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**Isle of May
seabird studies in 2001**

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1. Summary

The 2001 season for seabirds on the Isle of May was characterised by high interspecific variation, particularly in breeding success. Thus some species had their most productive season since monitoring began, while others had their least productive. Timing of breeding in auks and Northern fulmars was normal, while European shags and black-legged kittiwakes laid later than in recent years. Return rates were generally close to or above the long-term average, except for common guillemots which were lower. Sandeels and clupeids were the predominant prey items, but varied in importance between species.

European shags had an excellent breeding season. Although breeding started later than in 2000, overall breeding success (1.53 chicks per incubated nest) was the highest recorded since intensive monitoring began in 1986.

Atlantic puffins had their most successful season for four years and breeding success (0.78 chicks per pair laying) was above the long-term average.

In contrast, common guillemots had the lowest breeding success since monitoring began in 1986 (0.63 chicks per pair laying). Some chicks were neglected and fledging weights were considerably lower than the long-term average.

Razorbill breeding success (0.60 chicks per pair laying) was lower than the long-term average.

Black-legged kittiwakes started breeding later than in recent years. Losses were high during incubation but few failures occurred during chick-rearing. Thus overall breeding success (0.61 chicks per pair laying) remained above the long-term average, although not as high as in 2000.

Northern fulmars had a very poor season, with breeding success estimated at only 0.26 chicks per incubating pair, well below the long term average.

The return rate of colour-ringed European shags (89.8%) in 2001 was similar to that in 2000. Black-legged kittiwake return rate (81.2%) was the highest since 1990. The return rate of common guillemots (82.9%) was slightly below the long-term average whereas razorbill and Atlantic puffin return rates (82.9% and 90.5% respectively) were much higher than in 2000.

Sandeels predominated in the diet of European shags, black-legged kittiwakes and Atlantic puffins in 2001. In contrast to 2000, well over half of common guillemot chick diet was made up of clupeids, which also predominated in razorbill chick diet.

As in 2000, there was no commercial sandeel fishery on the Wee Bankie. Results for 2000 provided circumstantial evidence that the presence of an industrial fishery on the Wee Bankie was having an adverse effect on some components of the Isle of May seabird community and that closure of the fishery could potentially have an immediate and positive effect on seabird productivity. In particular, black-legged kittiwake breeding success returned to the high levels typical of the pre-fishery period. In 2001 breeding success of the two species with the highest reliance on sandeels (black-legged kittiwake and European shag) continued to be above the long term average, although black-legged kittiwake performance in 2001 was not

maintained at the 2000 level. Atlantic puffins, although less reliant on sandeels, had a very successful season. Common guillemots and razorbills which both fed their chicks predominantly on clupeids, and Northern fulmars, for which sandeels do not appear to form an important part in the diet, all had poor seasons.

It was uncertain in 2000 whether environmental factors, e.g. hydrographic conditions, that potentially affect the growth and life history strategy of sandeels, were involved in the recovery of the breeding success of European shags and black-legged kittiwakes. A new EU-funded interdisciplinary project was started in 2001 to investigate this further.

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 and breeding success of selected species of seabirds to be monitored at a range of colonies throughout the UK. 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 and the Isle of May NNR is the designated site in eastern Britain.

The Centre for Ecology and Hydrology (CEH, formerly known as ITE) has had a long-term interest in seabirds on the Isle of May. Since 1986, CEH has received NCC-CSD/JNCC support for a more formalised seabird monitoring programme. Long-term studies on numbers, breeding success, adult survival, and chick food are under way 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 CEH to:

- a) ensure that the breeding success of Northern fulmars *Fulmarus glacialis*, European shags *Phalacrocorax aristotelis*, black-legged kittiwakes *Rissa tridactyla*, common guillemots *Uria aalge*, razorbills *Alca torda* and Atlantic puffins *Fratercula arctica* is monitored;
- b) monitor adult survival of black-legged kittiwakes, common guillemots, razorbills and Atlantic puffins. Monitoring of European shag adult survival was also included up to March 1994, was then excluded for the 1994 season, but was reinstated in May 1995;
- c) assess food of young European shags, black-legged kittiwakes, common guillemots, razorbills and Atlantic puffins; and
- d) undertake special studies on species agreed between the nominated officer and the contractor.

Soon after the Seabird Monitoring Programme (SMP) on the Isle of May was initiated, the Danish industrial sandeel *Ammodytes* sp.fishery started to use the fishing grounds on the Wee Bankie, Marr Bank and Scalp Bank that lie 30-50 km east of the island which are known to be important feeding areas for many seabirds during the breeding season. Considerable concern has been expressed about the potential impact of this fishery on the seabirds in the area. In December 1999, EU Fishery Ministers agreed a ban on fishing for sandeels in 20,000 square kilometres of sea off eastern Scotland (including the Wee Bankie grounds) and northeast England in 2000. Results from the 2000 season provided circumstantial evidence that the presence of an industrial fishery on the Wee Bankie might be having an adverse effect on some components of the Isle of May seabird community. The ban was still in operation during 2001, and therefore monitoring was of vital importance to assess the performance of seabirds, and in particular to determine whether the recovery recorded in some species in 2000 was maintained.

3. Methods

Breeding success

The standardised methods used involved minimal disturbance of birds and are described in detail in Walsh *et al.* (1995).

