



JNCC Report

No. 375

**Isle of May
seabird studies in 2004**

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November 2005

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ISSN 0963-8091

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This report should be cited as:

Harris M P, Wanless S, Murray S & Mackley E (2005)
Isle of May seabird studies in 2004
JNCC Report, No. 375

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1. Summary

The 2004 breeding season was the least successful ever recorded for most seabirds on the Isle of May. Adult return rates of all the species followed were normal or above average, indicating that survival was generally high. European shags, black-legged kittiwakes and common guillemots all bred late. Most species appeared to find conditions difficult, with colony attendance being low. Problems were exacerbated by strong winds and prolonged heavy rain in late June, which resulted in the deaths of large numbers of young of shags and puffins. Although lesser sandeels remained the main food of young puffins and kittiwakes, guillemots and razorbills fed their young mainly clupeids and shags brought in a wide variety of bottom-living fish.

- Northern fulmar breeding success (0.21 chicks per incubating pair) was the lowest recorded.
- European shags bred late and had a very unproductive season (0.25 chicks fledged per pair laying compared with 1.83 in 2003). Many chicks died in torrential rain in late June but evidence from regurgitations and pellets suggest that adults also had problems finding food. Survival over winter appeared to have been normal, with a return rate of 82.2%.
- Black-legged kittiwakes bred extremely late. The low success (0.27 chicks fledged per active nest) reversed the improvement noted in recent years. Many chicks died after fledging, further decreasing the strength of the 2004 year class. Adult return rate (81.8%) was normal.
- Common guillemots started breeding about 7-10 days later than normal. Both egg and chick losses were substantially higher than normal and productivity, at 0.51 chicks leaving per pair laying, was the lowest recorded on the Isle of May. Many chicks were left unattended but most probably died rather than being killed by gulls. Adults fed their chicks almost entirely on sprats. Chicks grew slowly and all the evidence suggested that feeding conditions were poor. Adult return rate (90.1%) was higher than in recent years.
- Razorbill breeding success (0.54 chicks per pair) was well below the long-term average. Adult return rate (84.3%) was higher than the long-term average. For the first time since monitoring started, small clupeids, rather than sandeels, were the main item in the diet of chicks.
- Atlantic puffin breeding success (0.60 chicks per pair) was one of the lowest ever recorded on the Isle of May. In part this was due to burrows being flooded during the severe weather in late June but chicks also grew slowly, suggesting that feeding conditions were bad. Adult return rate (87.9%) was high, indicating that over-winter survival had been high.

There has been no commercial sandeel fishery on the Wee Bankie since 2000. Studies on the Isle of May in 2000-2003 generally reported an increase in breeding success in some species (notably shag and kittiwake), thus providing circumstantial evidence that closure of the fishery could potentially have an immediate and positive effect on seabird productivity. However, the situation was radically different in 2004 with all species having very low breeding success. 2004 was also characterised by sandeels, particularly the 1+ age class, being largely absent from the diet of many seabirds. While the reason for these changes is currently unknown, the possibility that they reflect major changes in the North Sea ecosystem due to climate change is a strong candidate.

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; the Isle of May NNR is the chosen 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 carried out 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;
- 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 fishery started to use the fishing grounds on the Wee Bankie, Marr Bank and Scalp Bank. These lie 30-50 km east of the island and 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, effective for 2000, in 20,000 square kilometres of sea off eastern Scotland (including the Wee Bankie grounds) and northeast England. 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 2004, 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 during 2000-2003 was maintained.

3. Methods

3.1 Breeding success

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

Northern fulmar

The positions of apparently incubating birds in nine areas were marked on photographs on 25, 28 and 31 May and 3 June. At sites where birds appeared to be incubating on three consecutive visits, or where an egg was seen, breeding was assumed to have occurred. These sites were checked again on 30 June, and on 18 July to determine sites that had hatched eggs. A final check was made on 19 August, when chicks present were assumed to have fledged successfully. The increase in the number of checks was made because of reports of i) deaths of fulmars in the southern North Sea during the late winter and spring, and ii) widespread breeding failures at colonies in the Northern Isles.

