INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

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ISLE OF MAY SEABIRD STUDIES IN 1993

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Annual Report to Joint Nature Conservation Committee

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C O N T E N T S

SUMMARY

1 The shag, kittiwake and the terns had almost complete breeding failures, guillemot and puffin had lower-than-average successes whereas the breeding outputs of fulmar and razorbill were normal. Failures of kittiwake nests occurred at all stages of the breeding cycle and no more than normal broods were neglected.

2 Breeding of shags was late and a large proportion of the population failed to nest. The reasons are unclear.

3 Adult survival of all species, except puffin remained high. The figure of 84% for the puffin is still lower than in the 1970s.

4 Sandeels predominated in the diet of shag, kittiwake and puffin whereas young guillemots received mainly medium-sized sprats. Kittiwakes received a wide variety of prey, including trawler waste. There was no suggestion that young auks were short of food.

1. BACKGROUND

The Joint Nature Conservation Committee (formerly the Nature Conservancy Council) has a responsibility to advise on the condition of the natural marine environment. Seabirds are one of the more important components of this environment, and Britain has internationally important populations of several species. JNCC has designed a programme that will allow the numbers of selected species of seabirds to be monitored at several colonies. In addition, selected colonies have been targeted for more detailed monitoring of reproductive performance and annual survival rates. These selected colonies are geographically spread in order to give as full a coverage as possible of British waters. The Isle of May NNR is a very suitable site in East Britain.

The Institute of Terrestrial Ecology (ITE) has had a long-term interest in seabirds on the Isle of May. Since 1986, ITE has received NCC/JNCC support for a more formalised seabird monitoring programme. Long-term studies on numbers, breeding success, adult survival, chick growth and chick food are underway on up to 8 species. Due to the long period of immaturity and high annual survival rates of seabirds, it is essential that continuity of these long-term studies is maintained. As part of its Seabird Monitoring Programme, NCC/JNCC has placed a contract with ITE to:

(a) ensure that the breeding success of fulmar *Fulmarus glacialis*, shag *Phalacrocorax aristotelis*, kittiwake *Rissa tridactyla*, common tern *Sterna hirundo*, arctic tern *S. paradisaea*, guillemot *Uria aalge*, razorbill *Alca torda* and puffin *Fratercula arctica* is monitored.

(b) monitor adult survival of shag, kittiwake, guillemot, razorbill and puffin.

(c) assess food of young shags, kittiwakes, guillemots, razorbills and puffins.

(d) assess feeding frequency of guillemot and puffin chicks.

(e) undertake special studies on species agreed between the nominated officer and the contractor.

BP Exploration, Scottish Natural Heritage and NERC also supply funds for the seabird studies on the Isle of May.

2. METHODS

2.1 Breeding success

The standardized methods used involved minimal disturbance of birds and are described in detail in 'Development of monitoring of seabird populations and performance' - Final Report to NCC for contract HF3-08-15.

Fulmar: The positions of apparently incubating birds were marked on photographs on 28 May, and 1 and 7 June; sites where birds appeared to be incubating on all three visits, or where an egg was seen, were assumed to have been bred at. These sites were checked again on 18 July, and on 20 August when those with a large chick were assumed to have been successful.

Shag: The positions of nests in 14 areas were marked on photographs and the state and contents of these nests were checked weekly from mid-March until 15 September. I assumed that remaining large young present on 15 September survived.

Kittiwake: The position of nests in 15 areas were marked on photographs and the presence or absence of an incubating bird, or the number of young present at each was checked on 21 May, 3 June and on 10 July - two days after the first young had fledged. Checks were repeated on 15 and 19 July. Some recently-fledged young died in late July so the estimate of production, already extremely low, will certainly have been slightly too high.

Guillemot, razorbill: Daily checks of the state of breeding of numbered nest-sites in five study plots were made from permanent hides.

Puffin: In each of four areas, samples of 50 burrows where an egg could be felt on 29-30 May (when most pairs had laid) were staked and re-checked on 3-5 July (when chicks were near fledging). All large young were assumed to have fledged as were young from empty burrows where there were many droppings, moulted down and feather sheaths.

Common and arctic terns: Nests with eggs were staked and counted on several dates in May and the cumulative total was taken as an estimate of the population. Regular checks were made of the number of fledged young at the fringe of the colony.

2.2 Adult survival rates

For all species these were based on sightings of individually colour-ringed birds. The areas in which birds were originally marked were checked regularly throughout the season and adjacent areas were also searched from time to time in an attempt to pick up birds which had moved. Searches were made for birds which had moved out of the study areas. These later searches are extremely time consuming, and superficially unrewarding, but they are essential if accurate estimates of survival are to be obtained.

