (Type I; Birkhead and Nettleship 1980) were also carried out at the west subcolony in 1990–92, with all eggs laid being recorded daily on five study plots (D, N, P, Q, and S). In those years and in 1988, daily counts of the 10 count plots were carried out throughout the breeding season to determine seasonal changes in attendance patterns.

2.2 East Digges Island

The Thick-billed Murre colony on East Digges Island (62°33'N, 77°50'W) is situated on 4 km of cliffs that range in height up to nearly 200 m, averaging about 150 m. On the mainland coast of the Ungava Peninsula that faces the

Figure 1
Map showing the position of Coats and East Digges islands



island, a further 8 km of cliffs are occupied, this colony being known as "Cape Wolstenholme" (Tuck 1961; Brown et al. 1975). Together, the two colonies have also been treated as a single colony (Digges Sound; Gaston et al. 1985). A photo census of the East Digges Island colony was carried out based on photographs taken from a boat on 30 July 1980, giving an estimate of 180 000 breeding pairs (Gaston et al. 1985). Counts from the photographs taken at sea were corrected by comparison with those made from photographs taken from the cliff top of small areas of the colony that were much closer to the camera (<100 m, compared to >250 m). Because of uncertainties about the

application of the correction factor (Gaston et al. 1985), it does not seem appropriate to use the overall census results to estimate population changes. Consequently, the photo census has not been repeated.

In 1980–82, Type I monitoring of breeding biology was carried out at four study plots (A1, B, D, and F1, all of them also count plots) distributed along the top part of the colony, and daily counts were performed at 10 plots throughout the breeding season (Fig. 4). Daily counts of the same 10 plots were repeated for shorter periods in 1985 (21–26 July), 1990 (6–15 July), and 1992 (11–20 August). To make comparisons among counts made at different times

Figure 2
Map of the north coast of Coats Island, showing the positions of the subcolonies

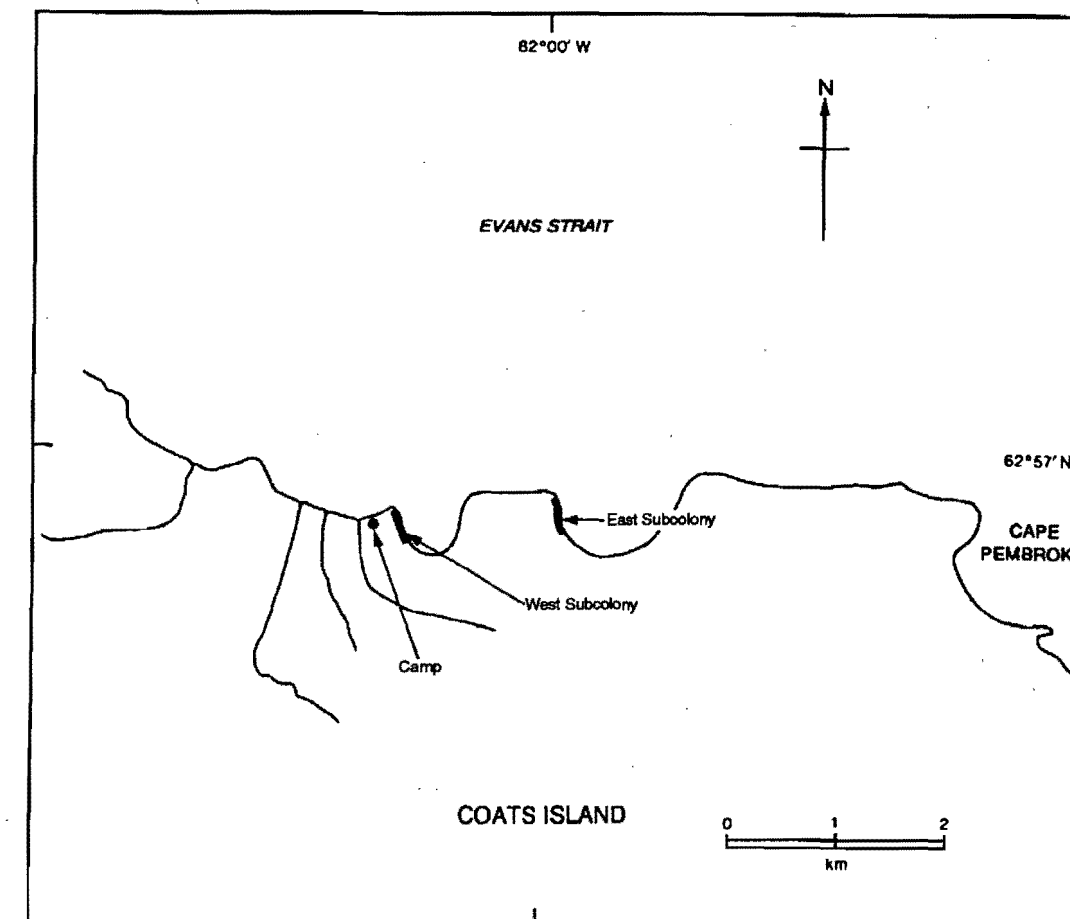


Figure 3
Sketch of the west subcolony at Coats Island, showing the positions of the study plots (not exactly to scale)