European shag

The positions of nests in 12 areas were marked on photographs and the state and contents of these nests were checked weekly from 20 April until 29 July. All medium size or large young present on the 29 July were assumed to have fledged successfully. Success was averaged both across the plots and summed over plots.

Black-legged kittiwake

The positions 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 noted. The extent of the plot at Greengates was increased since the recent decline in numbers had resulted in only a handful of pairs being present in the old area in 2004. Checks of nests were made on 3-4 and 11-12 June. The first young was seen flying on 27 July and a complete check of chicks was made on 29 July. Further checks of nests with small chicks were made on 3, 5, 8, 10 and 16 August. 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 50-51 burrows where an egg was present were staked in each of four areas on 26-28 April (by when most pairs had laid). The staked burrows were re-checked 28 June-1 July at the start of fledging. Young present at this time were assumed to have fledged successfully. Empty burrows where there were many droppings, moulted down and feather sheaths were also assumed to have been successful.

3.2 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 any individuals that 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 were concentrated at Little Hole (where most burrows are individually numbered). As in recent years, the area used for monitoring survival of adult black-legged kittiwakes included Tarbet, Rona (North Horn Gully), Low Light Gully, Little Hole, Cornerstone and its nearby cliffs.

3.3 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, identified, measured 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 2004 or published works. Observations were made of fish brought to young common guillemots and razorbills during four all-day watches, as well as opportunistically on most other days throughout the chick-rearing period. Uneaten fish were collected from breeding ledges to confirm identifications and size assessments of common guillemots' diet. Fish sizes for razorbills were assessed against the bird's bill but were essentially orders of size as it was not possible to collect samples from this species.

4. Results

4.1 Breeding success

Species summaries are given in Tables 1- 4 and a comparison with recent years' results is shown in Table 5 and Figure 1. Long-term averages presented do not include the current year.

Northern fulmar

The first egg was seen on 16 May. Breeding success was 0.21 young per incubating pair (Table 1). This is the lowest recorded for the species on the Isle of May and well outside the 95% Confidence Intervals for the long-term average between 1986-2003 (0.42, CI=0.38-0.46). The methodology used is not designed to determine when breeding attempts fail but most failures apparently occurred during incubation.

European shag

Breeding was much later than in 2003 with the first egg laid on 17 April (compared with 23 March in 2003). Productivity was extremely low (0.25 chicks per pair laying or 0.19 per nest built) (Table 2). The former estimate was well below the 95% Confidence Interval for the 1986-2003 average (0.90, CI=0.69-1.11). Of 139 nests built in the study plots, 103 pairs laid and incubated eggs, of which 22 raised a total of only 26 chicks to fledging.

As is often the case in late seasons, many birds did not breed and those that did were unsuccessful. However, the situation in 2004 was compounded by extremely heavy and prolonged rain on the 23 June, and to a lesser extent on 26 June. This severe weather occurred when many chicks were 2-3 weeks old and still in downy plumage, and therefore not waterproof, but were too big to be brooded by the parents. Twenty-nine of the 103 nests failed during the first storm and virtually all of the large chicks died. In 26 of 30 broods of three chicks ringed just before the storm, at least one of the young died, apparently of hypothermia. Very few, if any, broods of 3 young were reared on the island in 2004. Clearly, the severe weather had a major impact on breeding success but success would probably have been poor even without this event.

Black-legged kittiwake

Breeding of black-legged kittiwakes was extremely late in 2004, with the first courtship feed not recorded until 7 May and the first egg not seen until 22 May. The first chick was recorded on 18 June. The first young fledged on 27 July but only five juveniles were seen flying before the end of the month. The mean clutch size of nests including those where no eggs were laid was 1.65 eggs, fairly typical for the Isle of May in recent years (Table 13). About 10% of pairs that started nests did not produce a clutch.

Most pairs that laid hatched chicks, but the average brood size declined gradually during July. Many broods were left unattended. The first neglected broods were noted on 7 July and the proportion increased to over 75% during the last week of July. During this period, the average daily rates of unattended chicks were 31% and 48% for broods of one and two chicks, respectively. No broods of 3 young fledged on the island. Mean breeding success in 2004 was 0.27 (\pm se 0.07) chicks per completed nest, averaged across the plots, 0.29 after pooling areas (Table 3). This low value reversed the improvement noted in the previous four years (Table 5). Although some chicks were taken by gulls, chicks grew very slowly (A. Vallarino, pers. comm.) and many died in the nest, which suggested severe food shortage.

