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STATUS OF THE ATLANTIC PUFFIN *FRATERCULA ARCTICA* ON THE ISLE OF
MAY NATIONAL NATURE RESERVE, CRAIGLEITH AND FIDRA, FORTH ISLANDS
SPECIAL PROTECTION AREA

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Report to Scottish Natural Heritage

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SUMMARY

Background

Atlantic Puffins (*Fratercula arctica*) are a qualifying species for the Forth Islands Special Protection Area (SPA) designated on 25 April 1990. The Isle of May National Nature Reserve (NNR) is currently the main breeding colony for puffins in the Firth of Forth and a count made in 1998 showed it to be one of the largest colonies in Britain. An up-to-date assessment of numbers was required and Scottish Natural Heritage placed this contract with the Centre for Ecology and Hydrology (formerly the Institute of Terrestrial Ecology), whose staff have been studying puffins in the Firth of Forth since 1972, to determine the status (population size and distribution) of puffins on the Isle of May NNR, Fidra and Craigleith. This report documents standardized censuses of the numbers of occupied burrows at these colonies carried out in April and early May 2003.

Main findings

- The colony on the Isle of May was estimated at 69,300 occupied burrows (95% Confidence Interval 66,400 - 72,700). Numbers have increased at an average rate of 12.4% per annum between 1998 and 2003 and at 10.9% per annum over the period 1970 – 2003. New areas of the island are still being colonized by puffins and rates of increase here are generally higher than in the long-established areas.
- About 12,100 occupied burrows (95% CI 9,200 – 15,000) were counted on Craigleith. This is a dramatic reduction from the 28,000 estimated in 1999 and only 25% of that expected given the past rate of increase. The decline was attributed to the spread of the alien plant tree-mallow *Lavatera arborea*.
- The colony on Fidra was estimated at 1466 occupied burrows (approximate limits 1388 – 1528). Numbers have increased at 9.5% p.a. over the period 1976-2003.

The results of the census emphasize the importance of the puffin colony on the Isle of May which is now the largest single colony in Britain and Ireland holding about 8% of the total population.

Long-term demographic studies on the Isle of May indicate that breeding success and adult survival are high. Assuming no change of recruitment patterns, the population is expected to continue to grow. The two other major colonies in east Britain, on the Farne Islands and Coquet Island, appear to be becoming full up. Alternative nesting areas that are safe from mammalian predators appear to be limited in east Britain. It is therefore potentially possible that chicks from other colonies in eastern Britain may recruit to the Isle of May where there still appears to be plenty of suitable habitat. However, even without this increased immigration, the colony on the Isle of May is predicted to double in size by 2010.

1 BACKGROUND

The Isle of May National Nature Reserve (NNR) is currently the main breeding colony for puffins in the Firth of Forth and one of the largest colonies in Britain. A complete count of burrows occupied by puffins in April 1998 estimated the Isle of May population at 42,000 occupied burrows (Harris & Wanless 1998). A sample count of burrows on Craigleith in 1999 was extrapolated to give a total of 28,000 on the whole island based on habitat areas and 405 burrows were counted on Fidra in the same year (The Forth Seabird Group Report, RSPB records). Puffins are a qualifying species for the Forth Islands Special Protection Area (SPA) designated on 25 April 1990. An up-to-date assessment of numbers was required and Scottish Natural Heritage placed this contract with the Centre for Ecology and Hydrology (formerly the Institute of Terrestrial Ecology), whose staff have been studying puffins in the Firth of Forth since 1972, to determine the status (population size and distribution) of puffins on the Isle of May NNR, Fidra and Craigleith.

2 ISLE OF MAY

2.1. Methods

The count was undertaken between 24 and 27 April 2003 by a team of seven counters – S. Wanless, L. J. Wilson, M. P. Harris (MPH), L. Wickens, S. Bierman, G. Jones and M. Frederiksen. Checks of (a) the efficiency of counting and (b) the classification of burrows were made by MPH.

The counting unit employed was the 'apparently occupied burrow' which was defined as a burrow showing signs of use by puffins, i.e. fresh digging, droppings or regular wear. There is potential for confusion between a rabbit and a puffin burrow but the former tends to be much larger, to have much more substantial diggings and characteristic droppings in the entrance. Prior to the count, all counters were given a practical demonstration by MPH of how to identify occupied puffin burrows. The timing of the count was ideal, weather conditions were good, the population of rabbits was at its yearly low and there was little new growth of vegetation to obscure burrow entrances. A check of a sample of occupied burrows on the last day of the count indicated that about half already contained eggs. For convenience, in the rest of this report we use the term 'burrow' instead of 'occupied puffin burrow'.

The island was divided into the areas routinely used in the annual count of gull nests. Some of these areas were further sub-divided to allow comparison with past puffin counts. Burrows were counted by dividing each area into strips 25 m wide with the boundaries marked with bamboo canes. Each observer searched a strip about 5 m wide by zig-zagging slowly along it. Where there was potential for overlooking burrows or double-counting them, a cane was used to mark the earth in the entrance of each burrow as it was counted.

In 11 areas, small sections of the colony were delimited with string. In five of these, counters passing through marked each counted burrow with white plastic markers. In addition, each counter counted all burrows in one of the six other areas. Immediately following the count, MPH made a detailed examination of each possible burrow, where necessary lying on the ground and feeling to the end of the burrow with a bamboo cane to check for (a) puffin burrows which had been overlooked (i.e. were unmarked), (b) burrows which belonged to a rabbit rather than a puffin, (c) entrances which were not true burrows (e.g. were very short), and (d) cases where

there were two entrances to a single burrow (i.e. the burrow had been counted twice). Double-occupancy of a burrow, where two pairs use a single entrance, is extremely rare and the possibility of this was discounted.

Among previous burrow counts, which have always been made in late April, only in 1992 and 1998, was a similar occupancy check made. In 1992, based on checks made in four areas, the count was thought to have over-estimated the population by 7%. In 1998 checks suggested an over estimate of 2%. The interaction between overlooking and misclassification of burrows will vary from area to area and year to year due to a whole range of factors such as the state of the vegetation, soil erosion, burrow density, numbers of rabbits etc. For comparison with previous counts we use the uncorrected burrow counts.

2.2. Results

Burrows were recorded in all the main parts of the island where there was sufficient soil except for the lighthouse garden (though even here birds stand on the walls, and have to be rescued when they fall in) and the field between the Mouse House and Chapel. The total (uncorrected) count was 74,517 burrows. Area totals are presented in Table 1 and are shown in more detail in the appended maps.

Results from the 11 sections used to estimate observer error indicated considerable spatial variation in the various sources of error with raw counts both under- and over-estimating the corrected totals (Table 2). The overall correction factor pooling the results from the 11 sections was 0.93, i.e. the count was 7% too high, due mainly to burrows counted either being too short for breeding or having several entrances. The 95% Confidence Interval for this correction factor, ignoring the one plot where there were just two burrows, was 0.891 – 0.975. Applying this value to the raw count data (and rounding off to the nearest hundred) gives a corrected total of 69,300 occupied burrows and a 95% CI of 66,400 – 72,700.