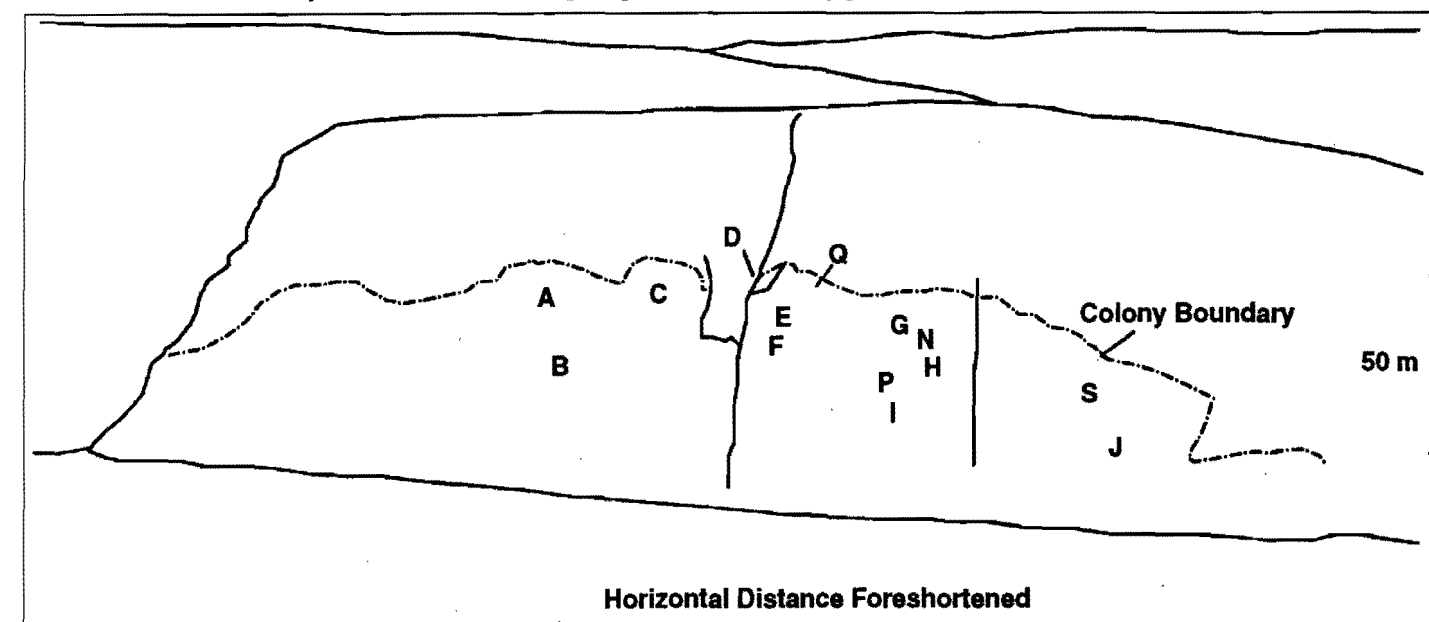
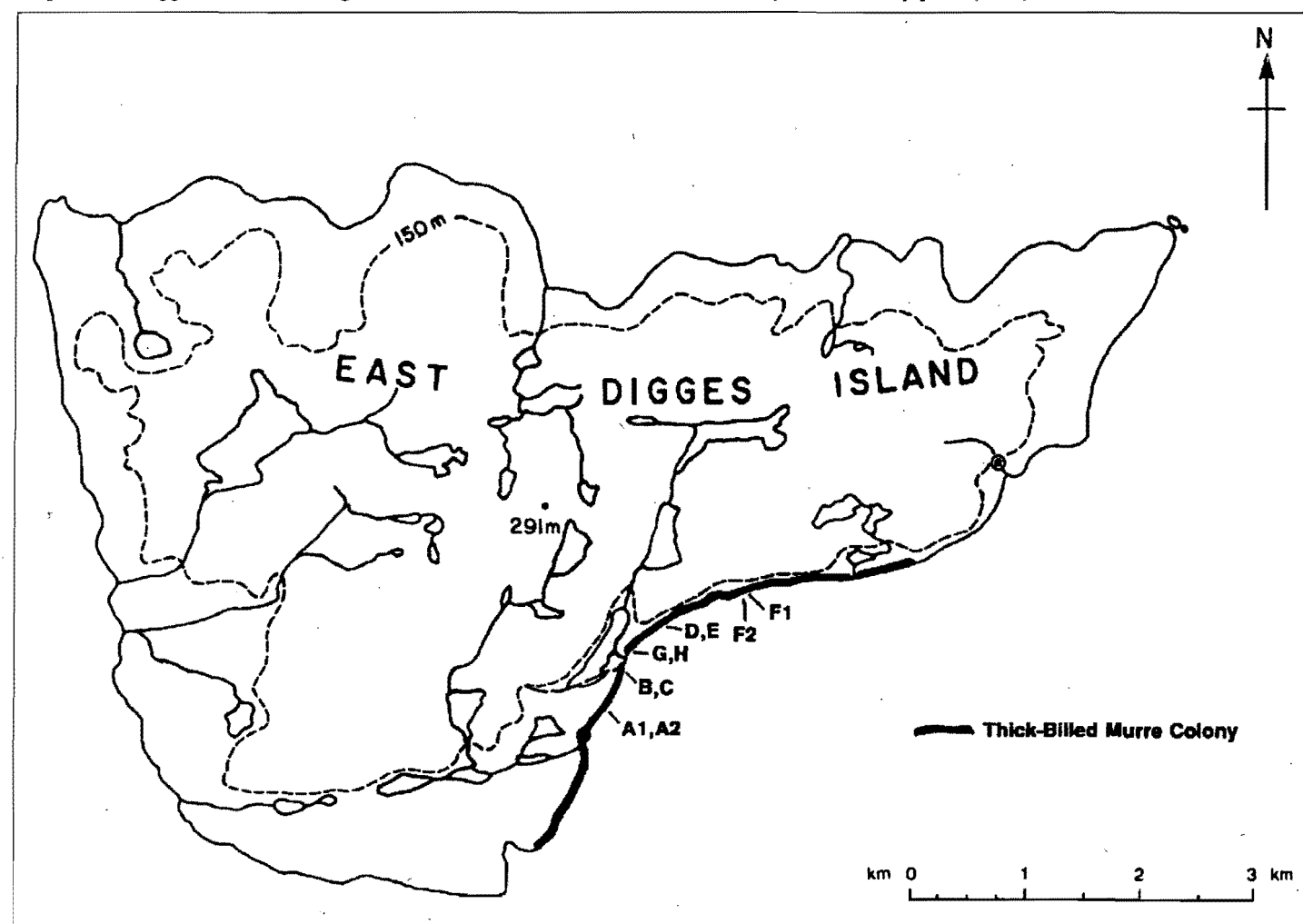