2.3 Food of chicks

Food regurgitated by young kittiwakes and loads of fish dropped by adult puffins caught in mist-nests were

collected, weighed and the fish identified and, where possible measured (total length to tip of tail). As so few chicks were reared, only three food samples were collected from young shags. A general assessment of the diet was made from the results of stomach flushing full-grown birds. Where necessary, fish otoliths were extracted and examined. Records were kept of fish brought to young guillemots and razorbills and uneaten fish were collected from breeding ledges.

2.4 Feeding frequency

All-day watches were made of marked sites/burrows of guillemot, razorbill and puffin from permanent hides. Observers took 2 - 3 hr shifts, recorded the number of feeds brought to each chick and where possible, noted the species and size of the fish.

3. RESULTS

3.1 Breeding success

Species accounts are given in Tables 1 - 4 and a comparison with recent year's results is shown in Table 5.

Fulmar: The first egg was seen on 18 May. Breeding success was 0.44 young per incubating pair.

Shag: This year was a bad season for shags on the Isle of May. Although adult survival remained high and large numbers of birds were present in the spring, breeding was

greatly delayed and the first egg was not laid until about 18 May (cf 16 March in 1992). Some pairs did not breed until July. Only in 1975 and 1976 was the first egg recorded later (22 May in both years); much more effort (by frustrated research workers) was put into searching for the first egg in 1993 than in earlier years and 1993 was probably by far the latest season in the last 30 years.

As is usual in such late years many birds did not lay, although most pairs occupied nest-sites. A count made 1-6 June found only 70 occupied nests but during a second count made 21-23 June there were 715 nests (plus 113 pairs with "trace" nests). This is the lowest annual nest-count since 1976, and under half that of 1992. Other studies showed that 68% of nests built during this season were in existence during the second count, so possibly some 1050 pairs attempted to breed. The mean fledging success was 0.21 young per incubated nest (Table 2).

Studies of individually marked birds indicated that adult survival between 1992 and 1993, was about 80%, which was not markedly lower than usual. Thus the low nest count was associated with many birds not breeding. Similar large-scale non-breeding events were recorded in 1974, 1975, 1976, 1985 and 1986 (Aebischer & Wanless, Bird Study (1992) 39, 43-52).

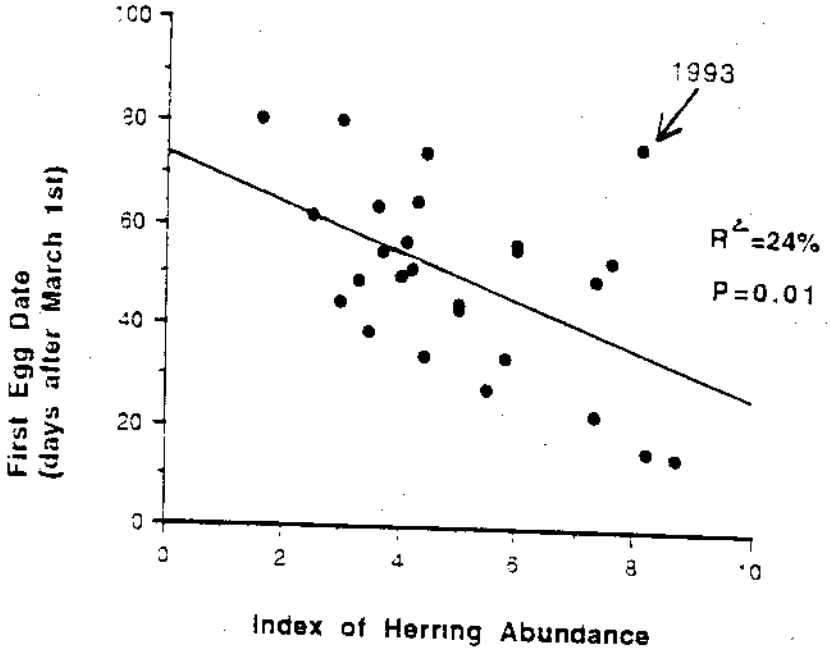
Aebischer & Wanless reported that first egg dates of shags on the Isle of May were significantly and negatively correlated with an index of the abundance of small herring in the adjacent seas during February such that the more herring there were, the earlier shags bred and significantly and positively correlated with the numbers of days of easterly winds in March (Figure 1). The two factors were not significantly correlated, and between 1973-87 together explained 70% of the variation in laying date with the equation:

First-egg date (days after 1 March) = -7.84 herring + 0.948 days of easterly wind + 75.