2.3 Comparison with past counts

The history of the puffin on the Isle of May is well documented (Eggeling 1960, Harris 1977, Harris & Wanless 1998). There are no very early records but in 1883 there were 30-40 pairs and maybe 50 pairs in 1936. The population was put at 5-10 pairs in the early 1950s but in 1957-58 at least 50 pairs attempted to form a colony. This attempt was brief and unsuccessful and in 1960 there were only a few pairs, all breeding in cliff fissures, although 40 pairs prospected the Burrian. The next year 200-300 birds were recorded on the Burrian. In June 1962 at least 500 birds were present on the island, breeding was recorded in the slopes above Colm's Hole and some birds were standing west of Holyman's Road. In 1963, approximately 200 pairs bred including the first on Rona since 1957. In 1970, the population was put at about 2,000 pairs. The first systematic census of the Isle of May puffin colony was made in 1975 and whole island counts were subsequently made in 1984, 1989, 1992 and 1998. Details of these are presented in Table 1 and the population trend between 1960 and 2003 is shown in Figure 1, upper figure. The average rate of increase between 1998 and 2003 was 12.4% p.a. Plotting the counts on a log scale (Figure 1, lower figure) indicates that the rate of increase between 1970 and 2003 has been remarkably constant at 10.9% per annum (se = 0.8%).

Between 1998 and 2003, the highest proportional increases in burrow numbers occurred between the Low Light and Nybo Bridge (1280 to 3358) and South Plateau (3026 to 6429),

while the lowest were on Burrian (7388 to 10110) and North Ness (5287 to 7791). The annual increases, shown area by area in Table 3, confirm general field observations, which suggest that the rates of increase in some of the longest established parts of the colony are slowing down whereas numbers are increasing rapidly in newly colonized areas, notably South Plateau and some of the inland areas.

3 CRAIGLEITH

3.1 Methods

The methodology followed that on the Isle of May. The count was made on 19 April by six counters supervised by S. Murray who also made checks of the counting efficiency in 11 areas. About 95% of the island was covered with a dense stand of tree-mallow *Lavatera arborea* (Map 3). These plants reach a height of 2.5 m, can be as close together as 0.15 m and even as early as this in the spring the most sheltered areas of the island were under a virtual closed canopy. This made counting of burrows difficult and time consuming. The lack of a good map of the island meant that the island was not sub-divided for the actual count. Given the marked differences in the numbers of burrows checked in the small open areas (where checking was easy) and in areas covered with tree-mallow (where checking was extremely difficult), the overall correction factor was based on the mean of the 11 areas.

3.2 Results

The occupied burrow count was 9683. The checks indicated that, on average, 25% of burrows were overlooked, highlighting the problems of counting under a virtual closed canopy (Table 4). There were considerable differences between areas, notably a high variability in areas of tree-mallow occupied by gulls, but during the count it proved impossible to demarcate open, gull and mallow-dominated areas with any certainty. The corrected burrow total was 12,100 with the 95% CI 9,200-15,000.

3.3 Comparison with past counts

Counting burrows on Craigleith is extremely difficult and the only past counts of burrows have been 75-100 burrows in 1959, 1325 burrows in 1977, 3361 in 1985 and 28,000 in 1999 (R.W.J. Smith, Edinburgh Natural History Society; The Forth Seabird Group Report, RSPB records). The 1999 count was based on samples of burrow density taken in different habitats and an estimate that 55% of the island was covered by tree-mallow but no estimate of precision was made (A Leitch, personal records). These counts suggest a remarkably constant rate of increase of 14.4% per annum (Figure 2; $R^2 = 99.9\%$). If this rate had been sustained, then there should have been about 48,000 burrows in 2003. In fact, the count was only 25% of this figure and, although absolute proof is lacking, the most likely explanation is that the continued spread of tree-mallow has made the island much less suitable for nesting puffins. Puffin burrow density is severely reduced in areas of mallow compared with open ground, which is a strong indication of the source of the problem (A Leitch, personal records).

4 FIDRA

4.1 Methods

An attempt to land on 26 April was unsuccessful due to bad weather so the count was delayed until 4 May. The methodology was as outlined above with S. Murray checking the efficiency of counting in two areas. The results from these two checks are used to give an approximate confidence interval on the count.

4.2 Results

Burrows were scattered at low density over the island with the exception of the low-lying area to the south-west of the landing which appeared to be a long-defunct rabbit warren. Tree-mallow was present in a very small area near the lighthouse.

A total of 1559 occupied burrows were counted. The checks suggested that some apparent burrows were in fact unusable and that the count overestimated the population by 6% (Table 4). The corrected total was 1466 burrows, with approximate confidence limits of 1388-1528.

4.3 Comparison with past counts

Birds were first recorded ashore on Fidra in 1966. Four burrows were occupied in 1967 when a single egg was found. Counts have been made in 22 subsequent years (Figure 3; RSPB reserve records, Forth Seabird Group Annual reports). Since 1976 the average rate of increase has been 9.5% p.a.

5 THE POPULATION IN A WIDER CONTEXT

The Isle of May is now the single largest colony of Atlantic puffins in Britain and Ireland (Table 5). Counts made during Seabird 2000 indicate that the Isle of May held 8% of the Scottish population and 7% of the British and Irish population. The 2003 count suggests that the importance of this colony continues to increase.

Within the Firth of Forth the only long established colonies are on the Isle of May, Craigleith and the Bass Rock. Numbers on the Bass Rock have not increased in recent years and there are probably now only about 10 pairs. Puffins (three burrows, one egg) colonized Inchkeith in 1965, though birds were seen ashore in 1961 (Smith 1966, 1974). Visits in 1975, 1976 and 1978 recorded 292, 380 and 395 burrows, respectively which indicated a rapid increase. Difficulties with access in recent years have resulted in there being no recent count of burrows at this colony. However, 1500-2000 birds have been counted on the sea under the cliffs since 1986 so this colony now has probably well in excess of 2000 pairs (Forth Seabird Group reports). Colonisation of Inchcolm possibly occurred in 1992 and breeding was proved the following year. In 1995, there were 30 pairs and in 1997 there were 65 birds. The Lamb was colonized about 1984 and eight sites (presumably burrows) were recorded in 1985, 56 in 1986 and at least 150 in 1995. Combining these estimates with our censuses suggests that the total population of the Firth of Forth in 2003 was in the region of 84,100 pairs. This compares with 18,000 burrows in 1985 (Smith 1974, Harris et al. 1987).