Northern fulmar

The position of apparently incubating birds in nine areas were marked on photographs on 25, 28 and 31 May. 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 22 and 31 July to determine sites which had hatched eggs. A final check was made on 21 August (by J. Wilson) when chicks present were assumed to have fledged successfully.

European shag

The position of nests in 12 areas were marked on photographs and the state and contents of these nests were checked weekly from 1 April until 6 August. On the last check, one nest still contained three small young. This was checked regularly (by J. Wilson) to determine its outcome. All medium size or large young present on the 6 August were assumed to fledge successfully. Successes are given averaged across the plots and summed over the plots.

Black-legged 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, were noted. Checks of nests were made 30 May - 1 June and 7 - 8 June. The first check of chicks was on 22 July, three days after the first fledged young on the island was recorded. Four further checks were then made, the last being on 5 August when all remaining chicks (bar one nest) were large and were assumed to have fledged successfully. The nest containing the smallest young was checked on 14 August (by J. Wilson), when it was found to have failed. Successes are given averaged across the plots and summed over the plots.

Common guillemot and razorbill

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

Atlantic puffin

Samples of 50 burrows where an egg could be felt were staked in each of four areas on 28, 29 and 30 April and 2 May (other checks indicated that most pairs had laid by this date). The staked burrows were re-checked on 7 and 8 July (when chicks were near fledging). All large young present at this time were assumed to fledge successfully. Empty burrows where there were many droppings, moulted down and feather sheaths were also assumed to have been successful.

Adult survival rates

Estimates of adult survival rates were based on sightings of individually colour-ringed birds and are therefore, strictly speaking, return rates. The areas in which birds were originally marked were checked regularly throughout the season and adjacent areas were searched from time to time in an attempt to pick up those which had moved. Searches were also made of the whole island for birds which had moved out of the study areas. These latter searches are very time consuming, and superficially unrewarding, but are essential if accurate estimates of survival are to be obtained. Observations on the survival of adult Atlantic puffins are concentrated at Little Hole (where most burrows are individually numbered). As in 2000, the area used for monitoring survival of adult black-legged kittiwakes included Cornerstone and nearby cliffs.

Food of chicks

Food regurgitated by young European shags, young black-legged kittiwakes and adults of both species feeding young, and loads of fish dropped by adult Atlantic puffins caught in mist-nets were collected. The regurgitates and food loads were weighed, fish identified and, where possible, measured (total length, snout to tip of tail). Fish otoliths were extracted from regurgitates and identified and the lengths of the fish from which they came were calculated using regressions derived from the otoliths of fish of known length collected from birds on the island in 2001 or published works. Observations were made of fish brought to young common guillemots and razorbills during three all-day watches and 22 two-hour watches (0600 – 0800) between 10 June and 5 July, as well as opportunistically on most other days. Uneaten fish were collected from breeding ledges to confirm identifications and size assessments for common guillemots. Fish sizes for razorbills were assessed against the bird's bill but were essentially orders of size since it was not possible to collect samples from this species.

4. Results

Breeding success

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

Northern fulmar

The first Northern fulmar egg was seen on 14 May. Breeding success was 0.26 young per incubating pair (Table 1), well below the 95% Confidence Intervals for the long-term average between 1986-2000 (0.43, CI=0.39-0.47). The methodology used is not designed to determine when breeding attempts fail, but most losses apparently occurred during incubation.

European shag

Productivity of European shags was extremely high and 2001 saw the highest value (1.53 ± 0.16 young per incubated nest averaged across the plots, 1.68 when results from all areas are pooled; Table 2) since monitoring began in 1986 and was well above the 95% Confidence Interval for the 1986-2000 average (0.81, CI=0.62-1.0). The timing of breeding was later than in 2000, with the first egg laid on 20 April. Of 147 nests built in the study plots, 135 pairs laid and incubated eggs and a total of 227 chicks fledged. Thirty-seven (36%) of 104 successful pairs raised three young.

Black-legged kittiwake

Conditions appeared less than favourable for black-legged kittiwake breeding at the beginning of the season. Breeding started later than in recent years and losses during incubation were high (Table 3). Nest building started on 11 May and the first egg was noted on 20 May. The first chick was seen on 13 June (A. Reid, personal communication). With an incubation period of 27 days this indicates a slightly earlier first egg date of 17 May. The first young fledged on 19 July. Eighty-nine percent of pairs initiating nest building completed a nest, however 12% of pairs occupying a site did not start a nest. The mean clutch size was 1.93 (Table 13).

Conditions during chick rearing appeared reasonable and brood neglect was fairly low (6% of broods of one chick; 19% of broods of two; Table 11). Within the study plots, only 3 pairs (1.5% of successful pairs) reared three young and elsewhere on the island very few broods of three large young were seen. Breeding success in 2001 was 0.61 ± 0.09 chicks per completed nest, averaged across the plots (Table 3). Although this value is lower than that for 2000, breeding success in 2001 was still higher than the long-term average (0.55, CI=0.31-0.78) (Table 5). However, the total number of pairs breeding continued to decline with only 410 nests being built in the study plots, compared with 616 in 1999 and 545 in 2000. Unlike the decline between 1999-2000, the pattern of decline in 2001 was fairly uniform across study plots.

