This document should be cited as:
Harris, M.P. 1996. Isle of May seabird studies in 1996. *JNCC Report*, No. 263

JNCC Report

No. 263

Isle of May seabird studies in 1996

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November 1996

Institute of Terrestrial Ecology
(Natural Environment Research Council)

JNCC/NERC Contract F72-12-59

ITE Project T08051h5

Annual report to Joint Nature Conservation Committee

ISSN 0963-8091

Joint Nature Conservation Committee report distribution

Report number:	263
Contract number/JNCC project number:	F72-12-59 (ITE Project T08051h5)
Date received:	September 1996
Report title:	Isle of May seabird studies in 1996
Contract title:	Seabird Monitoring Programme Isle of May studies
Contractor:	Institute of Terrestrial Ecology (NERC)
Restrictions:	None, but those wishing to quote are advised to contact the contractor as some results will be updated in the light of future research.

Comments: The Isle of May is one of JNCC's Seabird Monitoring Programme key sites. In 1996, JNCC continued to fund aspects of ITE's work there, in particular monitoring of breeding success, adult survival and food of a range of species. SNH carried out monitoring of the numbers of some species; the results of this work will be reported upon separately.

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1 Summary

1. Shag numbers increased only slightly following the dramatic crash in 1994 and the small recovery in 1995. The first egg was laid on 13 April and laying continued until late July. Nesting success (1.05 young per incubating pair) was among the highest ever recorded.

2. Most pairs of kittiwakes which were present built nests but the clutch-size was small. Breeding was the latest recorded with the first young not flying until the end of July. Few chicks were neglected and there was no evidence of serious food shortage. Breeding success was moderate (0.56 fledged per nest), but higher than 1993 (0.07), 1994 (0.16) and 1995 (0.40). Few pairs appeared to be prospecting and the population may well soon decline.

3. Puffins and guillemots both had a good season with outputs of 0.78 and 0.82 young fledged per pair respectively. Razorbill success was lower at 0.63, due, as usual, to losses at the egg stage. The reason for this remains obscure. Fulmar breeding success (0.44) was normal.

4. The overwinter survival rate of adult shags was extremely high (93.6%) while those of kittiwakes (75.8%) and puffins (90.1%) were normal. Both guillemots (88.9%) and especially razorbills (56.6%) survived much less well than in past years; this may have been due to many adults dying in a little-publicised wreck in east Scotland in the early spring.

5. Sandeels predominated in the diet of young shags, kittiwakes and puffins, but made up under half the fish brought to young guillemots. Puffins and kittiwakes fed their young mainly on 0-group fish, whereas shags concentrated on older and larger sandeels. Most non-sandeels eaten were sprats, but puffins also brought back small cod and saithe. There was no evidence that young of any species were short of food.

2 Background

The Joint Nature Conservation Committee (JNCC) has a responsibility to advise on certain aspects of 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 eastern 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 JNCC (formerly NCC CSD) 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 eight 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, JNCC has 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 kittiwake, guillemot, razorbill and puffin. Shag was included up to March 1994, was excluded for the 1994 season but was reinstated in May 1995;

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

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

An annual assessment of the feeding frequency of guillemot and puffin chicks was included up to and including 1994.

The Natural Environment Research Council (NERC) also supply funds for the seabird studies on the Isle of May.

3 Methods

3.1 Breeding success

The standardised methods used involve minimal disturbance of birds and are described in detail in the *Seabird monitoring handbook for Britain and Ireland* (Walsh *et al.* 1995).

3.1.1 Fulmar: The positions of apparently incubating birds in ten areas were marked on photographs on 30 May, and 2 and 5 June. At sites where birds appeared to be incubating on all three visits, or where an egg was seen, breeding was assumed to have occurred. These sites were checked again on 12 August (by S. Wanless) and on 21 August (by J. Wilson), when those with a large chick were assumed to have been successful.

3.1.2 Shag: The positions of nests in thirteen areas were marked on photographs and the state and contents of these nests were checked weekly from 1 April until 11 August. Birds incubating and with very small chicks on 11 August were assumed to have failed, those with older chicks to have been successful.