In 1993 the herring abundance was high (8.1) and there were 10 days of easterly winds at Leuchars, thus the predicted first egg date was 21 March, i.e. almost two months before the actual date. Some other factor must have been acting but what this might have been is, at present, unclear.

Kittiwake: It was an extremely unsuccessful season, indeed by far the worst on record. The mean success was only 0.07 chicks fledged per occupied nest (Table 3).

Most pairs present laid and the total nest count of 7009 was slightly up on the counts made in 1991 and 1992. The clutch-size (mean = 1.78, n = 91) was slightly lower than



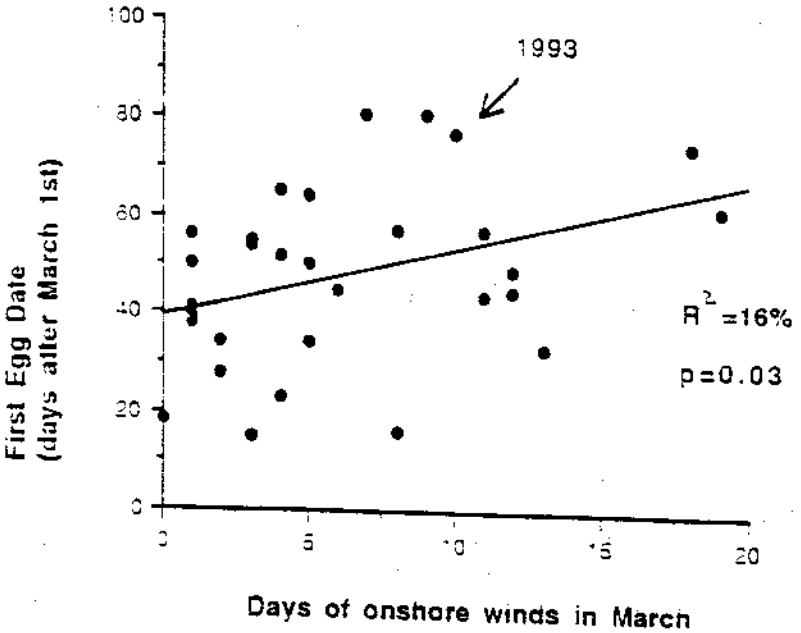


Figure 1. The relationship between first egg date and (a) an index of herring abundance and (b) the days in 1963-93 of easterly wind. Laying in 1993 was far later than predicted.

in recent years - 1992 1.83 (n = 40), 1991 1.86 (n = 125), 1989 2.04 (n = 130) and 1990 1.82 (n = 98). The first egg was seen on 4 May, which compares with 30 April 1992, 6 May 1991, 2 May 1990 and 27 April 1989. Failures occurred at all stages of the breeding cycle and no more than usual chicks were left unattended (Table 12). Some young died soon after fledging and probably no more than 200 young fledged successfully.

Guillemot: Laying was normal (first egg 24 April) and the first young left on the night of 17/18 June. Breeding success (0.76 young leaving per pair laying) was among the lowest recorded on the island.

Razorbill: Both the timing of breeding and success (0.72 young leaving per pair laying) were normal.

Puffin: Timing of breeding appeared normal, although laying was protracted with some pairs chicks not fledging until early September. The success rate of 0.69 chicks per egg laid was the second lowest since the study started in 1972.

Terns: A total of 681 nests were counted. Observations of incubating birds indicated that 80% were arctic, the rest were common terns. Of 55 large young ringed, 41 were arctic, 14 were common. Fledging success was difficult to

assess with any accuracy but was certainly very low. Probably no more than 50 young fledged successfully.

3.2 Adult survival

Not every adult alive is seen each year and thus the survival rates between 1992 and 1993 of 79.6% for shag, 80.8% for kittiwakes, 95.0% for guillemot, 91.5% for razorbill and 84.0% for puffin must be minimum estimates. Sample sizes are given in Table 6.

The figure for puffins was low despite considerable effort being put into looking for colour-rings. Survival may have been higher than the estimated 80% as the unusually long grass made observations very difficult at Colm's Hole. The survival at Little Hole (where the grass was cut regularly) was 90.3%. Many adults have been ringed at Little Hole in recent years by C. Wernham. Observations in future years will be concentrated there.