Common guillemot

Common guillemot productivity in 2001 (0.63 young per pair laying; Table 4) was the lowest value recorded since monitoring began in 1986 and was well below the 95% Confidence Interval for the long-term average (0.79, CI=0.76 - 0.82). The first egg

was laid on 23 April. The median laying dates in the earliest and latest areas monitored were 6 and 13 May respectively. The first young left on the night of 19/20 June. Chick losses (18%) were much higher than the 5-6% typically recorded on the Isle of May. Weights of chicks near fledging (219g) were considerably lower than the long-term mean (251, CI = 243-258). From 19 June onward, some chicks were occasionally left unattended. Opportunistic observations suggested that this neglect occurred throughout the day and was widespread among pairs with chicks over about 10 days of age. Neglected chicks were often brooded by a neighbouring adult until their own parent returned. However gull predation and attacks from adult common guillemots directed towards neglected chicks were also observed.

Razorbill

Timing of breeding was normal for the Isle of May, with the first egg being laid on 29 April. Breeding success (0.60 young per pair laying; Table 4) was lower than the long term mean (0.69, CI=0.65-0.74). Most losses occurred at the egg-stage, while survival of hatched chicks to fledging was 89%.

Atlantic puffin

The first adults carrying fish were seen on 24 May but the first young fledged on 2 July which indicates that some young must have hatched a few days earlier than this. Back calculating from this figure indicates that laying commenced in the second week of April. The overall success rate (0.78 chicks fledged per egg laid) was the highest for four years (Table 4) and very slightly above the long term mean (0.77, 95% CI=0.70-0.83).

Adult survival 2000-2001

Not every adult alive is seen each year and thus the return rates in 2001 of birds seen in 2000 must be treated as minimum estimates of survival. The results are compared with similar figures from earlier years in Table 6 and Figure 2. During 2001, an additional 20 European shags, 11 black-legged kittiwakes, 12 Atlantic puffins and 15 common guillemots were colour-ringed.

European shag

The return rate of colour-ringed European shags in 2001 (89.8%) was similar to 2000.

Black-legged kittiwake

The return rate of black-legged kittiwakes (81.2%) was 8.3% higher than in 2000 (72.9%) and was the highest value since 1990.

Common guillemot

The return rate of adult common guillemots (89.6%) represented a slight decrease from 2000. Allowing for an average of 1-2% of birds not seen in any year returning in later years, the survival between 2000 and 2001 still appears to be slightly lower than the long term average for 1986-2000 (93.1, 95% CI = 91.7 – 94.5).

Razorbill

The return rate of razorbills (82.9%) was much higher than in 2000 and continues the trend for year-to-year fluctuations which has been apparent through the study period.

Atlantic puffin

The return rate of Atlantic puffins (90.5%) was slightly higher than in 2000 and was higher than the long-term average (83.7, 95% CI = 78.8 – 88.6).

Figure 1 Breeding success (young reared per pair breeding) of seabirds on the Isle of May 1986 - 2001