The two other major puffin colonies in eastern Britain were also censused in 2003. Both are in Northumberland. The Farne Islands had c.56,000 burrows (John Walton, pers. comm.). This represented an increase since the previous count of 34,710 burrows in 1993 but the rate of increase of 3-4% per annum was much reduced from that of 6% per annum between 1975 and 1993 (Birds of the Farne Islands Annual Reports). Numbers on Coquet Island were estimated at 11,300 occupied burrows and an approximately equal number of apparently unoccupied burrows (P. Morrison, pers. comm.). The reason for this high proportion of apparently unoccupied burrows in 2003 was unknown but the total burrow count was very similar to those in 2001 and 2002 (RSPB unpublished data). The leveling off in numbers and the high density of burrows in flat areas with generally shallow soil resulting in the collapse of burrows suggests that these small islands now have only a limited capacity for any further increase in numbers of breeding puffins.

6 THE FUTURE

Numbers of puffins on both the Isle of May and Fidra continue to increase at 10-11% p.a. and conditions at both places appear favourable for further increases. In contrast, unless something fairly radical is done to control, or even reverse, the spread of tree-mallow on Craigleith, puffin numbers are likely to be reduced even further. Although tree-mallow is indigenous to England and Wales, it is an introduction in Scotland (Cox 2002). It is intolerant of grazing so consideration might be given to cutting some of this alien and then re-introducing rabbits to Craigleith to restrict its regeneration. On Fidra, tree-mallow appears well established but, since it is not so dense or widespread, controlling it would not be such a formidable exercise as on Craigleith.

In 1969-70 Operation Seafarer estimated that there were about 29,000 pairs of puffins in east Britain between the Moray Firth and Flamborough Head in Yorkshire. By the time of the Seabird Colony Register in 1985-87, numbers had increased to 55,000 pairs. Seabird 2000 put the number at over 130,000. Combining all available data suggests an average increase of 6% p.a. over the 30 year period and highlights the fact that the area is now one of the main breeding strongholds of the species in Britain and Ireland. Ongoing work on the Isle of May suggests that both breeding success and adult survival of the puffin remain high and, unless density dependence starts to act, there is no reason to suppose that the numbers in east Britain will not continue to increase. At the current rate of increase, the numbers breeding on the Isle of May will double by 2010 and if colonies elsewhere become full up even more birds could be attracted. Concurrent studies have shown that there is no evidence at present that herring and lesser black-backed gulls (*Larus argentatus* and *L. fuscus*) have a negative impact on puffin reproductive performance (Finney et al. 2001). However, the presence of these gulls in areas where puffins are breeding at low density does appear to reduce their attractiveness to puffins prospecting for a site (Finney et al. 2003). As the density of puffin burrows increases over most of the Isle of May, gulls will have less effect on puffin recruitment and puffin numbers might increase at an even faster rate. Given that there are still areas of apparently suitable habitat in which burrow density is currently low, there is plenty of scope for the colony to increase substantially in the future. The area of the island is 55ha. Assuming that just 50% of this is suitable for puffins, that none of the already occupied high density areas become unsuitable and an average density of 1 burrow / m², this gives a theoretical maximum colony size of about a quarter of a million burrows.

Given the importance of the Firth of Forth in general, and the Isle of May in particular, for breeding puffins, continued regular monitoring of the status of this species is clearly essential.

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Figure 1. Changes in the numbers of occupied puffin burrows on the Isle of May 1970-2003. The upper figure shows counts of occupied burrows on the Isle of May 1970-2003. The lower figure shows the annual rate of increase of 10.9% between 1970 and 2003.

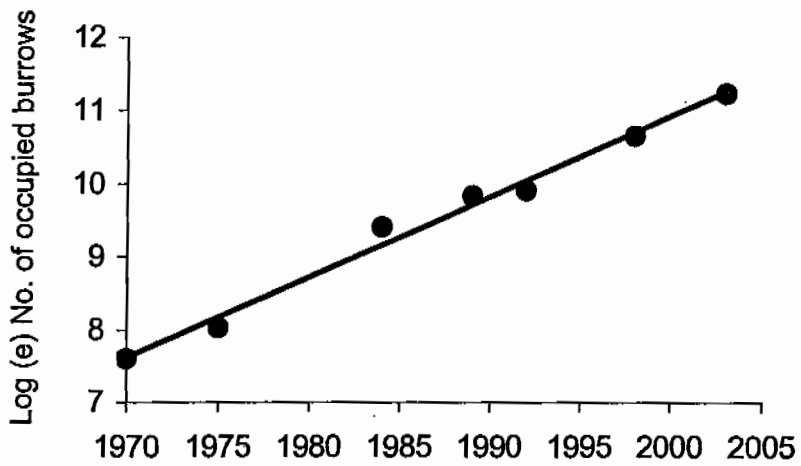
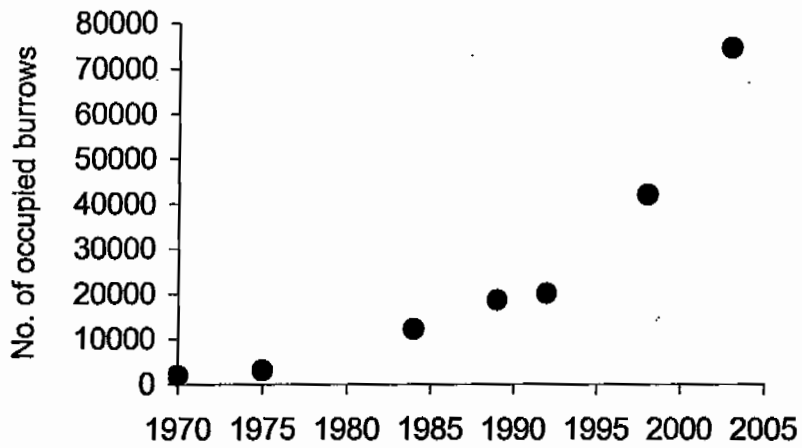


Figure 2. Changes in the numbers of occupied puffin burrows on Craigleith, 1959-2003. In the upper figure both the actual count for 2003 (solid dot) and the projected total (star) based on the average rate of increase between 1959 and 1999 are shown. In the lower figure the regression indicates an annual rate of increase of 14.4% for 1959-99.