In 1993, 1 (out of 27) kittiwakes seen in 1991 but not seen in 1992 were recorded, as were 6 (of 37) missing shags, 7 (of 38) missing puffins and 1 (of 6) missing razorbills. Incorporating these records increases the 1991-92 survival figures for these four species to 81.4% (from 80.7%), 83.1% (from 79.9%) 89.2% (from 86.8%), and 91.5% (from 89.8%) respectively (Table 15). Two missing guillemots were also found which increased the 1991-92 survival to 93.8% (from 93.3%).

During 1993 a further 32 kittiwakes, 10 shags, 21 puffins and 88 guillemots were colour-ringed.

3.3 Food of young

The three samples from shag young were composed almost entirely of sandeels 8-14 cm long. Of 24 stomach-flushings of full-grown birds in July, 22 had sandeels, 8 gadidae, 5 gobies, 3 flatfish, 2 dragonets, 1 butterfish, 1 sprat and 2 crustacea.

Most sandeels were 12-14 cm long. Sandeels were the commonest food of young kittiwakes (67% by number) (Table 7). Most sandeels in kittiwake regurgitates were 10-14 cm long (i.e. 1-group or older) Sandeels contributed c. 63% by weight of the kittiwake regurgitations. Other food included trawler waste (3 samples), whiting (4 fish) and butterfish (1), which might also have come from fishing boats, saithe (1), sprat (20 fish), 1 large green polychaete worm and minute crustacea (2 loads).

Of 673 fish delivered to young guillemots, 520 (77%) were clupeidae - mostly sprats 8-13 cm long (Table 8). Clupeidae made up 83% of the diet by weight. The remainder was made up of sandeels, mostly about 12 cm long.

Razorbill loads were made up of approximately equal numbers of sandeel and clupeidae (Table 9).

By number, sandeels made up 69% of the diet of young puffins (Table 10) but the proportion in biomass terms, was reduced to 56% as the other main food fish - herring - were much heavier. The proportion of sandeels in the diet was the lowest since 1978.

3.4 Feeding frequency

Three all-day watches were made on different groups of guillemot and razorbill chicks, and of puffin burrows (Table 11). On average, young guillemots received 4.9 feeds per day, young razorbills 3.7 feeds per day and young puffins 4.9 feeds per day.

4. CONCLUSIONS

4.1 Overall, seabirds on the Isle of May had an unsuccessful season.

The 1993 breeding season was the worst for the shag on the Isle of May since records began in 1960. Not only did a large proportion of the population not breed, but those which did nest laid many weeks later than normal and had a very low breeding success. Previous experience suggests that the very few young which did fledge (and which will not be independent until late September or even October) will have a low survival rate. The season must be regarded as a virtual failure. Shags on the Farne Islands also had a bad year whereas those in Aberdeenshire appear to have had breeding seriously delayed, but then reared substantial

numbers of chicks. I am investigating possible causes of this upset in breeding.

Kittiwakes also had an almost complete breeding failure, although most pairs did lay. Pairs failed at all stages of the cycle and no more than the normal proportion of broods were neglected.

Very few young terns were reared and, although the successes of puffins and guillemots were, by comparison, reasonable they were among the lowest recorded. Only fulmar and razorbill had a good breeding season.

The general impression is that whereas conditions in the 1980s appeared uniformly good for breeding of Isle of May seabirds, they are now more variable or unpredictable. Evidence from several sources suggests that although these seabirds are breeding satisfactorily, they are fairly close to the food limit.

4.2 Assuming that the normal proportion of 1992 missing birds of all species are found in future years, the adult survival rates of guillemot, razorbill, kittiwake and shag from 1992 to 1993 were normal.

Updated estimates of survival rates for these few species in recent years are given in Table 15. Those for shag range 79.8 - 92.5, close to the average of 85.4% calculated

for 1965 - 82 (Aebischer 1986; J. Anim. Ecol. 55, 613 - 629). The figures for kittiwake 80.8 - 93.2 are markedly higher than the 30 year mean of 78% for males and 82% for females and a combined-sex annual mean of 65% for 1982-85, at North Shields (Aebischer & Coulson 1990; J. Anim. Ecol., 59, 1063 - 1071). The few comparable data for guillemot and razorbill suggest that the Isle of May survival rates are also high.

4.3 The current estimates of annual survival rates of breeding puffins are 80 - 90%. These compare with an average figure of 96% in the 1970s which was obtained by the same methods in the same study areas. Modelling indicates that the species is unlikely to be able to maintain its numbers on the Isle of May unless (a) immature survival has increased substantially, (b) the age of first breeding has declined or (c) there is substantial immigration. The available data suggest that none of these has occurred. A separate project is addressing this problem.