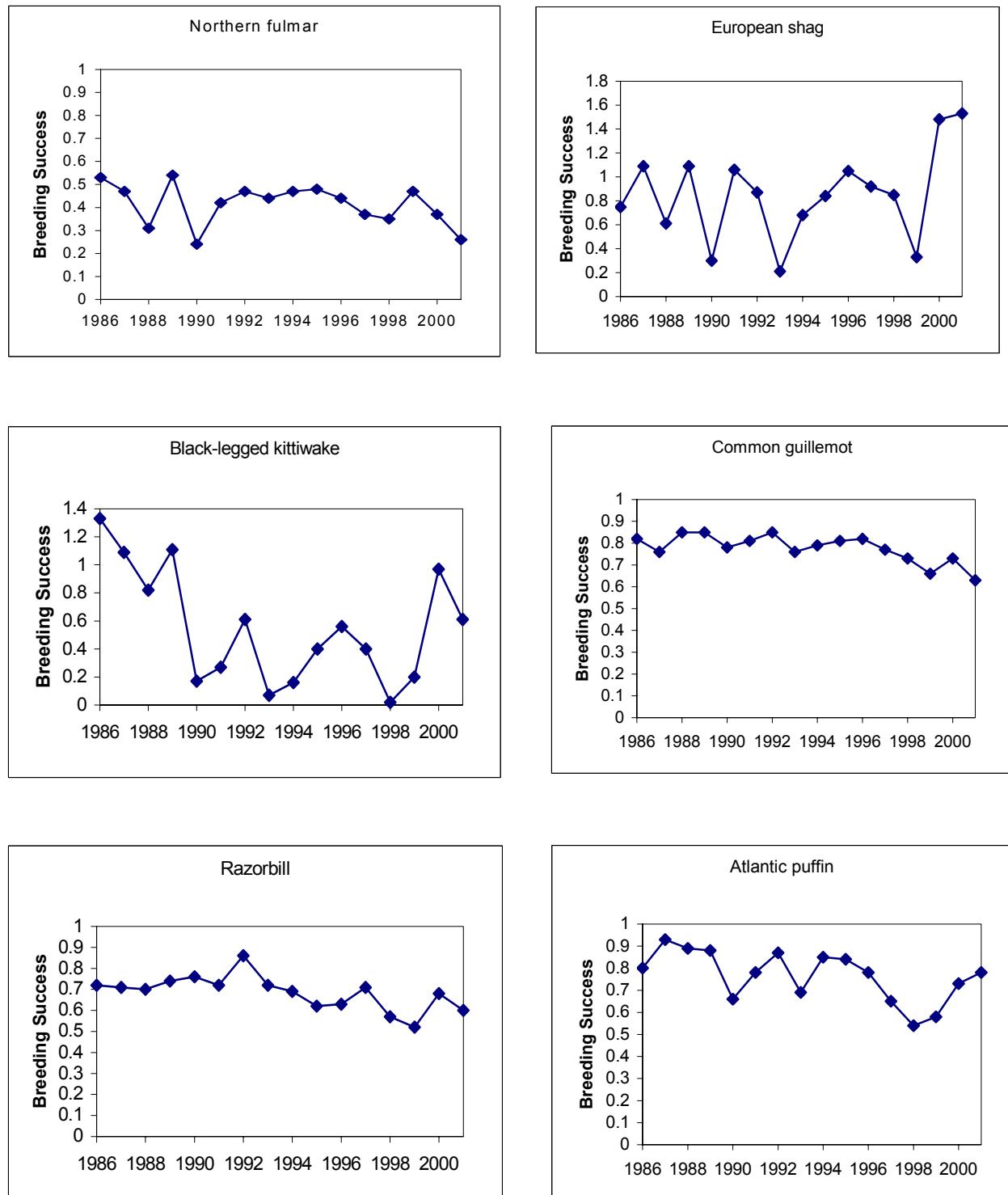
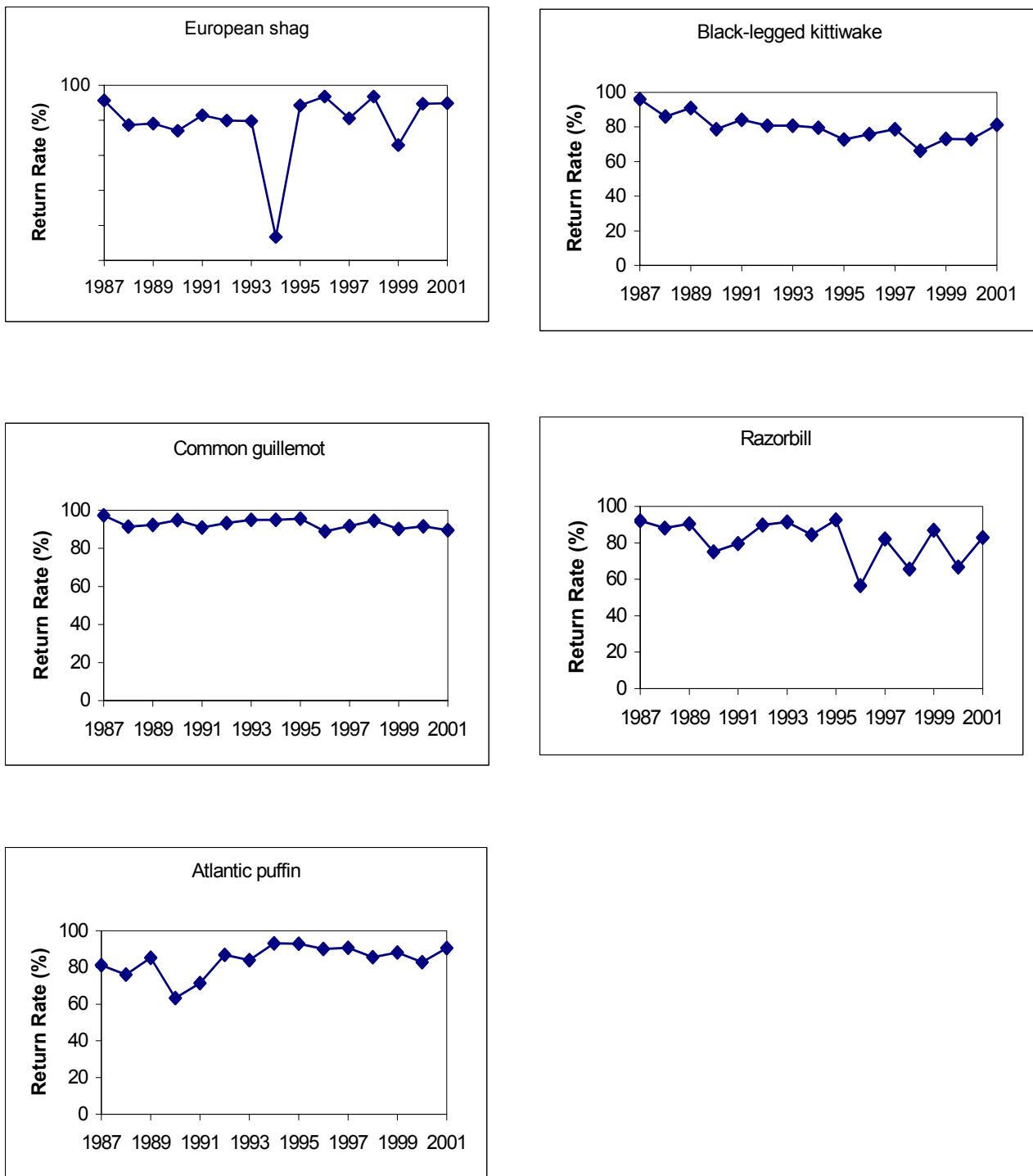


Figure 2 Annual return rates of adult seabirds on the Isle of May 1987 – 2001



Food of young

Species accounts are given in Tables 7-10, and a comparison of sandeel biomass data with recent years' results is given in Table 12 and Figure 3.

European shag

Food samples were readily obtained in 2001. These consisted mainly of sandeel. Of 64 regurgitates obtained between 6 July and 29 July, 99% contained sandeel and in terms of biomass sandeels accounted for 90% of the total (Tables 7 and 12). Five percent of sandeels were 0-group and 95% were older age classes. Dragonet *Callionymus* sp. (8-19 cm long) accounted for 6% of biomass, gadoids 1% and flatfish 3%.