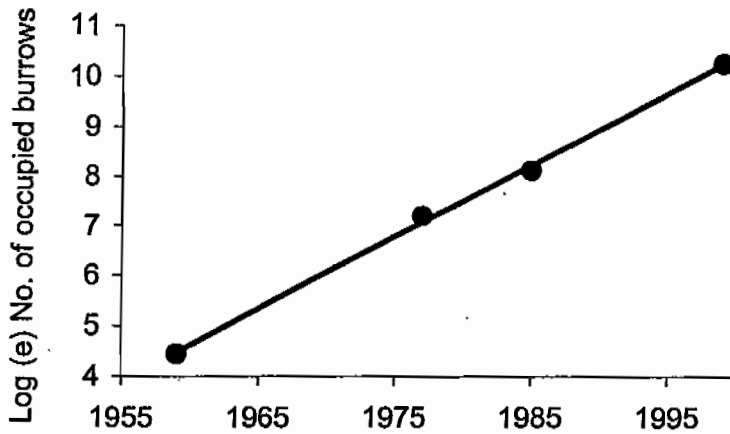
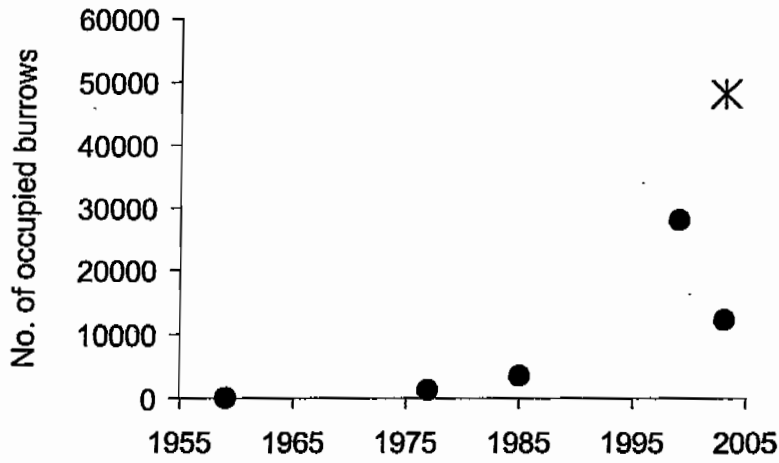


Figure 3. Changes in the numbers of occupied puffin burrows on Fidra, 1956-2003. The upper figure shows counts of puffin burrows on Fidra 1957-2003. The lower figure shows an average annual rate of increase of 9.5% between 1976 and 2003

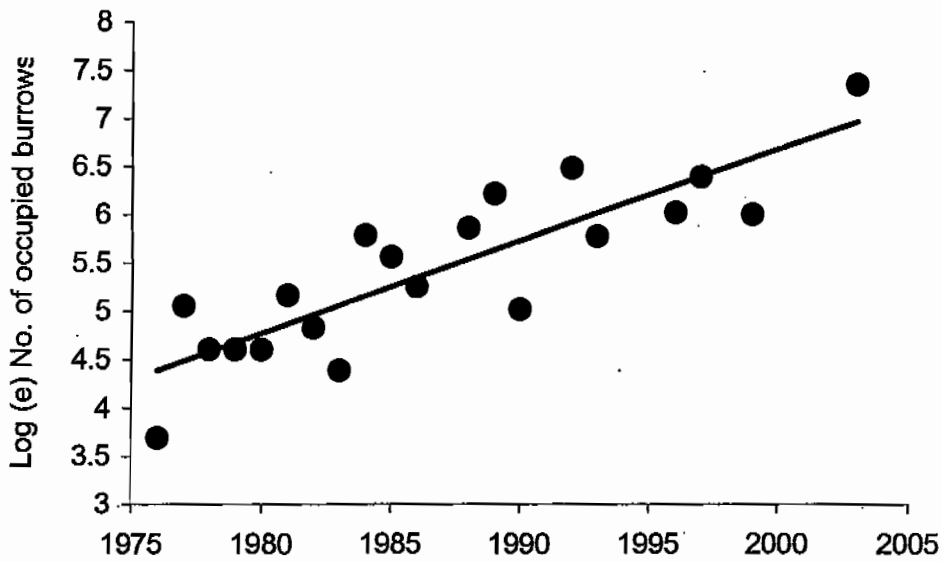
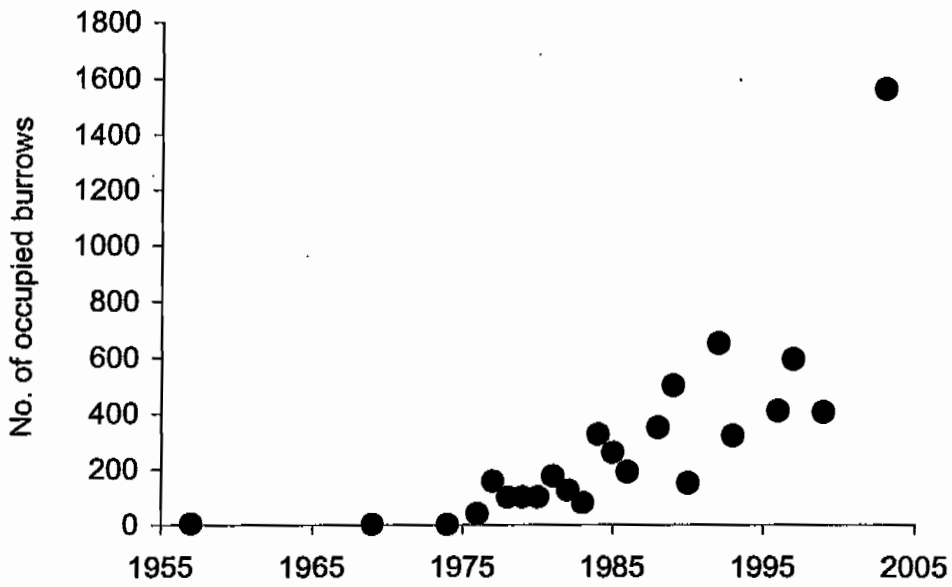


Table 1. Counts of occupied puffin burrows on the Isle of May on 24-27 April 2003 compared to counts in 1975, 1984, 1989, 1992 and 1998. Count areas are shown in Map 1.

Area	1975	1984	1989	1992	1998	2003
Kirkhaven to Colm's Hole	345	1518	2458	2525	5174	8884
Colm's Hole to Low Light (Burrian)	1112	2786	4092	5142	7388	10110
Holyman's Road (West side)						
South of Colm's Hole (East Braes)	40	561	1068	1078	2584	4342
North of Colm's Hole (Beacon)	63	347	517	414	1323	2477
Low Light to Tarbet Cliff	75	380	795	497	1213	3155
Tarbet Cliff to Nybo Bridge	0	0	0	19	67	203
Rona	549	2571	3237	3318	5148	7597
North Ness	160	225	371	286	139	194
North Plateau	316	2147	2659	3846	9955	18957
South Plateau						
Pilgrim's Haven to Loch	23	105	394	389	2616	5779
Loch Sides (incl. Mill Door, both sides below Dam)	c.10	c.100	c.150	246	410	650
South Horn	9	15	c.100	150	585	1388
Maidens	5	2	0	0	2	0
Ardcarron Gully to Kirkhaven	113	274	635	530	1324	2892
Lady's Bed	244	1180	2152	1620	3351	6070
West Braes	0	0	0	20	24	597
Horse Hole to Altarstanes	0	0	0	20	98	416
St Andrew's Well area	0	0	0	6	31	231
Nybo bridge to Altarstanes	0	0	0	0	8	31
Fields (Tennis Court, Chapel, Cross Park)	0	0	0	0	102	574
GRAND TOTAL	3064	12211	18628	20106	41542	74517

The 2003 count was made by S. Wanless, M.P. Harris, S. Beer, G. Jones, M. Frederiksen, L. Wickens, L. Wilson

Table 2. Checks of burrow counts and classification of puffin burrows in 11 sections of the colony on the Isle of May in April 2003.