A post-fledging check of kittiwakes on the Isle of May on 18-19 August found between 10 and 15 juveniles on the loch feeding on flies. All the birds seemed weak and showed no inclination to move onto the sea. Two birds were so weak that they could be caught; both were very light and their pectoral muscles were atrophied. Seventeen dead juvenile kittiwakes were found, 13 on the loch and one each in Pilgrim's Haven, Kittiwake Gully, Colms Hole and at Nybo Bridge. This mortality apparently continued after young had dispersed from the natal colony and there were reports of large numbers of dead kittiwakes along the Angus coast. A search of beaches at Ferryden, Lunan Bay and Catterline Bay on 14 August recorded a total of 172 dead juveniles and 11 adults. Thus, it seems clear that many juveniles died soon after fledging and consequently the 2004 year class was substantially lower than that indicated by the figure for breeding success given above.

Common guillemot

The first guillemot egg on the island (in a study plot) was seen on 24 April, 7 days later than in 2003. Median laying dates in the earliest and latest areas monitored were 11 and 17 May respectively, some 10 days later than in 2003. The first young left on the night of 23/24 June. Mean productivity (0.50 young per pair laying; Table 4) was the lowest ever recorded on the Isle of May and was well below the 95% Confidence Interval for the long-term average (0.77, CI=0.74-0.80). Both egg and chick losses (33% and 34%) were well above the long-term averages (16% and 8%). Normally, one member of the pair always remains with the chick but in 2004 many chicks were left unattended, suggesting that adults found it much harder than usual to find food. Surprisingly, these neglected chicks were rarely taken by gulls, even though gulls did come onto the ledges to pick up deserted/addled eggs and fish that had been dropped. Rather, it was clear that chicks were more likely to be killed by other guillemots (or occasionally razorbills) when they wandered into neighbouring territories or died of starvation or hypothermia following rain. In one of the intensively studied colonies, 38 dead young were counted on the ledges on a single day. Measurements of chicks during ringing indicated that growth rates were low and that fledging weights were markedly lower than normal. Many chicks fledged during the day instead of late evening, but again predation rates appeared to be low and most losses were due to the failure of the chick to meet up with the male. Some colour-ringed males returned to the colony within a few days of taking their chick to sea, indicating that the chick had died. Thus, as with the kittiwake, chick losses appeared to continue after fledging, further depressing year class strength.

Razorbill

Timing of breeding of razorbills was normal for the Isle of May, with the first egg being laid on 27 April and the first young seen on 28 May. Mean breeding success (0.54 young per pair laying; Table 4) was much lower than the long term mean (0.67, CI=0.63-0.70). Most losses occurred at the egg stage. Razorbill chicks survived better than did those of guillemots, with 82% of those hatching subsequently fledging; this rate was identical to that in 2003. No unattended razorbill chicks were recorded.

Atlantic puffin

Breeding appeared to start early since the first puffins carrying fish were seen on 17 May – a week earlier than in 2003, and the first young in the study area fledged on the night of 28/29 June. Back-calculation from these figures indicated that laying commenced around 6 April. The mean success rate (0.60 chicks fledged per egg laid; Table 4) was one of the lowest recorded and well below the long term mean (0.77, 95% CI=0.75-0.83). Some of the losses were due to the prolonged, heavy rain on 23 and 26 June which resulted in many burrows being flooded and chicks in them drowning. However, chicks also grew slowly and both mean peak weight and weight at fledging were the lowest recorded over the last 30 years.

4.2 Adult survival 2003-2004

Not every adult alive is seen each year and thus the return rates in 2004 of birds seen in 2003 must be treated as minimum estimates of survival. The results are compared with those of previous years in Table 6 and Figure 2. During 2004 an additional 25 European shags, 26 black-legged kittiwakes, 26 Atlantic puffins, 2 razorbills and 5 common guillemots were colour-ringed. The low numbers of guillemots and razorbills ringed reflects the exceptionally bad conditions in 2004 and the decision made to minimize disturbance to the breeding areas during the chick-rearing period. The long-term averages presented do not include the current year.