Figure 4
Map of East Digges Island, showing the locations of the Thick-billed Murre colony and the study plots (A-H)



of year, we have treated the averages for the period 1980-82 as a baseline (index = 100) and expressed later counts as percentages of the average counts for the corresponding dates.

3. Results

3.1 Coats Island

Inspection of the three photo sets (1972, 1984, 1990) shows that the occupied areas at both the east and west subcolonies expanded during the period 1972-90 (Fig. 5), and it appears that most changes took place before 1984. A photograph of the west subcolony taken in 1981 shows that

most of the expansion there had taken place by then, although the birds cannot be counted on the print. The exact area of expansion cannot be estimated from the photographs, because the angle of view is unknown. The east subcolony expanded especially at the north (seaward) end, whereas the west subcolony expanded mainly upwards, especially at the south end. On the 1990 photographs, 1444

Figure 5
Sketch of the east and west subcolonies at Coats Island, taken from oblique aerial photographs, showing the expansion of the occupied area between 1971-72 and 1990 (note the difference in approximate scale between the two subcolonies)

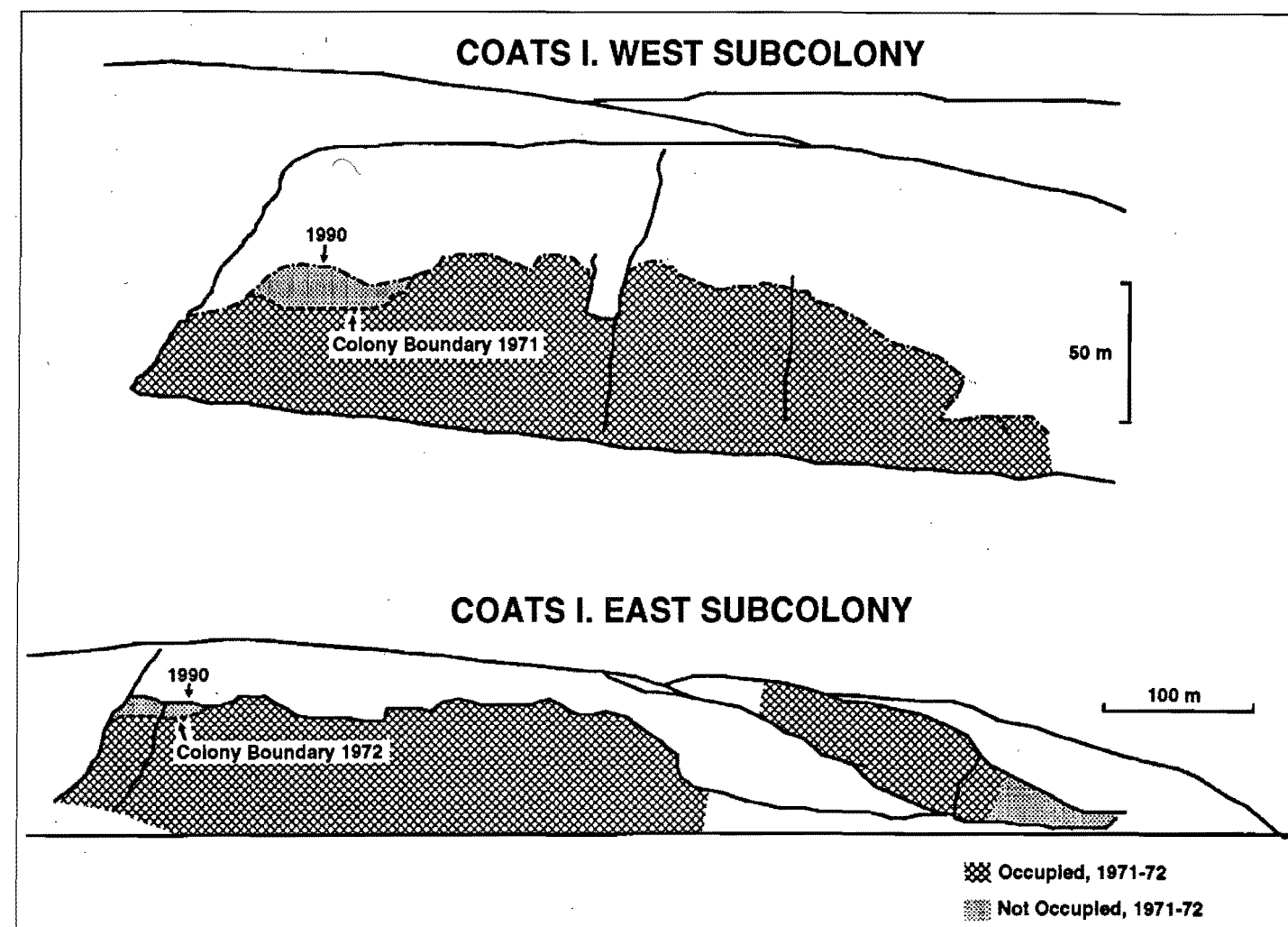
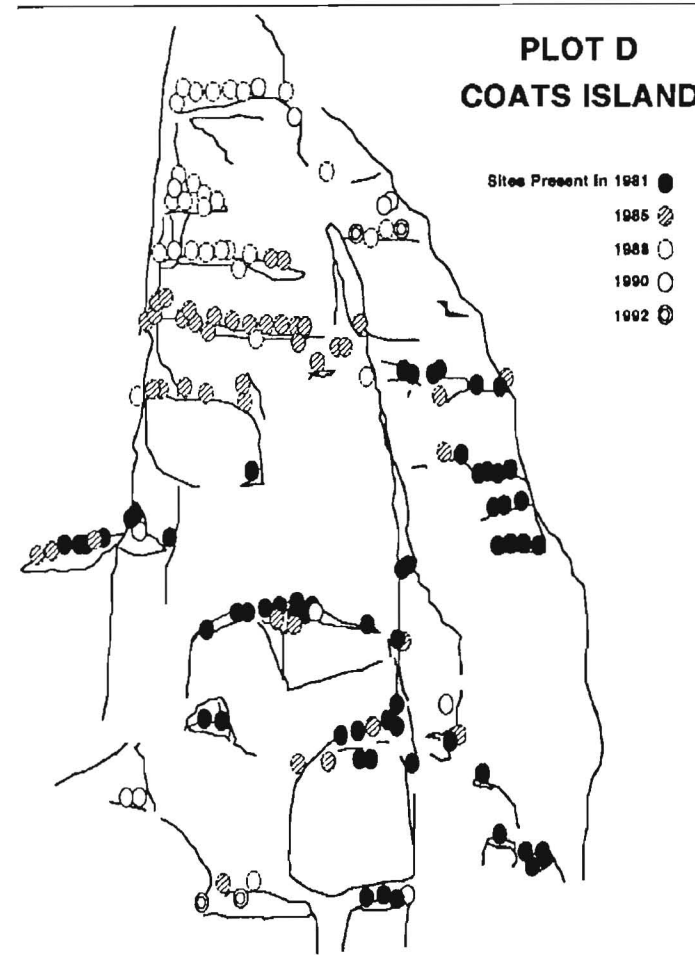


Figure 6
Sketch of plot D, Coats Island, showing the expansion of breeding sites from 1981 to 1990



birds at the west subcolony and 1872 at the east subcolony were on areas totally devoid of birds in 1971 and 1972. Observations at count plot D, photographed in 1981 and 1985 and mapped annually from 1986 onwards, showed that colonization took place ledge by ledge, over a number of years (Fig. 6).

Evidence of recent expansion could be seen on the ground during 1984–92, in the form of hundreds of sites occupied on peat. Observations over several years demonstrated that once the grass forming the peat has been killed by the breeding birds, it breaks up and washes away within a few years, leaving the bedrock exposed. Several large ledges on the west subcolony, which supported grass in 1984, had lost their turf by 1991.