Area	Count made	Mistaken classification		Correctly classified (A)	Missed (B)	Corrected Total (A+B)	Correction Factor
		Too short / rabbit	Joined another burrow				
(a)							
Rona	66	4	3	59	8	67	1.02
Lady's Bed	96	9	3	84	2	86	0.90
Tarbet -Low Light	51	3	4	44	1	45	0.88
Burrian	97	5	7	85	8	93	0.96
Kettle	85	1	5	79	8	87	1.02
(b)							
Beacon	2					3	1.5
North Plateau (N)	80					73	0.91
North Plateau (S)	52					51	0.91
East Braes	59					46	0.98
South Plateau (S)	40					34	0.85
South Plateau (N)	21					19	0.90
Total	649					604	0.93

Table 3. Percentage changes in numbers of occupied puffin burrows in the main sections of the Isle of May between 1992 and 2003

Area	1992	1998	2003	% annual increase 1992 - 98	% annual increase 1998-2003
Kirkhaven – Colm's Hole	2525	5174	8884	12.7	11.4
Burrian	5142	7388	10110	6.2	6.5
East Braes and Beacon	1492	3907	6819	17.4	11.8
Low Light to Nybo Bridge	516	1280	3358	16.3	21.3
Rona and North Ness	3604	5287	7791	6.6	8.1
North Plateau	3846	9955	18957	17.2	13.7
South Plateau and Lochside	635	3026	6429	29.7	16.3
South Horn to Kirkhaven	2300	5262	10350	14.8	14.5
Total (includes other areas)	20106	41542	74517	12.9	12.4

Table 4. Checks of burrow counts and classification of puffin burrows in 11 areas of Craigleith in April 2003 and in two areas of Fidra in May 2003

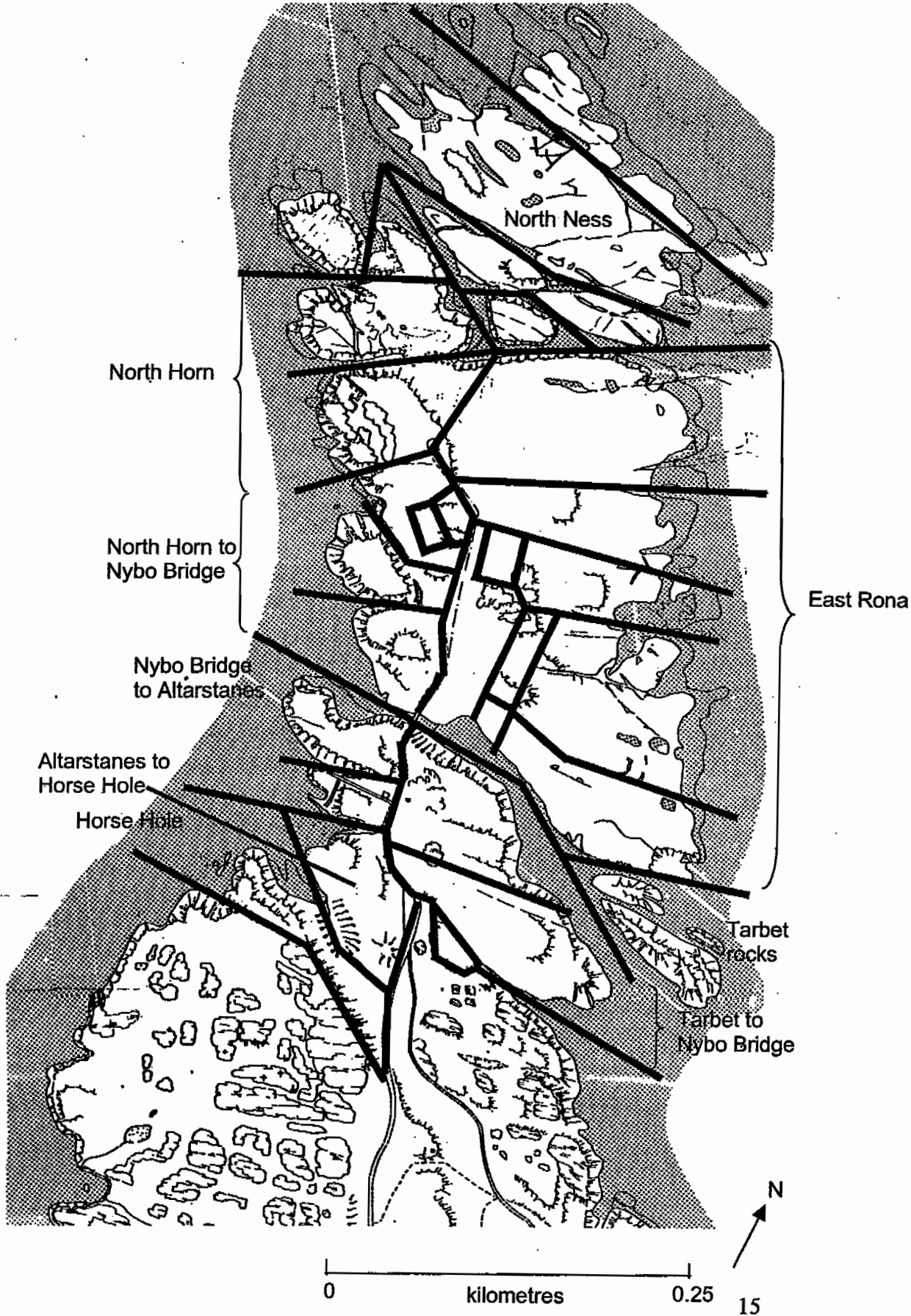
Plot no.	Marked	Unusable	Missed	Double entrance	Total	Correction factor	Habitat
Craigleith 19 April 2003							
1	9	0	3	0	12	1.33	Mallow
2	6	0	2	0	8	1.33	Mallow
3	9	0	0	0	9	1.00	Mallow
4	75	7	31	0	99	1.32	Mallow/gulls
5	60	5	10	1	64	1.07	Mallow/gulls
6	8	0	12	0	20	2.50	Mallow/gulls
7	43	0	11	0	54	1.26	Mallow/gulls
8	59	3	2	3	55	0.93	Open
9	18	1	1	0	18	1.00	Open
10	104	12	7	2	97	0.93	Open
11	76	5	11	1	81	1.07	Open
					Mean	1.25	
					SE	0.13	
					95%CI	0.95-1.55	
Fidra 4 May 2003							
1	57	7	1	0	51	0.90	Open
2	54	3	2	0	53	0.98	Open
					Mean	0.94	
					SE	0.04	