3.1.3 Kittiwake: The position of nests in fifteen areas were marked on photographs and the presence or absence of an incubating bird, or the number of young present at each, were checked on 31 May, 10 June and on 26 July, a day after the first young on the island had fledged. Checks were repeated on 11 August by which time no small chicks were still alive and very few large chicks were present. The later were assumed to have fledged.

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

3.1.5 Puffin: In each of four areas, samples of 50 burrows where an egg could be felt on 30 April and 2 May (when earlier checks indicated that 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.

3.2 Adult survival rates

For all species, adult survival rates 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 of the whole island were made for birds which had moved out of the study areas. These latter searches are extremely time consuming, and superficially unrewarding, but they are essential if accurate estimates of survival are to be obtained. Observations on the survival of adult puffins are now concentrated at Little Hole (where most burrows are individually numbered).

3.3 Food of chicks

Food regurgitated by adults feeding young and by young of kittiwake and shag, and loads of fish dropped by adult puffins when caught in mist-nets, were collected. These samples were weighed and the fish identified and, where possible, measured (total length to tip of tail). Where necessary, fish otoliths were extracted and examined and the lengths of the fish from which they came were calculated. Records were kept of fish brought to young guillemots and razorbills and uneaten fish were collected from breeding ledges to assess sizes and confirm identifications.

4 Results

4.1 Breeding success

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

4.1.1 Fulmar: Breeding success was 0.44 young per incubating pair. The methodology used is not designed to determine when breeding attempts fail, but it appeared that more chicks than eggs were lost.

4.1.2 Shag: The first egg was seen on 16 April. Chicks found later suggest that a very few pairs may have laid before this, probably on 13 April. A total of 105 pairs laid (or were apparently incubating) in the study plots, substantially down from 131 in 1995. Thirteen other nests were started but there was no evidence that eggs were laid in these. A total of 104 young fledged, 1.05 per nest, based on the average of the 13 study plots. Breeding success was particularly high at Colm's Hole (N) where 6 pairs reared 12 young (2.0 per nest) and low at the colony at the North Horn Viewpoint (16 nests, 5 young, 0.31 young per nest). Success remained low at the latter plot despite the public being denied access during the summer. Overall, success was among the highest ever recorded.

4.1.3 Kittiwake: Breeding was extremely late (Table 13); the first egg was not seen until 24 May and the first fledged young not until 25 July. Breeding was also unusually synchronised and most young were flying by 11 August. Chicks were infrequently neglected (7% of broods of one and 27% of broods of two - Table 11) and there was no evidence that adults were having difficulty in feeding chicks. A total of 148 completed nests were checked on 17 June; 23 were empty, 32 had one egg, and 63 had two eggs, giving a mean clutch-size of 1.34. No nest was seen with three eggs. Broods of three young now seem to be a thing of the past on the Isle of May.

The 1996 breeding season was much better than those of 1993, 1994 and 1995 (Tables 3 and 5), but the overall breeding success of 0.56 chicks fledged per completed nest was still much lower than at the start of the study in 1986.

Despite the slightly improved breeding output, Isle of May kittiwakes are still producing far fewer young than those at most other British North Sea colonies. Laying is becoming much later and the average clutch-size is declining gradually (Table 13). Very few prospecting pairs (as judged by the low incidence of birds building 'trace' nests late in the season) were seen. Isle of May kittiwakes are experiencing severe problems and I anticipate that the population will soon start to decline.

4.1.4 Guillemot: Laying was much delayed, the first egg not being laid until 28 April. The mean laying date was 2-3 days later than the previous season (1995) and 7-10 days later than the average for 1981-95. The first young left on the night of 19/20 June. Breeding success (0.82 young leaving per pair laying) was normal (Tables 4 and 5).

4.1.5 Razorbill: Breeding success (0.63 young leaving per pair laying) was relatively low. As usual, most losses occurred at the egg-stage and survival to fledging of chicks which hatched remained high (91%). As with guillemots, breeding was very late, the first egg being laid on 3 May.