Black-legged kittiwake

Of black-legged kittiwake food samples collected during the chick-rearing period 87% contained sandeels (Table 7). Of 6,865 otoliths examined, 93% were sandeel. Of these, 98% were 0-group fish with an estimated size range of 3 – 7 cm long ($n = 6271$ otoliths examined). In terms of biomass, sandeels contributed 76% by weight of the diet with clupeids (mostly sprat *Sprattus sprattus*, 3-8 cm) and gadoids (7-15 cm long) contributing 18% and 6% respectively.

Common guillemot

In marked contrast to 2000, 69% of 1300 fish delivered to young common guillemots were clupeids (probably mainly sprat), with the majority assigned to the medium size category corresponding to fish about 10 cm long (Table 8). The remainder of food items were mostly sandeels (31%) by number, predominantly in the small size category corresponding to fish averaging 9 cm long. Gadoids accounted for less than 1% of food by number. The average weight of a prey item (calculated from lengths) was 6.0 g. This was lower than the long term (19 year) average of 7.4 g and may have contributed to the low fledging weights of the chicks. In biomass terms, sandeels comprised only 18% of the diet.

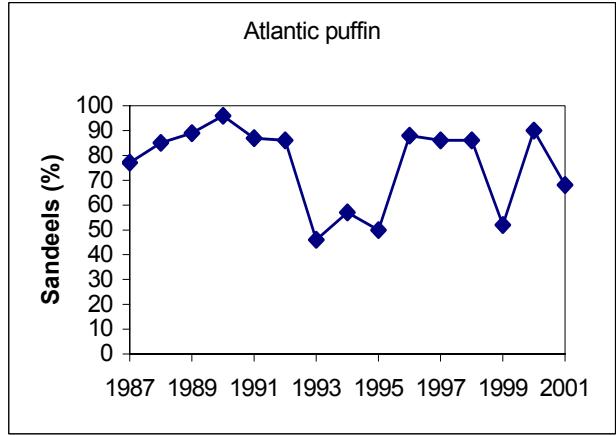
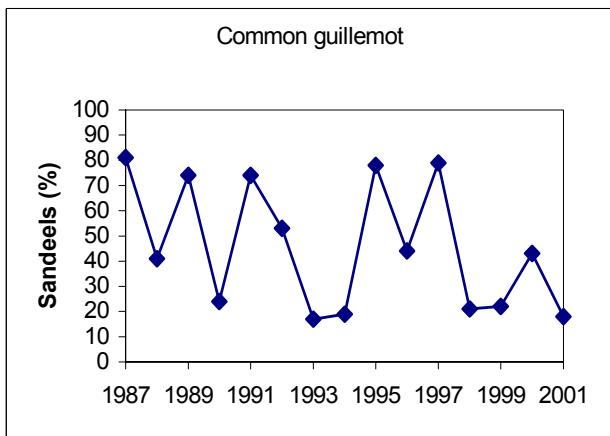
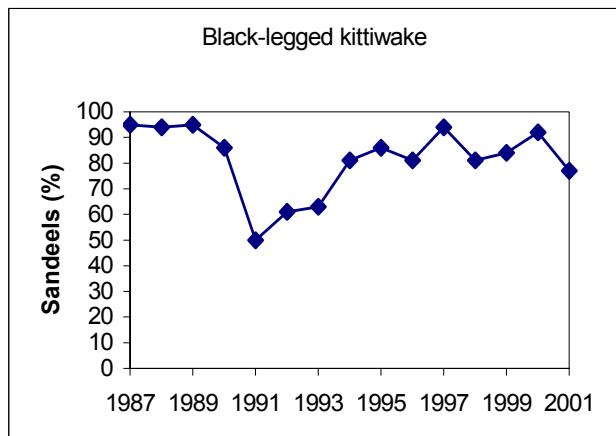
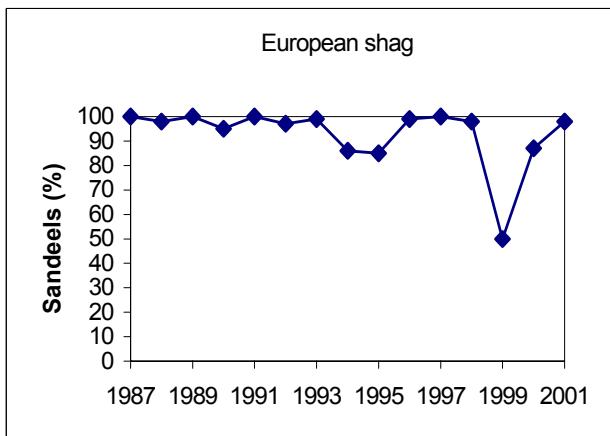
Razorbill

Most loads of fish brought to razorbill chicks contained clupeids. The loads with sandeels were mostly made up of several small fish (Table 9).

Atlantic puffin

Sandeels made up 83% by number of the diet of young Atlantic puffins with the proportion in biomass terms being 68% (Table 12). Most sandeels were 0-group with a mean length of 6.3 cm; only 48 (3%) were longer than 10 cm (Table 10). Many of the clupeids were small, and thus difficult to identify, but the bulk appeared to be sprat. The mean load size of 9.6 g was close to the long-term average for this species.