Table 5. The largest colonies of Atlantic puffin in Britain and Ireland in 2003 (Seabird 2000 results, updated)

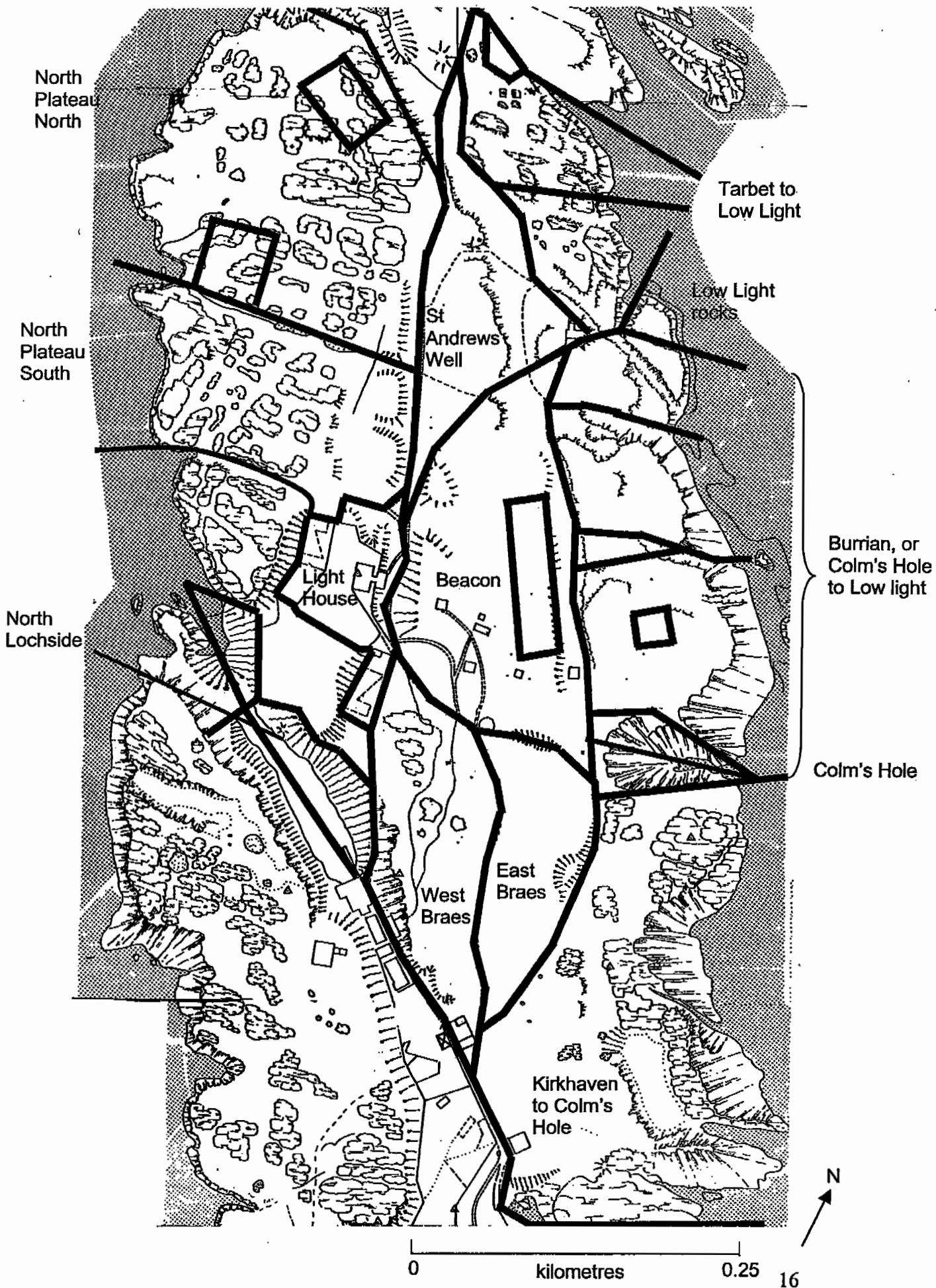
Colony	Last count	Burrows	Status
Isle of May	2003	69,000	increasing rapidly
Sule Skerry	1998	59,500	declining?
Dun, St Kilda	1999	55,400	increasing slowly
Boreray, St Kilda	1999	51,000	declining?
Farne Islands	2003	50,000	increasing slowly
Garbh Eilean, Shiant Isles	2000	49,300	stable
Fair Isle	2000	40,000	increasing?
Soay, St Kilda	2000	24,000	declining
Hermaness, Unst	1997	23,700	stable
Foula	2000	22,500	declining
Flannan Isles	1998	15,632	increasing
Craigeith	2003	12,000	declining
Coquet	2003	11,300	stable
Skomer	2000	10,600	increasing

Map 1. Areas used for between-year comparisons of counts of burrows on the Isle of May