4.1.6 Puffin: Breeding was late; the first fish were seen brought ashore on 30 May while the first chick fledged on the night 6/7 July, but most went during 12-18 July. The overall success rate (0.78 chicks fledged per egg laid) was normal (Tables 4 and 5), but there was considerable variation between areas. Success was surprisingly low (0.68) at Burrian, and high (0.85) at Kirkhaven/ Kettle.

The second very dry spring and summer resulted in extremely poor vegetation growth in many colonies and severe soil erosion is well underway. Visitor access to all puffin colonies needs to be restricted to prevent severe damage to burrows.

4.2 Adult survival

Not every adult alive is seen each year and thus the survival rates between 1995 and 1996 of 75.8% for kittiwake, 88.9% for guillemot, 56.6% for razorbill and 90.1% for puffin must be treated as minimum estimates. Sample sizes are given in Table 6.

Guillemot survival on the Isle of May in recent years has been as high as ever recorded (Harris & Wanless 1995). The wreck of seabirds in February 1994 had no obvious effect on guillemot survival, but survival between 1995 and 1996, and also that of razorbills over the same period, was much the lowest recorded since the study started in 1981. This appeared to be due, at least in part, to a wreck in the Firth of Forth and nearby areas in February and March 1996. Four of the 23 "missing" razorbills were found dead during this period. The wreck, which attracted little public attention (but see counts of dead birds in Scottish Bird News No. 43, September 1996), probably affected the population much more than did that of 1994.

An almost completed analysis of resighting data of puffins ringed on the Isle of May since 1973 has produced evidence for a marked step-down in the survival of adult puffins in 1981. Before this, survival averaged 97.5%, after this it has been 92.4% except for an exceptionally low survival of 80.6% between 1990 and 1991. This very low survival followed a very large winter wreck during which many birds ringed on the Isle of May were found dead. At the time, a wreck in February 1983 was thought to have similarly increased puffin mortality, but this now appears not to have been the case. As yet, no reason for the general reduction in survival has been determined. The annual survival estimates produced by this analysis are, on average, 2.9% higher than those estimated using the raw data, even including sightings made up to 7 years later. Hence my annual caution in how the preliminary estimates given in these reports should be used. The analysis has also produced evidence for increasing mortality with age. It is again unclear when this occurs, but possibly in birds 20-30 years old.

During 1996, 32 shags, 25 kittiwakes, twenty puffins and six guillemots (including two breeders) were colour-ringed.

4.3 Food of young

4.3.1 Shag: The 28 samples from shags were composed mainly of sandeels *Ammodytes marinus* 12-13 cm long (Tables 7 & 12). The only other items recorded were two dragonets *Callionymus lyra* and a single 'shrimp'. Two minute goby (Gobiidae) otoliths were among those recovered by digestion of the samples. Of the 224 sandeel otoliths examined, at least 218 (97%) came from fish one year or more old.

4.3.2 Kittiwake: Sandeels were the commonest food (94% by number) of young kittiwakes (Table 7). Virtually all sandeels in kittiwake regurgitates were 0-group fish 7-8 cm long. Sandeels contributed 81% by weight of the kittiwake regurgitations (Table 12). An unusually high number of regurgitations (28%) had clupeids present, mostly 4-7 cm long; of 43 otoliths examined, 36 (84%) were from sprats *Sprattus sprattus* and seven (16%) from herring *Clupea harengus*. Two whiting *Merlangius merlangus* may have been trawler discards. No Crustacea were recorded.

4.3.3 Guillemot: Of 589 fish delivered to young guillemots, 261 (44%) were sandeels, mostly 12-14 cm long, and 328 (56%) were Clupeidae, 8-11 cm long (Table 8). The bulk of the clupeids were sprats. The average weight of a fish (calculated from lengths) was 6.0 g. The predominance of clupeids reverses last year's findings and returns to the long-term trend of clupeids making up an increasing proportion of the diet (Table 12).

4.3.4 Razorbill: Most razorbill loads were made up of either several small or a single large (*ca.* 10 cm) sandeel (Table 9).