Figure 3 Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2001



5. Conclusions

During the first year of the closure of the Wee Bankie sandeel fishery in 2000, all the species monitored except Northern fulmar, showed an increase in breeding success over the 1999 figure, with the recovery being particularly marked in European shags and black-legged kittiwakes. Given the continued closure of the fishery in 2001, it was clearly of interest to see if the recorded increases were maintained. Results from this year's monitoring indicated that in general the recovery was sustained, with most species again having a more successful season than in 1999. Once again the Northern fulmar did not conform to this pattern and showed a further decrease in success. Common guillemots also showed a reverse of the trend and had their worst breeding season since monitoring started.

In 2000 it was uncertain how much of the apparent recovery was due to the absence of fishing pressure and how much was due to environmental factors. This uncertainty remains, but in 2001 a new EU Project (Interactions between the marine environment, predators and prey: implications for sustainable sandeel fisheries, IMPRESS) started on the Isle of May. This project will focus on how climate and hydrography affect sandeel availability and seabird performance. It will complement the long term approach of the Seabird Monitoring Programme and in particular improve our understanding of how sandeel demography is affected by environmental factors and predator consumption and how, as a consequence, this drives predator performance and survival.

6. Acknowledgements

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7. References

- Walsh, P M, Halley, D J, Harris, M P, del Nevo, A, Sim, I M W, and Tasker, M L (1995) *Seabird monitoring handbook for Britain and Ireland*. JNCC/RSPB/ITE/Seabird Group, Peterborough
- Wanless, S & Harris, M P (1989) Kittiwake attendance patterns during chick rearing on the Isle of May. *Scottish Birds* 15 (1989):156-161

8. Further reading

The following is a list of additional papers on Isle of May seabirds published or in press since publication of the 2000 report.

- Daunt, F, Monaghan, P, Wanless, S & Harris, M P (in press) Offspring ectoparasite load and parental age in shags. *Ardea*.
- Daunt, F, Monaghan, P, Wanless, S, Harris, M.P & Griffiths, R (2001) Sons and daughters: age-specific differences in parental rearing capacities. *Functional Ecology*, **15**, 211-216.
- Lewis, S, Wanless, S, Wright, P J, Harris, M P, Bull, J & Elston, D A (in press) Diet and breeding performance of black-legged kittiwakes *Rissa tridactyla* at a North Sea colony. *Marine Ecology Progress Series*.
- Finney, S K, Wanless, S, Harris, M P, Monaghan, P (2001) The impact of gulls on puffin reproductive performance: an experimental test of two management strategies. *Biological Conservation* **98**, 159-165.
- Harris, M P, Bull, J & Wanless, S (2000) Common Guillemots *Uria aalge* successfully rear two chicks. *Atlantic Seabirds*, **2**, 92 – 94.
- Harris, M P, Rothery, P & Wanless, S (in press). Increase in the frequency of the bridled morph of the common guillemot *Uria aalge* on the Isle of May, 1946 – 2000: a return to former levels. *Ibis*
- Harris, M P & Wanless, S (2001) Razorbills *Alca torda* successfully rearing young Common Guillemots *Uria aalge*. *Atlantic Seabirds* **3**: 89-93
- Harris, M P, Wanless, S and Webb, A (2000) Changes in body mass of Common Guillemots *Uria aalge* in southeast Scotland throughout the year: implications for the release of cleaned birds. *Ringing and Migration*, **20**, 134-142.
- Harris, M P, Wanless, S and Rothery, P (2000) Adult survival rates of shag, guillemot, razorbill, puffin and kittiwake on the Isle of May 1986-96. *Atlantic Seabirds*, **2**, 133 – 150.

Table 1 Breeding success of Northern fulmars on the Isle of May in 2001

Area	Incubating birds	No. probably hatched	Young fledged
Cleaver	10	5	5
Pilgrim's Haven	3	0	0
Cornerstone	7	2	2
Loch (S)	33	13	11
Greengates	42	12	9
Horse Hole	10	3	3
Tarbet	15	4	4
Low Light	9	1	1
Colm	5	0	0
Totals	134	40	35
		Overall mean	0.26 fledged/ pair

Notes:

No pairs bred in plot 7 (Rona) in 2001.

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. Fledging checks were made by J. Wilson.

Table 2 Breeding success of European shags on the Isle of May in 2001

Area	Total incubated	Other nests	Young fledged			Total young fledged	Mean young fledged per incubated nest
			1	2	3		
Maidens	13	2	1	5	3	20	1.54
Chatterstanes	5	0	1	1	2	9	1.80
Pilgrim's Haven	13	2	2	2	5	21	1.62
North Pilgrims	2	0	0	1	0	2	1.00
South Face	1	0	0	0	0	0	0
Mill Door (N)	11	2	1	3	6	25	2.27
Mill Door (S)	12	1	2	5	3	21	1.75
Horse Hole	24	1	4	9	5	37	1.54
North Horn	25	4	2	13	5	43	1.72
Tarbet	10	0	3	3	3	18	1.80
Low Light	9	0	1	1	4	15	1.67
Colms Hole	10	0	1	6	1	16	1.60
Mean ± se						1.53 ± 0.16	
Total	135	12	18	49	37	227	1.68

No nests were built in the plots at South Ness, Lady's Bed Stack, South Horn or Bishop's Cove in 2001.