4.4 It is easy to colour-mark large numbers of adult seabirds but much sustained effort is needed to find them again. In birds with high survival rates even a few missed individuals can result in great proportional error in the estimated survival. My approach is to make a major effort (by daily searches) to find colour-rings early in the season when birds are easily seen and to carry out searches

for specific missing birds later in the season. As many of these birds nest in front of permanent hides and/or are used for other studies many areas are under daily surveillance. There is a growing amount of evidence which suggests that, although it is impossible to be sure that a bird is not present, a small (and annually variable) proportion of adults which have bred at least once do not breed each year, although some may visit the colonies later in the season or, in the case of the shag, return to roost during the subsequent autumn.

4.5 Sandeels accounted for most of the food of shags in 1993 and 63% (by weight) of that of young kittiwakes. There is a suggestion that sandeels are becoming less dominant in the diet of young kittiwakes (Table 13) which might conceivably be linked with lower nesting success. The diet of young puffins was still mainly sandeel but the proportion of herring increased quite substantially. Young guillemots received mainly sprats.

Although the feeding frequency of auks had been fairly high in 1986 - 92, there was a marked reduction in the food intake of young guillemots (Table 14). The situation improved in 1993 with the calculated daily intake of food (31 g) being the highest since 1988.

5. THE FUTURE

5.1 During the 1970s and for most of the 1980s conditions were very favourable for seabirds in the North Sea. Conditions started to change in the north in the early 1980s with reductions in numbers and/or breeding success of a range of species. There is good evidence that, at least for guillemots, change started in the north and gradually moved south. Population declines started significantly earlier and were fastest in northern colonies.

5.2 Conditions appear to be changing in the Firth of Forth as shown by low survival of adult puffins, low recruitment of some cohorts of young guillemots, poor breeding of kittiwakes, delayed (and irregular) breeding of shags, reduction in the intake of young guillemots and sporadic food shortage in several species.

5.3 The seabird studies on the Isle of May were sometimes criticized in the past as being 'too academic' as they were concerned with populations which were expanding. However, we now have a solid base against which to assess changes in biology and survival which are occurring in a range of species. Only by detailed studies in such circumstances can we hope to understand the processes, and hence the likely causes, involved in population declines and breeding failure.

5.4 In 1991 several Danish fishing vessels were trawling for sandeels at the Marrs and Cockenzie Banks to the northeast of the Isle of May. Many more were reported to be fishing there in 1992. As yet data are not available for 1993. There is no evidence that such fishing has an adverse effect on the availability of food for seabirds. However, if such a fishery develops it will be important to continue the monitoring of seabird breeding and food of seabirds on the Isle of May.

5.5 SNH are now financing the monitoring of the breeding populations of all seabird species on the Isle of May. The Isle of May is one of JNCC's main seabird biological monitoring sites. Hopefully both will continue to give adequate financial support for it to continue.

6. ACKNOWLEDGEMENTS

John Calladine, SNH summer warden, assisted with much of the work. C. Wernham, A. Russell, S. Russell, K. Ferry, S. Wanless, T. Barton, M.A. Robinson and others helped collect fish and regurgitates and with the feeding watches. S. Wanless improved this report with her criticisms.

7. PUBLICATIONS ON ISLE OF MAY SEABIRDS

The following have either been published since the last report or are <u>in press</u>.

Harris, M.P., Halley, D. & Wanless, S. 1992. The post-fledging survival of young Guillemots *Uria aalge* in relation to hatching date and growth. *Ibis* 134, 335-339

Harris, M.P. & Wanless, S. 1993. The diet of young and adult Shags *Phalacrocorax aristotelis* during the chick-rearing period assessed by three methods. *Bird Study* 40, 135-139.

Wanless, S., Harris, M.P. & Russell, A.F. 1993. Factor influencing food load sizes brought in by Shags *Phalacrocorax aristotelis* during chick-rearing. *Ibis* 135, 19-24.

Wanless, S. & Harris, M.P. 1992. Activity budgets, diet and breeding success of Kittiwakes *Rissa tridactyla* on the Isle of May. *Bird Study* 39, 145-154.

Wanless, S., Corfield, T., Harris, M.P., Buckland, S.T. and Morris, M.A. (1993). Diving behaviour of the shag *Phalacrocorax aristotelis* in relation to water depth and prey size. *Journal of Zoology* 234, 11-25.