The 1972 count for the east subcolony, excluding one area that was out of focus (18-6A), was 9557 birds. This has been corrected by adding the proportion of birds occupying area 18-6A in 1990 (4184/25 056 = 16.7%), to give an estimate of 11 473 birds for the entire east subcolony in 1972. This number must be further corrected to account for the fact that the 1972 photos were obtained a month earlier than those in 1984 and 1990. The mean change in numbers on the study plots at the west subcolony between 16 July (mean for week of 13–19 July) and 11 August (mean for week of 8–14 August) over four years (1988, 1990, 1991, 1992) was an increase of 10.1%. If one assumes a similar trend in 1972, a mid-August count would have been

Colony	1972	1984	1990
West subcolony		26 082	28 797
East subcolony			
Section 18-6A		3 614	4 184
Rest	9 557	15 711	20 872
Totals (including corrections for 18-6A and time of year)	12 632	19 325	25 056
Whole colony		45 407	53 853

approximately 12 600 birds (Table 1). The photograph also shows that land-fast ice was still present adjacent to the colony on 16 July 1972. This suggests a relatively late year for ice breakup. However, in 1992, when ice also persisted until mid-July, attendance by the murres was hardly affected (AJG, unpubl. data).

The total counts for the east subcolony (Table 1) suggest an average annual increment of 3.6% during 1972–84 and 4.4% between 1984 and 1990. At the west subcolony, the increase between 1984 and 1990 was 1.6% per year. For both colonies together, the increase during 1984–90 was 2.8% per year. The total increase at the east subcolony is estimated at 12 424 birds between 1972 and 1990, of which only 1872 (15%) can be attributed to the expansion of the colony boundary. However, large parts of the area occupied in 1992 on the east subcolony supported only scattered birds in the 1972 photographs. Increases in numbers on such areas since 1972 have involved changes of an order of magnitude and more.

The number of birds present on the west subcolony on breeding study plots D, N, and P at the time when the 1990 census photographs were taken was 487. There were 281 breeding pairs on these plots in 1990, yielding a correction factor of 0.58. Applying this to the aggregate count for the east and west subcolonies (53 853) gives an estimate for the total colony of 31 235 breeding pairs. Given the likely inaccuracies in the method, we prefer to round this off to 30 000 pairs.

Counts at the 10 study plots on the west subcolony during 1985–92 showed no consistent trends. Mean counts for the period 1–7 August were significantly correlated with year at only three plots (Table 2): two positively (C and D) and one negatively (I). Most of the change in numbers at plot I occurred between 1985 and 1986. The possibility that the boundaries of plot I were not always correctly identified in 1985 (the first year of counting) cannot be dismissed; we subsequently found this plot difficult to count. Although the trend at plot C is significant, the increase from 1986 to 1992 was only 27%, most of it occurring between 1991 and 1992. Changes in numbers on this plot may be related to the success of a pair of Glaucous Gulls *Larus hyperboreus* nesting immediately adjacent to the plot boundary. When these birds had young, they actively discouraged murres from loafing near their nest, and young may have been present more frequently in the earlier years. No young were present in 1992.

Only at plot D has a clear increase in numbers taken place. The number of occupied sites on this plot increased from about 60 in 1981 (based on interpretation of Fig. 7a) to 89 in 1986 (+48%), when intensive observations of the plot began, and to 137 in 1992 (a further 54% increase). The mean count increased by 33% between 1986 and 1992. A

Table 2
Counts of study plots on the west subcolony at Coats Island made from 1 to 7 August between 1985 and 1992 (all sample sizes = 7)

Year	Study plot																			
	A		B		C		D		E		F		G		H		I		J	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	258	43	240	41	[107] ^a		135	41	109	19	100	20	104	12	112	16	277	64	147	14
1986	249	20	244	25	107	9	155	18	134	23	102	12	100	8	93	9	204	26	126	15
1987	276	15	260	25	112	3	170	19	165	21	117	9	105	5	107	6	235	20	130	14
1988	280	31	253	26	114	7	177	26	130	27	103	24	108	8	107	8	219	28	133	19
1989	326	16	265	15	115	7	202	8	163	11	111	8	[117]		[116]		211	13	136	10
1990	288	26	237	13	115	6	194	17	161	20	98	7	92	6	104	8	197	7	119	10
1991	242	16	217	11	117	10	198	7	128	12	101	16	98	4	100	5	188	17	122	8
1992	244	27	243	16	136	9	206	14	137	21	112	7	103	9	101	6	188	13	130	5
r (x vs. yr.)	-0.05		-0.33		+0.84		+0.94		+0.27		+0.13		-0.19		-0.17		-0.81		-0.56	
P (two-tailed)	NS		NS		<0.01		<0.01		NS		NS		NS		NS		<0.01		NS	

NS = not significant

a Values in square brackets are subject to uncertainty because of possible misidentification of plot boundaries.