Table 3 Breeding success of black-legged kittiwakes on the Isle of May in 2001

<i>Area</i>	<i>Completed nests</i>	<i>Trace nests</i>	<i>Other pairs with site</i>	<i>Fledged young per completed nest</i>				<i>Total young produced</i>	<i>Fledgling success per completed nest</i>
Cleaver	21	8	4	0	1	2	3	8	0.38
Pilgrim's Haven	16	1	3	3	6	6	1	21	1.31
South Face	22	2	0	7	9	6	0	21	0.96
Colony 4	50	9	16	14	25	11	0	47	0.94
Cornerstone	54	7	8	18	27	8	1	46	0.85
Loch (S)	18	3	12	12	6	0	0	6	0.33
Loch (N)	78	2	4	38	27	13	0	53	0.68
Greengates	22	4	5	19	3	0	0	3	0.14
Bishop's Cove	36	2	1	20	12	4	0	20	0.56
Horse Hole	5	3	0	2	2	1	0	4	0.80
Iron Bridge	33	4	3	27	5	1	0	7	0.21
Rona	22	0	0	7	11	3	1	20	0.91
Tarbert	60	7	8	44	13	3	0	19	0.32
Low Light	11	2	2	7	3	1	0	5	0.46
Colm's Hole	11	2	3	8	3	0	0	3	0.27
Total	459	56	69	239	160	57	3	283	0.61 ± 0.09
								Mean ± se	0.62

Table 4 Breeding success of auks on the Isle of May 2001

<i>Species</i>	<i>Area</i>	<i>Pairs laying</i>	<i>Young hatched</i>	<i>Young "fledged"</i>	<i>Young leaving / pair</i>
Common guillemot	Dense	311	244	208	0.67
	Hide / White Ledge	109	86	67	0.62
	Colony 4	261	210	159	0.61
	South	53	40	33	0.62
	Cornerstone	241	180	155	0.64
	Mean ± se				0.63 ± 0.01
Razorbill	Hide / White Ledge	26	10	9	0.35
	Colony 4	53	35	34	0.64
	South	18	16	14	0.78
	Cornerstone	70	53	44	0.63
Atlantic puffin	Mean ± se				0.60 ± 0.09
	Lady's Bed	40	?	31	0.78
	Kirkhaven	49	?	40	0.82
	Burrian	48	?	36	0.75
	Rona	48	?	36	0.75
	Mean ± se				0.78 ± 0.02

Notes:

For Atlantic puffins, the number of young that hatched is unknown

Table 5 Breeding success (mean number of young reared per breeding pair) of seabirds on the Isle of May, 1989-2001

<i>Species</i>	1989	1990	1991	1992	1993	1994	1995
Northern fulmar	0.54 (93)	0.24 (66)	0.42 (100)	0.47 (129)	0.44 (121)	0.47 (122)	0.48 (126)
European shag	1.09 (234)	0.30 (154)	1.06 (187)	0.87 (181)	0.21 (80)	0.68 (74)	0.84 (131)
Black-legged kittiwake	1.11 (1327)	0.17 (1095)	0.27 (1172)	0.61 (1062)	0.07 (1034)	0.16 (861)	0.40 (874)
Common guillemot	0.85 (757)	0.78 (748)	0.81 (754)	0.85 (745)	0.76 (797)	0.79 (775)	0.81 (805)
Razorbill	0.74 (97)	0.76 (100)	0.72 (104)	0.86 (105)	0.72 (119)	0.69 (134)	0.62 (143)
Atlantic puffin	0.88 (164)	0.66 (176)	0.78 (153)	0.87 (184)	0.69 (182)	0.85 (189)	0.84 (180)
	1996	1997	1998	1999	2000	2001	
Northern fulmar	0.44 (135)	0.37 (136)	0.35 (120)	0.47 (115)	0.37 (143)	0.26 (134)	
European shag	1.05 (105)	0.92 (109)	0.85 (125)	0.33 (58)	1.48 (127)	1.53 (135)	
Black-legged kittiwake	0.56 (825)	0.40 (822)	0.02 (683)	0.20 (616)	0.97 (545)	0.61 (459)	
Common guillemot	0.82 (786)	0.77 (842)	0.73 (852)	0.66 (870)	0.73 (942)	0.63 (975)	
Razorbill	0.63 (140)	0.71 (132)	0.57 (134)	0.52 (142)	0.68 (149)	0.60 (167)	
Atlantic puffin	0.78 (173)	0.65 (166)	0.54 (179)	0.58 (181)	0.73 (132)	0.78 (185)	

Notes:

The number of pairs monitored is given in brackets. Details of the monitoring methods for these species can be found in this and previous reports to JNCC.

Table 6 Annual return rates of adult seabirds on the Isle of May, 1987-2001

	No. seen in 2000	No. alive in 2001	Return rate (%)					
			2000-2001	1999-2000	1998-1999	1997-98	1996-97	1995-96
Black-legged kittiwake	138	112	81.2	72.9	73.1	66.2	78.7	75.8
Common guillemot	365	327	89.6	91.6	90.2	94.6	91.8	88.9
Razorbill	35	29	82.9	66.7	86.9	65.5	82.1	56.6
Atlantic puffin	190	172	90.5	82.8	88.2	85.5	90.7	90.1
European shag	147	132	89.8	89.4	65.8	93.6	91.1	93.6
	1994-95	1993-94	1992-93	1991-92	1990-91	1989-90	1988-89	1987-88
Black-legged kittiwake	72.7	79.5	80.8	80.7	84.2	78.7	90.9	86.0
Common guillemot	95.6	95.0	95.0	93.3	91.0	94.9	92.4	91.5
Razorbill	92.6	84.5	91.5	89.8	79.6	75.0	90.5	88.1
Atlantic puffin	93.0	93.1	84.0	86.8	71.4	63.3	85.2	76.1
European shag	88.5	13.4	79.6	79.9	82.8	74.0	78.1	77.3

Notes:

Only birds which had definitely bred in 2000 or earlier are included.