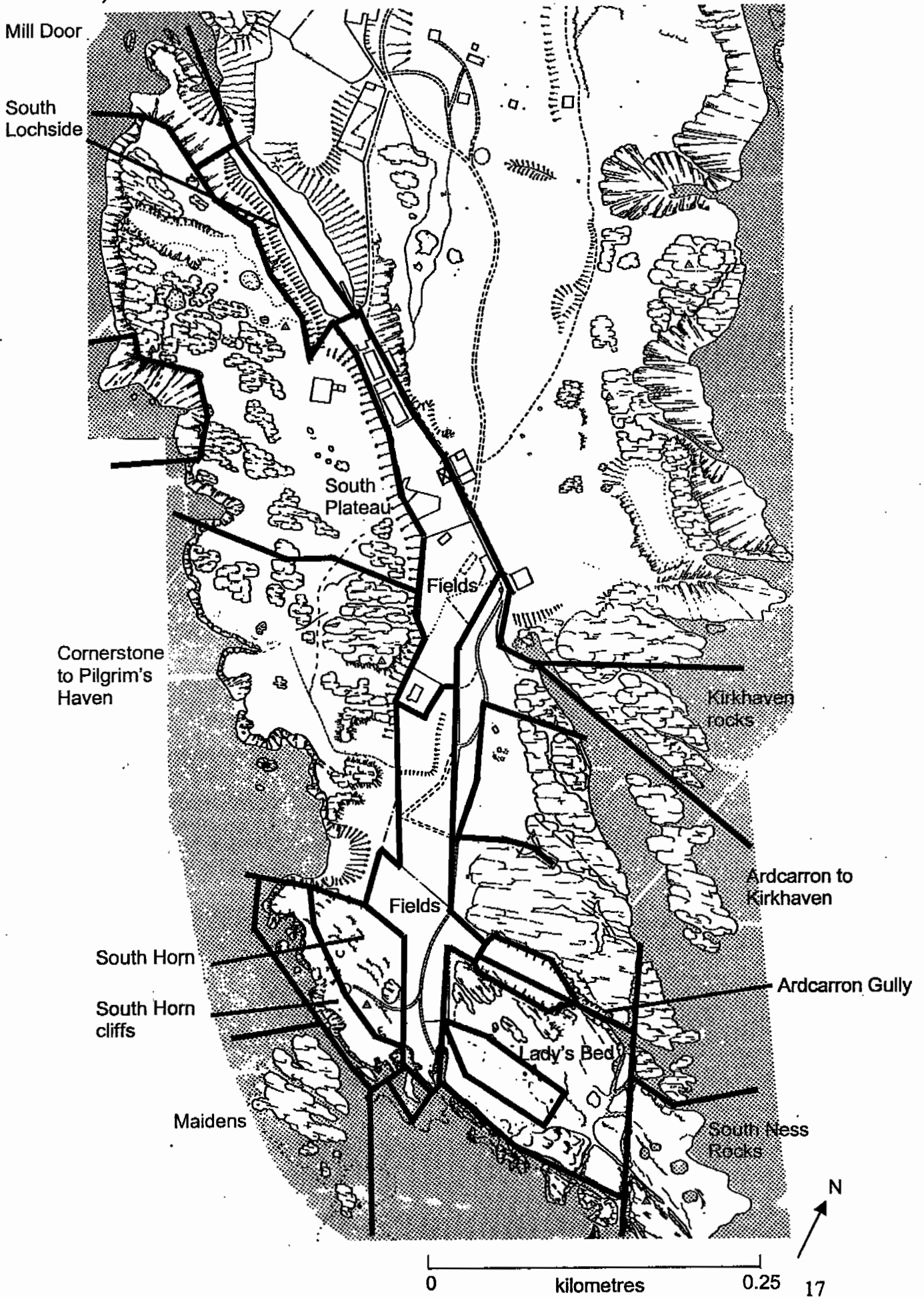
a) North



b) Middle

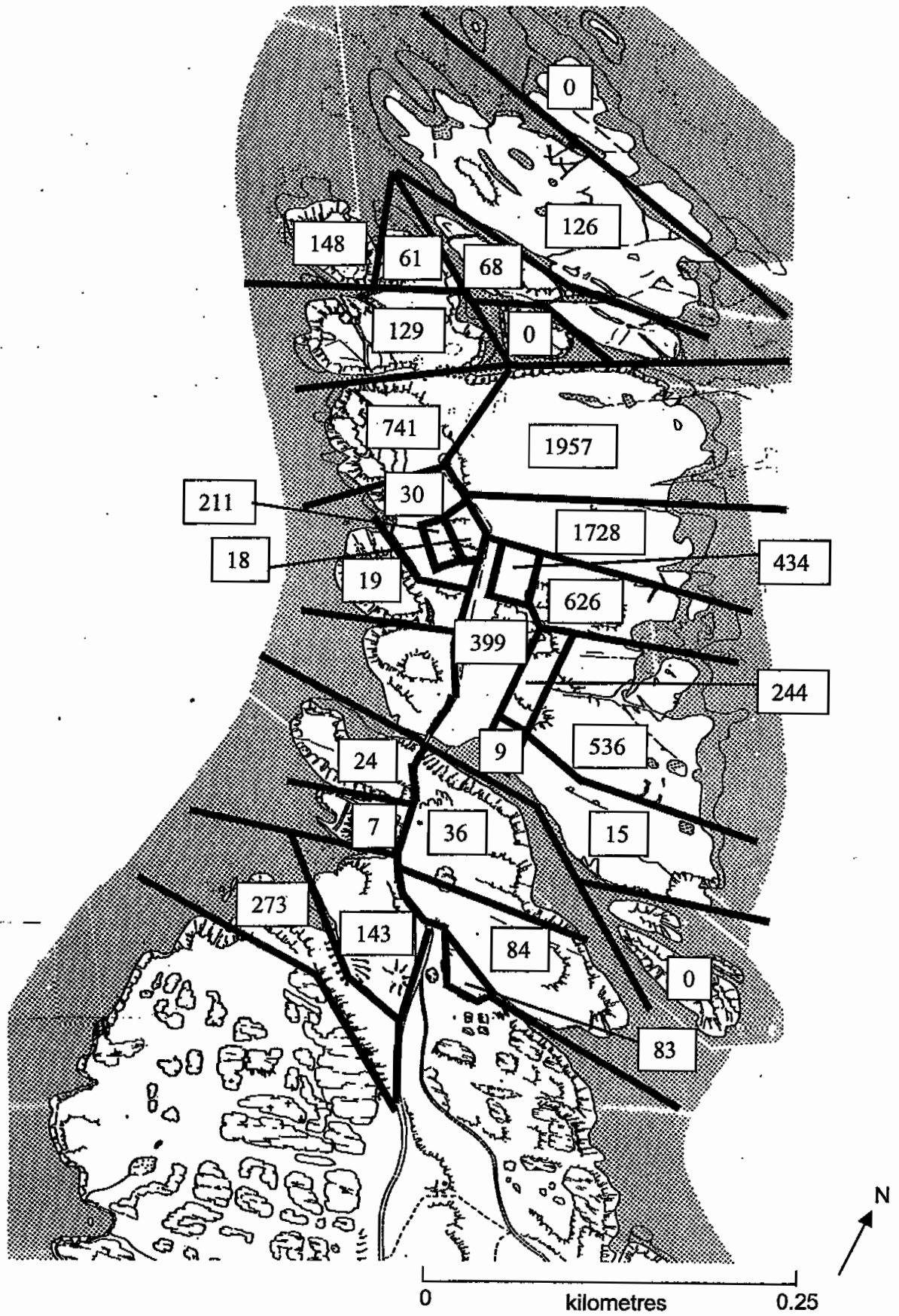


c) South

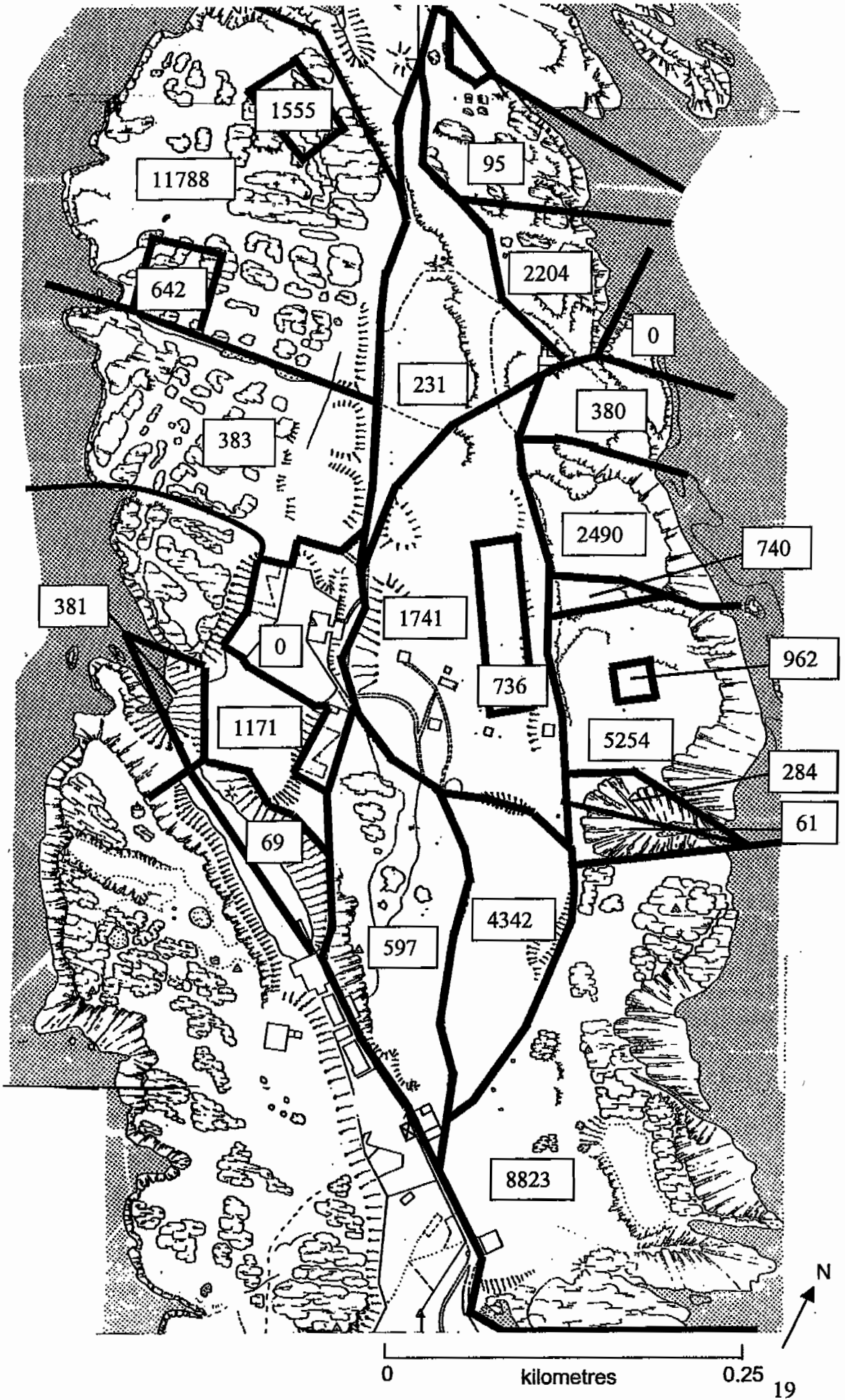


Map 2. Area counts of occupied puffin burrows on the Isle of May in April 2003