Figure 7
Photographs of plot D, Coats Island: (a) in 1981, (b) in 1984, and (c) in 1988

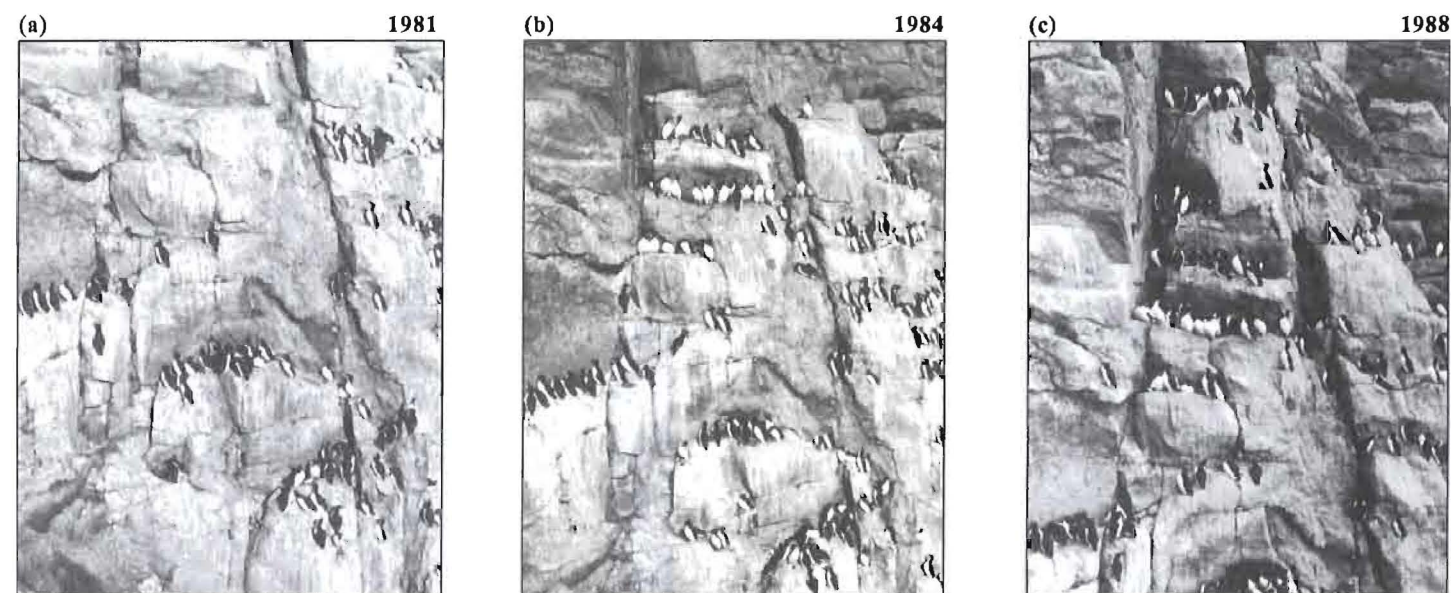


Table 3
Increase in numbers of breeding sites at plot D, Coats Island, 1981–92 (only those still occupied in 1992 are included)

Year	Sites added on ledges previously:	
	Occupied ^a	Unoccupied ^b
1981–84	3	10
1984–86	2	14
1986–88	17	17
1988–90	10	1
1990–92	3	3

a Occupied = supporting at least one breeding pair.
b Unoccupied = no breeding pairs present previously.

comparison of photos a, b, and c in Figure 7 shows that most of the sites added between 1981 and 1988 (56%) were on ledges that were previously unoccupied (Table 3). However, since 1988, most expansion (82%) has occurred through the addition of sites on ledges that were already occupied. No successful breeding has taken place on the uppermost occupied ledge since 1989, owing to predation by arctic foxes *Alopex lagopus*. It seems possible that no further upward expansion is possible in this area.

3.2 East Digges Island

Counts made at the study plots in 1990 were lower than those made at the same dates in 1980–82, whereas those made in 1985 and 1992 were higher (although not significantly; Table 4). Compared to the index level for 1980–82, subsequent counts ranged from 95% (1990) to 104% (1992; Fig. 8). None of the total counts for the three later years (1985, 1990, 1992) differed significantly from total counts for all three of the earlier years (1980–82). However, counts made at plot H in 1992 were significantly higher than any of those made at the same dates in 1980–82, suggesting that a modest increase had taken place in that part of the colony.