4.3.5 Puffin: By number, sandeels made up 90% of the diet of young puffins (Table 10) and the proportion in biomass terms was only slightly lower, at 88% (Table 12). Many of the small Clupeidae were difficult to identify, but extraction of otoliths indicated that the bulk were sprat. The bulk of the Gadidae were small cod *Gadus morhua* with lesser numbers of saithe *Pollachius virens* and most came from the early part of the chick rearing period. 'Shrimps' are unusual food of young puffins in Britain. This is the first year that no young rockling have been recorded in puffin samples.

5 The future

5.1 During the 1970s, and for most of the 1980s, conditions were very favourable for seabirds in the North Sea, as populations of most species, excluding terns, increased greatly. Since the late 1980s, monitoring has shown drops in numbers, and to a lesser extent, breeding success, of several species. The reasons for these changes are not clear but, at least for guillemots, change started in the north and gradually moved south. Population declines started significantly earlier and were fastest in northern colonies. Numbers of auks are now increasing again. A run of unproductive years by kittiwakes, and the apparent dearth of prospecting birds in the colony, causes concern for the future breeding population.

5.2 Long-term studies, partly funded under JNCC's integrated Seabird Monitoring Programme, in the Firth of Forth have shown a much reduced survival of adult puffins in the 1980s and early 1990s and of adult shags in 1994, low recruitment of some cohorts of young guillemots, poor breeding and non-breeding of kittiwakes, delayed (and irregular) breeding of shags, reduction in the food intake of young guillemots and sporadic food shortage in several species. Again, neither the ultimate nor the proximate factors causing these changes have been determined.

5.3 In 1991, several Danish fishing vessels were trawling for sandeels at the Marr and Cockenzie Banks to the northeast of the Isle of May. Many more were reported to be fishing there in 1992, and in 1993 the reported catch was 115,000 tonnes. An additional 72,000 tonnes came from the fishery area 1A immediately south of the Isle of May. Fewer boats fished the area in 1994, apparently because sandeels were available closer to Denmark. In 1995, Danish vessels were fishing in the entrance to the Firth of Forth early in the season but then moved elsewhere. Some Scottish vessels have been reported fishing for sandeels off eastern Scotland and landing their catches in Denmark. The Danish fleet returned in 1996 and the summer saw a high profile protest by the Greenpeace ship 'Sirius' which spent much time around the Wee Bankie and the Isle of May. The 'Save the Wee Bankie' campaign got much TV and other media attention and the Isle of May is now well known to a much wider public.

5.4 The summer of 1997 will see the start of the two-field-season multi-institute project ELIFONTS (Effects of Large-Scale Industrial Fisheries on Non-Target Species). This is part-funded by the EC Directorate General XIV (Fisheries). The objectives relevant to seabirds are as follows.

1 To determine the availability of lesser sandeels to top predators (grey seals, kittiwakes, guillemots, and shags) in the Moray Firth and Firth of Forth.

2 To investigate the effects of between-and within-year variations in sandeel availability on the foraging behaviour, foraging efficiency, diet and reproductive output of top predators and on the diet of predatory fish.

3 To evaluate the potential impact of a large-scale fishery on top predators in the Firth of Forth and to examine the generality of the results.

5.5 There is, as yet, no direct evidence that such industrial fishing has an adverse effect on the availability of food for seabirds. Whether or not such a fishery continues to develop, it is imperative that the monitoring of seabird breeding, numbers and recruitment as well as the food of seabirds on the Isle of May continues, so that we can determine the factors controlling the numbers of seabirds in the North Sea and so assess the importance of the many anthropogenic influences on the seabird populations.

6 Acknowledgements

Nigel Harding and Jared Wilson of Scottish Natural Heritage, Nicolas Haye and Sarah Wanless continued observations when I was absent from the island. A. Russell, S. Russell, K. Ferry, S. Wanless, T. Dudney, P. Packham and others helped collect fish and regurgitates. S. Wanless improved the report with her criticisms.