Halley, D.J. & Harris, M.P. 1993. Inter-colony movement and behaviour of immature guillemots *Uria aalge*. *Ibis* 135, 264-270.

Harris, M.P., Halley, D.J. & Swann, R.L. (in press). Age of first breeding in the Common Murre. *Auk*.

Harris, M.P. & Wanless, S. (in press). Ingested elastic and other artefacts found in puffins in Britain over a 24-year period. *Mar. Polln. Bull.*

Harris, M.P. & Calladine, J. (1993). A check on the efficiency of finding colour-ringed Kittiwakes *Rissa tridactyla*. Ringing & Migration 14, 113-116.

Halley, D.J. & Harris, M.P. (in press). Age-related differences in agonistic behaviour in Common Guillemots. Seabird 16,

Table 1. Fledging success of fulmars on the Isle of May in 1993.

	Area	Incubating birds	No. probably hatched	Young fledged
1.	Cleaver	8	6	6
2.	Pilgrim's Haven	3	1	1
3.	Cornerstone	7	6	1
4.	Loch (S)	38	24	16
5.	Greengates	28	20	13
6.	Horse Hole	11	5	4
7.	Rona	0	0	0
8.	Tarbet	20	11	11
9.	Low Light	3	1	1
10.	Colm's Hole	3	0	0
	Total	**121**	**74**	**53**

0.44 fledged/pair

Notes: Incubating birds were those sitting tight on three checks or where an egg was seen. Chicks present on 20 August were assumed to have fledged.

Checks were made by J. Calladine.

Table 2. Fledging success of shags on the Isle of May in 1993.

	Area	Total incubated	Young fledged 1	2	3	Other nests	Total young fledged	Mean young fledged per incubated nest
1.	Lady's Bed (South)	2	0	0	0	0	0	0
2.	Lady's Bed (Mid)	2	0	0	0	0	0	0
3.	Maidens	4	0	0	0	3	0	0
4.	South Horn	1	0	0	0	1	0	0
5.	Chatterstanes	2	0	1	0	1	2	1.0
7.	South Face	1	0	0	0	0	0	0
8.	Mill Door (N)	9	0	0	0	0	0	0
9.	Mill Door (S)	11	0	0	0	4	0	0
10.	Bishop Cove	2	0	1	0	1	2	1.0
11.	Rona	4	1	0	0	0	1	0.25
12.	Tarbet	25	2	1	1	4	7	0.28
13.	Colm's Hole (S)	4	0	0	0	3	0	0
14.	Colm's Hole (N)	13	0	1	0	6	2	0.15

Mean ± SE = **0.21 ± 0.10**

Notes: (1) No pairs bred in Plot 6

(2) On the last check on 15 September there were still five broods with a total of 11 large young which were assumed to be going to fledge.

Table 3. Fledging success of kittiwakes on the Isle of May in 1993.

	Area	Completed nests	Trace nests	Fledged young/ nest			Total young produced	Fledging success per completed nest	Fledging success all nests (incl. trace)
				0	1	2			
1.	Cleaver	39	2	39	0	0	0	0	0
2.	Pilgrim's Haven	30	1	19	10	1	12	0.40	0.39
3.	South Face	37	0	37	0	0	0	0	0
4.	Colony 4	117	2	111	5	1	7	0.06	0.06
5.	Cornerstone	121	3	101	20	0	20	0.17	0.16
6.	Loch (S)	96	0	95	1	0	1	0.01	0.01
7.	Loch (N)	108	3	108	0	0	0	0	0
8.	Greengates	107	2	102	5	0	5	0.05	0.05
9.	Bishop's Cove	79	3	78	1	0	1	0.01	0.01
10.	Horse Hole	4	1	4	0	0	0	0	0
11.	Iron Bridge	63	1	54	8	1	10	0.16	0.16
12.	Rona	48	1	47	1	0	1	0.02	0.02
13.	Tarbet	116	0	116	0	0	0	0	0
14.	Low Light	42	0	42	0	0	0	0	0
15.	Colm's Hole	27	0	23	3	1	5	0.19	0.19
							Mean	**0.07**	**0.07**
							SE	**0.03**	**0.03**

Notes: No broods of three were fledged anywhere on the island

Table 4. Breeding success of auks on the Isle of May in 1993.