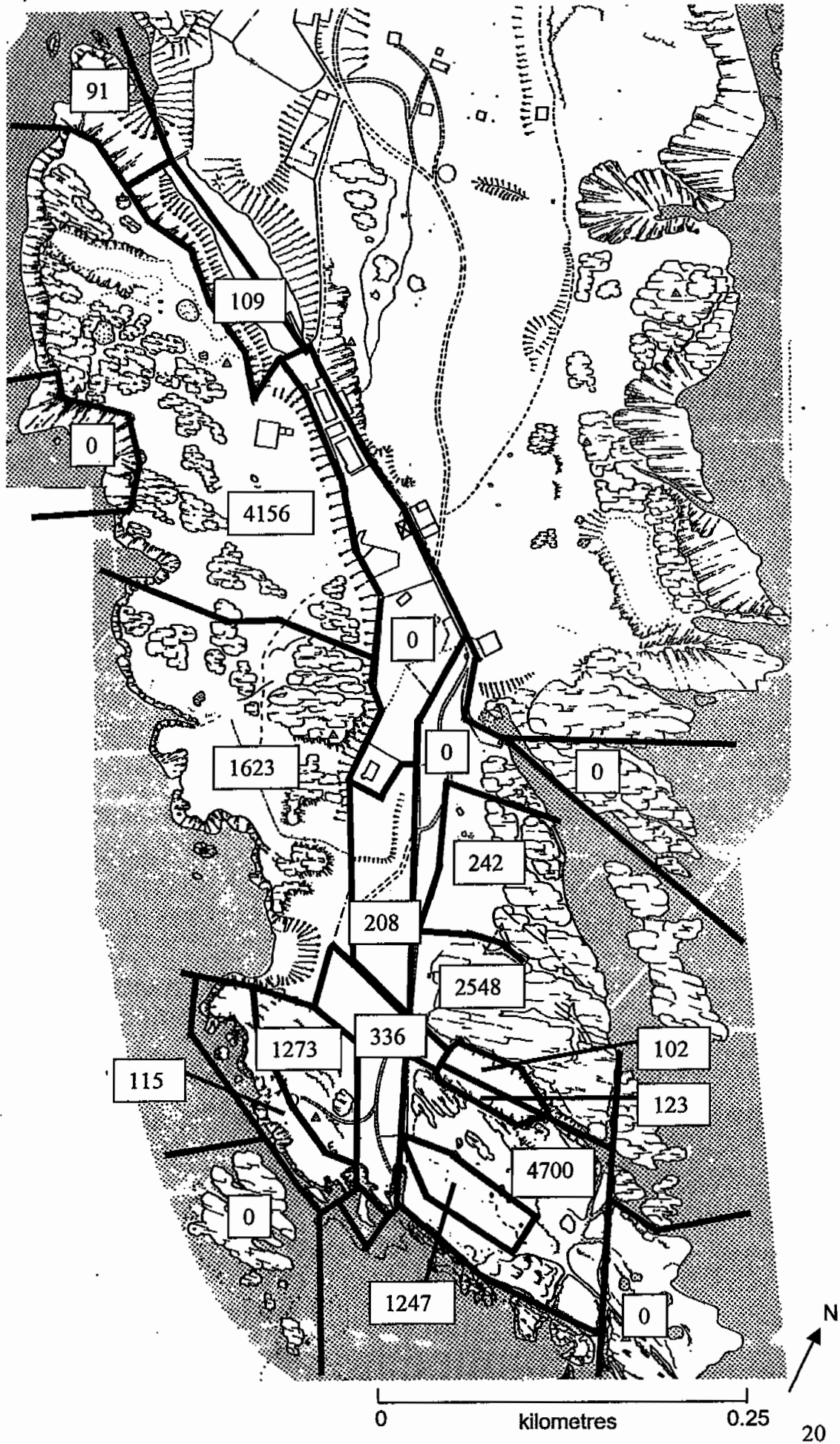
a) North



b) Middle



c) South



Map 3. Approximate areas of Craigeleith that were open, covered with tree-mallow and occupied by gulls in April 2003