7 Recent/in press publications on Isle of May seabirds

Barton, T.R., Harris, M.P., & Wanless, S. 1995. Natural attachment duration of nymphs of the tick *Ixodes uriae* (Acari: Ixodidae) on kittiwake *Rissa tridactyla* nestlings. *Experimental and Applied Acarology, 19*: 499-509.

Barton, T.R., Harris, M.P., Wanless, S., & Elston, D.A. 1996. The activity periods and life-cycle of the tick *Ixodes uriae* (Acari: Ixodidae) in relation to host breeding strategies. *Parasitology, 112*: 571-580.

Catchpole, E.A., Freeman, S.N., Morgan, B.J.T., & Harris, M.P. In press. Integrated recovery/recapture data analysis of shags. *Biometrics.*

Grémillet, D., Dey, R., Wanless, S., Harris, M.P., & Regel, J. In press. Determining food intake by great cormorants. *Journal of Field Ornithology.*

Halley, D.J., Harris, M.P., & Wanless, S. 1996. Colony attendance patterns and recruitment in immature common murres *Uria aalge. Auk, 112*: 947-957.

Harris, M.P., Halley, D.J., & Wanless, S. 1996. Philopatry in the common guillemot *Uria aalge. Bird Study, 43*: 124-137.

Harris, M.P., & Wanless, S. 1996. Differential responses of guillemot *Uria aalge* and shag *Phalacrocorax aristotelis* to a late winter wreck. *Bird Study, 43*: 220-230.

Harris, M.P., & Wanless, S. 1995. The food consumption of young common murres (*Uria aalge*) in the wild. *Colonial Waterbirds, 18*: 209-213.

Harris, M.P., Wanless, S., & Barton, T.R. 1996. Site use and fidelity in the common guillemot *Uria aalge. Ibis, 135*: 399-404.

Harris, M.P., Wanless, S., Barton, T.R,. & Elston, D.A. In press. Nest site characteristics, duration of use and breeding success in the guillemot *Uria aalge. Ibis.*

Table 1 Fledging success of fulmars on the Isle of May in 1996

Area	Incubating birds	No. probably hatched	Young fledged
1. Cleaver	8	4	4
2. Pilgrim's Haven	1	1	1
3. Cornerstone	11	5	4
4. Loch (S)	46	34	19
5. Greengates	29	25	11
6. Horse Hole	9	6	5
7. Rona	0	-	-
8. Tarbet	18	16	11
9. Low Light	9	9	4
10. Colm's Hole	4	2	1
Total	135	102	60
		Overall mean	0.44 fledged/pair

Notes: Incubating birds were those sitting tight on three checks or where an egg was seen. Chicks present on 21 August were assumed to have fledged. The final check was made by J. Wilson.

Table 2 Fledging success of shags on the Isle of May in 1996

	Area	Total incubated	Young fledged 1	2	3	Other nests	Total young fledged	Mean young fledged per incubated nest
3.	Maidens	8	3	4	0	2	11	1.38
4.	South Horn	1	0	0	0	0	0	0
5.	Chatterstanes	3	1	2	0	1	5	1.67
16.	Pilgrims Haven (S1)	9	1	4	1	2	12	1.33
6.	Colony A	1	0	0	0	0	0	0
8.	Mill Door (N)	8	3	2	0	1	7	0.88
9.	Mill Door (S)	11	3	4	1	1	14	1.27
10.	Bishop Cove	1	0	1	0	0	2	2.00
8.	Horse Hole	21	2	8	0	1	18	0.86
15.	North Horn	16	0	1	1	3	5	0.31
12.	Tarbet	8	1	2	2	0	11	1.38
13.	Low Light	12	4	0	1	0	7	0.58
14.	Colm's Hole (N)	6	1	4	1	2	12	2.00
							Mean	1.05±0.19
	Total	105					104	

Notes: Plot 1 and 2 had no nests in 1996
On the last check on 11 August there were still 3 incubating pairs and 3 with small chicks which are assumed to have failed.