Species	Area	Pairs laying	Young hatched	Young 'fledged'	Young leaving/ pair
Guillemot	Dense	280	226	216	0.77
	Hide/White	88	68	59	0.67
	Colony 4	228	194	175	0.77
	South	47	38	36	0.77
	Cornerstone	154	136	130	0.84
	Mean ± S.E.				0.76 ± 0.03
Razorbill	Hide/White	21	17	17	0.81
	Colony 4	38	26	24	0.63
	South	15	13	10	0.67
	Cornerstone	45	38	35	0.78
	Mean ± S.E.				0.72 ± 0.04
Puffin	Lady's Bed	45	?	29	0.64
	Kirkhaven	42	?	26	0.62
	Burrian	42	?	31	0.74
	Rona	53	?	41	0.77
	Mean ± S.E.				0.69 ± 0.04

Table 5. Breeding success (young reared per pair breeding) of some seabirds on the Isle of May 1987-93.

Species	1987	1988	1989	1990	1991	1992	1993
Fulmar	0.47 (69)	0.31 (64)	0.54 (93)	0.24 (66)	0.42 (100)	0.47 (129)	0.44 (121)
Shag	1.09 (288)	0.61 (221)	1.09 (234)	0.30 (154)	1.06 (187)	0.87 (181)	0.21 (80)
Kittiwake	1.09 (1291)	0.82 (1278)	1.11 (1327)	0.17 (1095)	0.27 (1172)	0.61 (1062)	0.07 (1034)
Guillemot	0.76 (800)	0.85 (732)	0.85 (757)	0.78 (748)	0.81 (754)	0.85 (745)	0.76 (797)
Razorbill	0.71 (64)	0.70 (98)	0.74 (97)	0.76 (100)	0.72 (104)	0.86 (105)	0.72 (119)
Puffin	0.93 (62)	0.89 (157)	0.88 (164)	0.66 (176)	0.78 (153)	0.87 (184)	0.69 (182)

Notes: The number of pairs followed is given in brackets. Details of methods, etc. can be found in this and previous reports to SNH.

Table 6. Annual survival of adult seabirds on the Isle of May 1987-93.

Species	No. alive in 1992	No. seen in 1993	% Survival 1992/93	1991/92	1990/91	1989/90	1988/89	1987/88
Shag	162	129	79.6	79.9	82.8	74.0	78.1	77.3
Kittiwake	151	122	80.8	80.7	84.2	78.7	90.9	86.0
Guillemot	403	383	95.0	93.3	91.0	94.9	92.4	91.5
Razorbill	59	54	91.5	89.8	79.6	75.0	90.5	88.1
Puffin	294	247	84.0	86.8	71.4	63.3	85.2	76.1

Notes: (1) Only birds which had definitely bred in 1992 or earlier are included.

(2) Directly comparable figures for adult survival in earlier seasons are given. These have not been corrected for missing birds seen in later years, and so are serious under-estimates of survival.

These figures should not be used for population dynamics calculations without consultation with M.P. Harris.

(3) Details of earlier estimates are given in previous reports to NCC/JNCC.

Table 7. Food fed to young kittiwakes and shags on the Isle of May in 1993.

	Kittiwake	Shag
No. of regurgitations	56	3
Range of dates	8 June - 7 July	29 July
Total weight (g)	1069	172
% regurgitations with sandeels	73	100
with Gadidae	21	0
with Clupeidae	16	0
% (by weight) of sandeels in sample	63	99
% (by numbers) of sandeels in sample	67[2)]	99
Lengths (cm) of majority of sandeels	10 - 14	8 - 14
Non-sandeel remains identified	4 whiting (15-18 cm) 1 butterfish (8 cm) 1 saithe (6 cm) 20 sprat (6-10 cm) 1 polychaete (10 cm) 2 loads minute crustacea 3 loads trawler waste	1 flatfish (3 cm)

Notes: (1) Samples collected from chicks or adults with chicks.

(2) Counts and lengths of fish in kittiwake samples were based on otoliths in the regurgitations.

Table 8. Food of young guillemots on the Isle of May in 1993.

	Number of sandeels				Number of Clupeidae			Number of Gadidae
	minute/larval	small	medium	large	small	medium	large	
Length (cm)	-	**10**	**12**	**15**	**8**	**10**	**13**	-
All-day watches								
20 June	0	8	74	7	55	189	35	0
27 June	0	1	2	1	34	43	1	0
4 July	0	0	3	0	13	23	5	0
Other days								
1 June - 9 July	0	26	31	0	32	77	13	0
TOTAL	**0**	**35**	**110**	**8**	**134**	**332**	**54**	**0**

Note: Lengths were based on visual estimates gainst the bird's bill checked by samples of dropped fish collected from the breeding ledges.