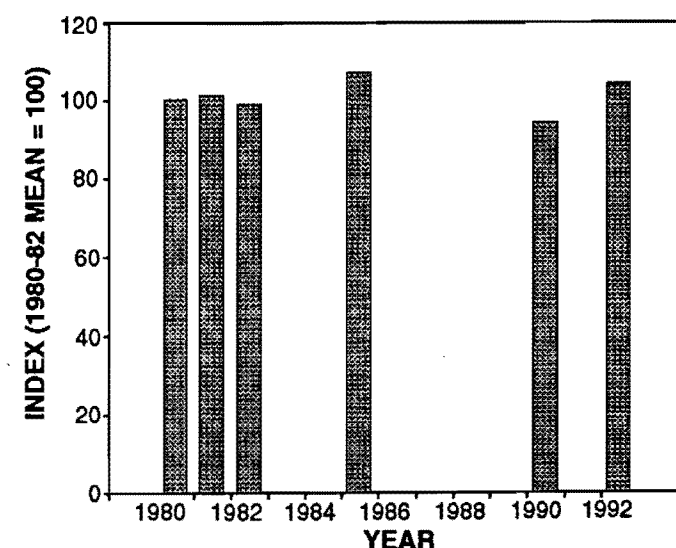
Although the 1980 photo census has not been repeated, photographs of large parts of the colony were taken into the field in 1992, and a careful comparison was made of colony boundaries. All previously occupied areas were still occupied. Some expansion was apparent in very small areas at the top of the cliffs, where additional ledges had been occupied, but the total number of birds involved was less than 1000. The general impression obtained by

Table 4
Counts made at study plots on East Digges Island, 1980–92

Year	Study plot										Total
	A1	A2	B	C	D	E	F1	F2	G	H	
6–15 July											
1980	71.5	172.4	114.4	165.0	82.8	180.3	150.9	213.1	109.8	152.3	1412.5
N=10	(9.5) ^a	(15.0)	(20.6)	(21.7)	(14.3)	(25.2)	(16.0)	(33.4)	(19.3)	(26.2)	(185.1)
1981	71.8	168.8	109.6	162.8	75.3	175.0	143.2	213.5	111.4	148.8	1380.2
N=10	(9.8)	(14.3)	(8.3)	(20.1)	(5.6)	(14.8)	(11.9)	(21.2)	(21.6)	(18.4)	(110.7)
1982	82.6	176.1	123.7	183.0	80.7	198.4	157.4	238.1	103.8	153.8	1476.8
N=10	(16.0)	(19.7)	(15.9)	(18.8)	(8.5)	(30.7)	(18.0)	(31.3)	(12.8)	(19.8)	(158.5)
1990	74.2	161.6	112.2	164.5	76.4	163.2	133.1	200.3	95.1	159.9	1335.8
N=10	(16.6)	(24.3)	(25.5)	(25.1)	(14.1)	(26.2)	(17.8)	(36.5)	(13.4)	(34.6)	(225.0)
21–26 July											
1980	83.3	188.3	132.7	179.7	92.7	206.3	167.2	254.0	119.3	166.7	1590.2
N=6	(13.6)	(29.9)	(32.4)	(26.1)	(23.6)	(43.6)	(28.4)	(56.8)	(18.8)	(34.8)	(297.8)
1981	83.2	169.0	124.6	187.8	82.0	191.0	165.4	233.8	123.4	160.6	1520.8
N=5	(9.3)	(17.9)	(14.3)	(22.2)	(12.8)	(27.8)	(13.5)	(44.4)	(22.2)	(24.8)	(198.4)
1982	89.5	194.7	144.8	194.7	88.5	235.3	169.8	250.8	117.2	187.7	1673.0
N=6	(8.6)	(9.9)	(11.6)	(12.7)	(3.8)	(8.6)	(6.2)	(46.0)	(5.8)	(4.3)	(81.6)
1985	82.8	209.0	139.3	191.3	97.5	223.2	181.0	273.2	120.0	197.3	1714.7
N=6	(4.9)	(6.3)	(24.3)	(16.3)	(4.0)	(15.7)	(16.1)	(22.1)	(9.4)	(22.4)	(114.5)
11–20 August											
1980	80.4	180.0	130.4	192.3	83.0	198.8	163.9	239.7	124.5	162.9	1555.9
N=10	(5.4)	(17.1)	(10.2)	(9.7)	(6.9)	(19.2)	(15.9)	(19.3)	(13.2)	(16.7)	(91.1)
1981	78.9	174.6	127.6	192.9	82.9	194.3	165.6	250.1	119.8	169.2	1562.5
N=10	(13.8)	(23.9)	(13.8)	(19.8)	(12.7)	(26.3)	(18.3)	(35.3)	(10.9)	(20.2)	(197.3)
1982	70.3	175.6	128.4	185.7	81.6	207.4	159.9	245.8	112.6	173.2	1540.5
N=10	(5.5)	(11.2)	(10.4)	(10.1)	(7.6)	(20.9)	(10.0)	(23.5)	(6.0)	(9.4)	(91.9)
1992	80.8	192.7	128.1	177.3	92.6	208.3	160.8	247.6	128.6	192.6	1609.4
N=10	(9.5)	(11.5)	(14.3)	(12.8)	(8.3)	(19.2)	(10.4)	(11.1)	(11.8)	(18.0)	(89.8)

a Numbers in parentheses are standard deviations.

Figure 8
Changes in the mean number of Thick-billed Murres present on 10 study plots on East Digges Island in relation to the baseline (1980–82)



AJG, who worked on the colony during 1980–82, was that the numbers of birds present on different parts of the colony in 1992 were very similar to those seen earlier. J.B. Geale, who carried out the 1990 survey and who also worked at East Digges Island in 1980 and 1982, had a similar impression.