Table 3 Fledging success of kittiwakes on the Isle of May in 1996

Area	Completed nests	Trace nests	Fledged young/ completed nest			Total young produced	Fledging success per completed nest	Fledging success all pairs (incl. trace)
			0	1	2			
1. Cleaver	36	1	12	14	10	34	0.94	0.92
2. Pilgrim's Haven	29	0	17	6	6	18	0.62	0.62
3. South Face	32	1	14	11	7	25	0.78	0.76
4. Colony 4	96	7	54	31	11	53	0.55	0.52
5. Cornerstone	89	3	38	30	21	72	0.81	0.78
6. Loch (S)	70	11	40	20	10	40	0.57	0.49
7. Loch (N)	92	7	43	33	16	65	0.71	0.66
8. Greengates	76	8	57	17	2	21	0.28	0.25
9. Bishop's Cove	53	5	23	20	10	40	0.75	0.69
10. Horse Hole	8	0	6	2	0	2	0.25	0.25
11. Iron Bridge	50	5	25	20	5	30	0.60	0.55
12. Rona	38	4	35	3	0	3	0.08	0.07
13. Tarbet	101	12	76	17	8	33	0.33	0.29
14. Low Light	32	4	26	6	0	6	0.19	0.17
15. Colm's Hole	24	0	8	8	8	24	1.00	1.00
						Mean	0.56	0.53
						SE	0.07	0.07

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

Table 4 Breeding success of auks on the Isle of May in 1996

Species	Area	Pairs laying	Young hatched	Young 'fledged'	Young leaving/ pair
Guillemot	Dense	270	231	226	0.84
	Hide/White	83	75	72	0.87
	Colony 4	215	187	176	0.82
	South	48	40	36	0.75
	Cornerstone	170	149	143	0.84
	Mean ± S.E.				0.82±0.02
Razorbill	Hide/White	24	19	19	0.79
	Colony 4	45	28	22	0.49
	South	15	7	6	0.40
	Cornerstone	56	50	48	0.86
	Mean ± S.E.				0.63±0.11
Puffin	Lady's Bed	44	?	37	0.84
	Kirkhaven	46	?	39	0.85
	Burrian	41	?	28	0.68
	Rona	42	?	32	0.76
	Mean ± S.E.				0.78±0.06

Table 5 Breeding success (young reared per pair breeding) of some seabirds on the Isle of May 1989-96

Species	1989	1990	1991	1992
Fulmar	0.54 (93)	0.24 (66)	0.42 (100)	0.47 (129)
Shag	1.09 (234)	0.30 (154)	1.06 (187)	0.87 (181)
Kittiwake	1.11 (1327)	0.17 (1095)	0.27 (1172)	0.61 (1062)
Guillemot	0.85 (757)	0.78 (748)	0.81 (754)	0.85 (745)
Razorbill	0.74 (97)	0.76 (100)	0.72 (104)	0.86 (105)
Puffin	0.88 (164)	0.66 (176)	0.78 (153)	0.87 (184)
	1993	1994	1995	1996
Fulmar	0.44 (121)	0.47 (122)	0.48 (126)	0.44 (135)
Shag	0.21 (80)	0.68 (74)	0.84 (131)	1.05 (105)
Kittiwake	0.07 (1034)	0.16 (861)	0.40 (874)	0.56 (825)
Guillemot	0.76 (797)	0.79 (775)	0.81 (805)	0.82 (786)
Razorbill	0.72 (119)	0.69 (134)	0.62 (143)	0.63 (140)
Puffin	0.69 (182)	0.85 (189)	0.84 (180)	0.78 (173)

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

Table 6 Annual survival of adult seabirds on the Isle of May 1987-96

Species	No. seen in 1995	No. alive in 1996	% Survival 1995-96	1994-95	1993-94	1992-93	1991-92
Kittiwake	128	97	75.8	72.7	79.5	80.8	80.7
Guillemot	406	361	88.9	95.6	95.0	95.0	93.3
Razorbill	53	30	56.6	92.6	84.5	91.5	89.8
Puffin	213	192	90.1	93.0	93.1	84.0	86.8
Shag	126	118	93.6	?	?	79.6	79.9

Species	% Survival 1990-91	1989-90	1988-89	1987-88
Kittiwake	84.2	78.7	90.9	86.0
Guillemot	91.0	94.9	92.4	91.5
Razorbill	79.6	75.0	90.5	88.1
Puffin	71.4	63.3	85.2	76.1
Shag	82.8	78.7	90.9	86.0

Notes: Only birds which had definitely bred in 1995 or earlier are included.