Table 9. Food of young razorbills on the Isle of May in 1993.

	Number of loads of							
	Single sandeel			Several sandeels				
	large	medium	small	large	medium	small	Clupeidae	Small fish
All-day watches								
20 June	1	1	1	0	5	3	6[1)]	2
27 June	0	0	0	0	0	0	3	0
4 July	1	0	0	0	0	0	2	0
Others								
9 June - 12 July	3	1	0	0	3	0	6	0
TOTAL	**5**	**2**	**1**	**0**	**8**	**3**	**17**	**2**

Notes: (1) Includes 1 sandeel + 1 clupeid

Table 10. Food of young puffins on the Isle of May in 1993.

		Sample size	Mean	S.E.
a)	Load weight (g)	217	8.4	0.3
b)	Fish/load	217	6.9	0.3
c)	Numbers and lengths of fish (mm)			
	Sandeels *Ammodytes* sp.	849	62.1	0.6
	Herring *Clupea harengus**	370	64.5	0.3
	Saithe *Pollarchius virens*	6	50.5	1.5
	Squid sp	1	35	

* includes some unidentifiable small Clupeidae

Table 11. Feeding frequencies of young auks on the Isle of May in 1993.

Species	Date	No. of young	Mean (± S.E.) feeds/chick/day
Guillemot	20 June	98	4.3 ± 0.2
	27 June	24	5.1 ± 0.4
	4 July	11	5.3 ± 0.6
Razorbill	20 June	5	3.8 ± 0.4
	27 June	3	3.3 ± 0.6
	4 July	2	4.0 ± 0.0
Puffin (a)	16 June	53	4.8 ± 0.3
	8 July	54	4.8 ± 0.3
	13 July	22	5.0 ± 0.4

Notes: (1) Based on all-day watches by observers taking 2 - 3 hr shifts.

(2) Puffin feeding frequencies were from watches organised by C. Wernham as part of her own research and the study funded by BP and NERC.

Table 12. Proportions of kittiwake broods of one and two chicks which had no adults present during daily checks in the middle of the day.

	% Unattended broods of	
Year	**One young**	**Two young**
1986	1	7
1988	31	66
1989	13	32
1990	21	45
1991	2	13
1992	13	28
1993	12	31

Note: Figures are based on 50-100 brooks in the same areas each year. These are means of daily checks made between the dates the first neglected chick was noted and the start of fledging in the areas. In 1993, the counts were made 19 June - 12 July. (Details of methods are given in Wanless & Harris, Scott. Birds 15 (1989): 156 - 161.)

Table 13. Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1986 - 93.

	1986	1987	1988	1989	1990	1991	1992	1993
Shag	97	100	98	100	95	100	97	99
Kittiwake	98	95	94	95	86	50	61	63
Guillemot	90	81	41	74	24	74	53	17
Puffin	83	77	85	89	96	87	86	56

Notes: (1) Dates and sample sizes can be found in the contract report for respective years.

(2) Sandeels also made up the bulk of the food of young razorbills in most years but it is extremely difficult to assess the proportions in terms of biomass.

Table 14. Annual measures of daily feeding frequency and food intake (g) of seabirds on the Isle of May 1986 - 93.

		1986	1987	1988	1989	1990	1991	1992	1993
Guillemot	Feeds/day	3.9	3.7	3.5	6.2	6.1	4.1	4.3	4.9
	Intake/day	33	37	39	25	20	17	23	31
Razorbill	Feeds/day	2.0	2.8	-	5.1	6.9	4.0	2.9	3.7
Puffin	Feeds/day	4.0	3.9	5.1	5.7	4.9	3.7	5.0	4.9
	Intake/day	36	43	47	53	42	31	41	41

Table 15. Updated estimates of survival of breeding seabirds on the Isle of May 1986 - 93.

	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Shag	83.9 (168)	87.5 (152)	83.4 (170)	87.2 (157)	83.1 (184)	79.6 (162)
Kittiwake	92.0 (176)	93.2 (163)	83.7 (179)	86.0 (165)	81.4 (161)	80.8 (151)
Guillemot	92.5 (385)	96.2 (373)	95.9 (363)	92.0 (381)	93.8 (403)	95.0 (403)
Razorbill	92.4 (61)	93.4 (61)	82.2 (62)	83.7 (49)	91,5 (59)	91.5 (59)
Puffin	86.5 (163)	91.0 (145)	82.5 (177)	75.8 (227)	89.2 (287)	84.0 (294)