Directly comparable figures for earlier seasons are given. These have not been corrected for missing birds seen in later years, and for some species may severely under-estimate actual survival rates.

These figures should not be used for population dynamics calculations without consultation with S Wanless.

Details of earlier estimates are given in previous reports to NCC-CSD/JNCC.

Table 7 Food of young black-legged kittiwakes and European shags on the Isle of May during chick-rearing in 2001

	<i>Black-legged kittiwake</i>	<i>European shag</i>
No. of regurgitations	60	64
Range of dates	13 June – 7 Aug	6 July - 29 July
Total weight (g)	1,432	5,092
% regurgitations with sandeels	88	99
with Gadidae	8	2
with Clupeidae	33	0
% (by weight) of sandeels in sample	76	84
% (by numbers) of sandeels in sample	91	99
Modal length of sandeels (cm)	7.8	10.5
Other remains identified	small pelagic crustacea (3 samples) Polychaete jaw (1 sample)	Dragonet (5 samples) Flatfish (1 sample)

Notes:

Samples were collected from chicks or adults during the chick rearing period.

Counts and lengths of fish were based on otoliths retrieved from the regurgitations (except Butterfish and Dragonet where lengths of intact fish were measured).

Table 8 Food of young common guillemots on the Isle of May during chick-rearing in 2001

	<i>Number of sandeels</i>			<i>Number of Clupeidae</i>			<i>Number of Gadidae</i>	
	<i>minute</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>small</i>
Mean length (cm)	6	9	12	15	9	10	14	5
All-day watches								
17 June	4	48	40	2	2	122	0	0
23 June	0	10	18	1	1	51	1	0
1 July	0	10	12	0	35	46	3	2
Other records								
30 May - 14 July	5	147	96	6	68	549	18	3
Total	9	215	166	9	106	768	22	5

Notes:

Lengths were based on visual estimates against the bird's bill checked by measurements of dropped fish collected from the breeding ledges.

Table 9 Food of young razorbills on the Isle of May in 2001

	<i>Single sandeel</i>	<i>Several sandeels</i>	<i>Clupeidae</i>						
	<i>minute</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>minute</i>	<i>small</i>	<i>medium</i>	<i>large</i>	
All-day watches									
17 June		1	1	6		19	4	1	9
23 June		4	3	7	4	6	4	1	23
1 July	1	1	0	2	0	1	1	1	8
Other records									
4 June - 2 July	1	6	9	7	16	37	33	10	45
Total	2	12	26	22	20	63	42	13	85

Notes:

Figures are numbers of loads of various types of food

Sizes are qualitative as it was not possible to collect food samples from razorbills

Table 10 Food of young Atlantic puffins on the Isle of May, 2 June to 4 July 2001

	<i>Sample size</i>	<i>Mean</i>	<i>s.e</i>
a) Load weight (g)	216	9.6	0.3
b) Fish/load	216	12.1	0.4
c) Numbers and lengths of fish (mm)			
Sandeels <i>Ammodytes sp.</i>	1,932	62.7	0.3
Clupeidae	293	62.5	0.6
Sprat <i>Sprattus sprattus</i>	36	69.8	4.3
Cod <i>Gadus morhua</i>	12	43.7	3.3
Whiting <i>Merlangius merlangus</i>	1	35.0	-
Rockling	14	30.9	1.7

Note:

Most of the Clupeidae category were small sprat.

Table 11 Percentage of black-legged kittiwake broods of one and two chicks that had no adults present during daily checks in the middle of the day

<i>Year</i>	<i>One young</i>	<i>Two young</i>
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
1997	14	42
1998	23	63
1999	5	25
2000	2	8
2001	6	19

Notes:

Figures are based on 50-200 broods in the same areas each year and are the means of daily checks made from the date that the first neglected chick was noted, to the start of fledging in the areas. (Details of methods are given in Wanless & Harris, *Scottish Birds* 15 (1989):156-161).

Table 12 Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2001

	<i>1987</i>	<i>1988</i>	<i>1989</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>1994</i>
European shag	100	98	100	95	100	97	99	86
Black-legged kittiwake	95	94	95	86	50	61	63	81
Common guillemot	81	41	74	24	74	53	17	19
Atlantic puffin	77	85	89	96	87	86	46	57

	<i>1995</i>	<i>1996</i>	<i>1997</i>	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>
European shag	85	99	100	98	<50	87	95
Black-legged kittiwake	86	81	94	81	84	92	76
Common guillemot	78	44	79	21	22	43	18
Atlantic puffin	50	88	86	86	52	90	68

Notes:

Dates and sample sizes can be found in the contract reports for the respective years.

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

Table 13 Black-legged kittiwake first-egg dates and clutch-sizes on the Isle of May, 1986-2001

<i>Year</i>	<i>First date egg seen</i>	<i>Mean clutch-size (eggs)</i>
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
1997	10 May	2.03
1998	13 May	1.46
1999	16 May	1.99
2000	5 May	1.89
2001	17 May	1.93