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 actual survival rates.

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

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 1996

	Kittiwake	Shag
No. of regurgitations	43	28
Range of dates	2-18 July	17 June-20 July
Total weight (g)	671	1472
% regurgitations with sandeels	91	100
with Gadidae	14	0
with Clupeidae	28	0
% (by weight) of sandeels in sample	81	99
% (by numbers) of sandeels in sample	94	99
Lengths of majority of sandeels	7-8 cm (0-group)	12-13 cm
Non-sandeel remains identified	Sprat (36 otoliths, 4-7 cm)	Dragonet (12.5 cm, 8 cm)
	Herring (7 otoliths; 4-7 cm)	Shrimp (1)
	Whiting (2 otoliths; 10 cm, 18 cm)	

Notes: Samples collected from chicks and adults with chicks.
Counts and lengths of fish in kittiwake samples were based on otoliths retrieved from the regurgitations.

Table 8 Food of young guillemots on the Isle of May in 1996

	Number of sandeels				Number of Clupeidae			Number of Gadidae
	minute/ larval	small	medium	large	small	medium	large	
Mean length (cm)	?	7.5	13.5	15.5	8	10.5	12	
All-day watches								
23 June	1	40	86	13	63	110	3	0
30 June	7	7	26	5	13	17	0	0
Other days								
5 June-15 July	3	23	46	4	77	43	2	0
Total	11	70	158	22	153	170	5	0

Note: Lengths were based on visual estimates against 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 1996. Number of loads of various types of food.

	Single sandeel			Several sandeels			Clupeidae	Small fish
	large	medium	small	large	medium	small		
All-day watches								
23 June	10	2	0	1	6	6	1*	1
30 June	2	0	1	0	2	1	2*	0
Others								
14 June-22 July	0	0	2	1	3	1	0	
Total	18	2	1	3	9	10	4	1

Notes: *Includes 1 single large sprat.
No fish were collected for measuring but large, medium and small fish were thought to be 8-12 cm, 6-8 c and 4-5 cm long, respectively.

Table 10 Food of young puffins on the Isle of May 14 June to 16 July 1996

	Sample size	Mean	S.E.
a) Load weight (g)	118	9.7	0.40
b) Fish/load	118	9.0	0.41
c) Numbers and lengths of fish (mm)			
Sandeels *Ammodytes* sp.	879	70.1	0.5
Sprat *Sprattus sprattus*	16	76.8	2.0
Clupeidae	37	57.4	1.7
Gadidae[+]	56	45.9	0.8
Shrimp	4	38.5	4.6

Note: [+] Most were cod *Gadus morhua* with a few saithe *Pollarchius virens*

Table 11 Proportions of kittiwake broods of one and two chicks which had no adults present during daily checks in the middle of the day

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
1994	1	19
1995	3	14
1996	7	27

Note: Figures are based on 50-200 broods 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 1996, the counts were made 12-24 July. (Details of methods are given in Wanless, S. & Harris, M.P. *Scottish Birds* 15 (1989): 156 - 161.)

Table 12 Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-96

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Shag	100	98	100	95	100	97	99	86	85	99
Kittiwake	95	94	95	86	50	61	63	81	86	81
Guillemot	81	41	74	24	74	53	17	19	78	44
Puffin	77	85	89	96	87	86	46	57	50	88

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

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 13 Kittiwake first-egg dates, and clutch-sizes on the Isle of May, 1986-96

Year	First date egg seen	Mean clutch-size (eggs)
1986	9 May	no data
1987	4 May	no data
1988	6 May	no data
1989	27 April	2.04
1990	2 May	1.82
1991	6 May	1.86
1992	30 April	1.83
1993	4 May	1.78
1994	17 May	0.86
1995	16 May	1.61
1996	24 May	1.13