4. Discussion

Our estimate of the number of birds present at Coats Island in 1990 (30 000 breeding pairs), based on the photo count, is higher than previous estimates for the colony. In 1953, A.R. Loughrey (in Tuck 1961) estimated 30 000 birds (equivalent to about 20 000 pairs), and in 1955, C.R. Harrington (in litt.) estimated 15 000 pairs. An estimate based on a preliminary analysis of the 1972 photographs was similar to Harrington's (15 000 pairs; Nettleship and Smith 1975; Brown et al. 1975). Based on direct counts at the west subcolony in 1981, Gaston et al. (1987) estimated 26 500 birds, very close to the photo count of 26 082 for 1984.

Since 1972, all the evidence points to a sharp increase in the numbers of birds at the Coats Island colony, with the east subcolony doubling between 1972 and 1990. Given the expansion of the boundaries, there is no reason to think that a similar increase did not take place at the west subcolony. The fact that estimates in the mid-1950s were similar to, or larger than, the 1972 estimate suggests that the increase since 1972 was not a continuation of an earlier increase, but that prior to 1972 the population was either stable or changing relatively slowly. This corresponds with other observations that suggest a decline in populations of murres elsewhere in the eastern Canadian Arctic between the 1950s and 1970s (Nettleship 1977; Nettleship and Evans 1985).

The results of study plot counts do not indicate that the population increase is continuing. The highest mean counts at seven of the 10 plots occurred during 1987–89, corresponding to the period of most rapid colonization at plot D. It is possible that the rate of population increase has slowed during the past few years. The fact that most of the colonization at the west subcolony took place between 1972 and 1981 suggests that the population increase may have been especially rapid during the 1970s.

Changes in the population of the East Digges Island murre colony are more difficult to assess. L.M. Tuck, who visited the colony in 1955, estimated that "not less than two million, but most likely not more than three million" (Tuck 1961) birds were present in the entire Digges Sound aggregation. However, he emphasized the difficulty of estimating the population. The estimate of about 300 000 pairs made in 1980 (Gaston et al. 1985) is likewise very approximate, because the confidence limits on the correction factors used were not known. The huge discrepancy between the estimates for 1955 and 1980

suggests that some decline may have occurred. However, comparison of photographs taken by Tuck in 1955 with those taken in 1980 showed no change in the colony boundaries (Gaston et al. 1985). Given the uncertainties involved in the estimates, there is no way to assess the magnitude of the decline.

Since 1980, there has been no evidence for any marked change in the population at East Digges Island. Both the daily counts of study plots and the comparison of photographs suggest that the colony has been essentially stable over the past decade. During studies carried out in 1980–82, observers noted areas on East Digges Island where birds were breeding on turf, as well as unoccupied areas on the mainland cliffs where the vegetation suggested previous manuring by murres (Gaston et al. 1985). They surmised that a shift in population from the mainland to the island might be occurring. In light of the increase that occurred at Coats Island after 1972, it seems possible that some expansion in population also took place at East Digges Island during the same period, which resulted in the colonization of grassy areas observed to have occurred in 1980.

The majority of Thick-billed Murres are known to return to breed very close to where they were reared (Noble et al. 1991). Observations at East Digges Island in 1992 failed to reveal any murres — among over 2000 inspected — banded at Coats Island. However, intercolony movements have been observed for other species of auks (Harris 1991; Halley and Harris 1993), and so it is likely that emigration sometimes occurs. If a small proportion of birds reared at Digges Sound shifted to Coats Island, the next closest colony, to breed, this could have a significant impact on the much smaller Coats Island population. Conversely, a similar proportion of Coats Island birds emigrating to Digges Sound would have a negligible effect on the dynamics of the larger colony. If interchange is occurring, it is possible that the considerable fluctuations seen at Coats Island over the past several decades reflect, in part, the dynamics of the Digges Sound colony.

Although the evidence is not strong, numbers of Thick-billed Murres at colonies in northern Hudson Bay probably declined between the 1950s and 1970s, albeit to an unknown extent, increased between the 1970s and 1980s, and are now stable. In discussing the decline of High Arctic Thick-billed Murre colonies between the 1950s and 1970s, Nettleship and Evans (1985) pointed to the heavy mortality

that occurred from drowning in gill-nets off West Greenland in the late 1960s and early 1970s. This mortality is unlikely to have affected the Hudson Bay population: whereas nearly half of all recoveries of birds banded in the High Arctic have come from West Greenland, only a small proportion (<10%) of birds from Coats and East Digges islands have been recovered there, and most of these have been found in summer rather than in fall, when the gill-net mortality occurred (AJG, unpubl. data). None of the other possible causes of decline — oiling, hunting, and depletion of prey stocks by commercial fisheries — has undergone changes that can be correlated with our projections for fluctuations in the murre population of Hudson Bay since the 1950s. Consequently, the cause of these fluctuations cannot be explained at present.

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