European shag

Of 152 colour-ringed European shags alive in 2003, 125 (82.2%) were resighted in 2004. Although this was the lowest value since 1998-99, it was close to the long-term average (80.8, 95% CI = 70.9-90.6). In addition, three colour-ringed European shags that had not been seen in 2003 were seen again in 2004.

Black-legged kittiwake

The return rate of black-legged kittiwakes (81.8%) was close to the previous long-term average (79.7, 95% CI = 76.0-83.5).

Common guillemot

The return rate of common guillemots (90.1%) was higher than over the previous three winters but slightly lower than the long-term average (92.5, 95% CI = 91.0-93.9).

Razorbill

The return rate of razorbills (84.3%) was higher than the long-term average (81.5, 95% CI = 76.2-86.9) and continues the picture of year-to-year fluctuations which has been apparent since monitoring started.

Atlantic puffin

The return rate of Atlantic puffins (87.9%) was above the long-term average (84.2, 95% CI = 80.1-88.2).

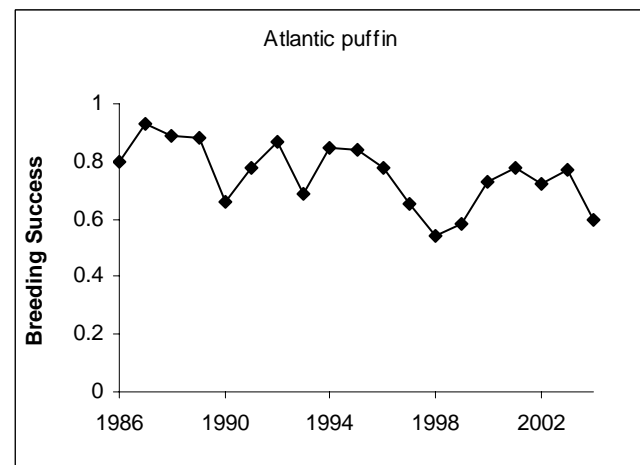
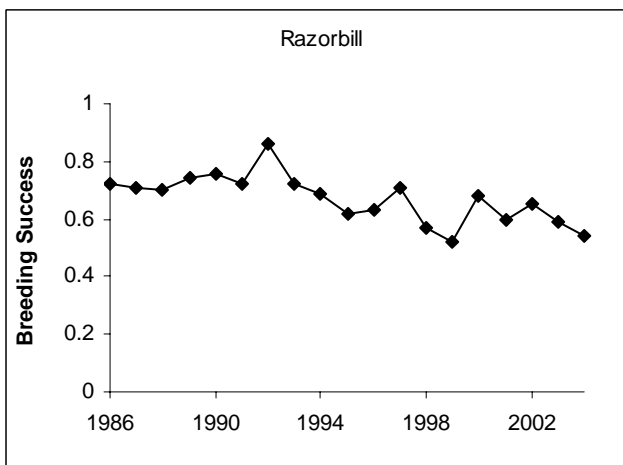
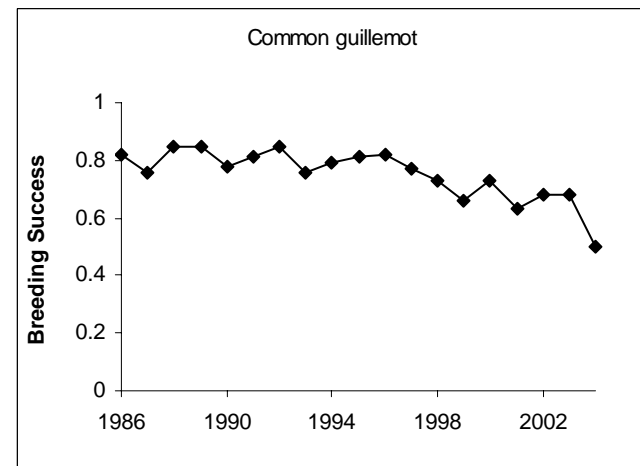
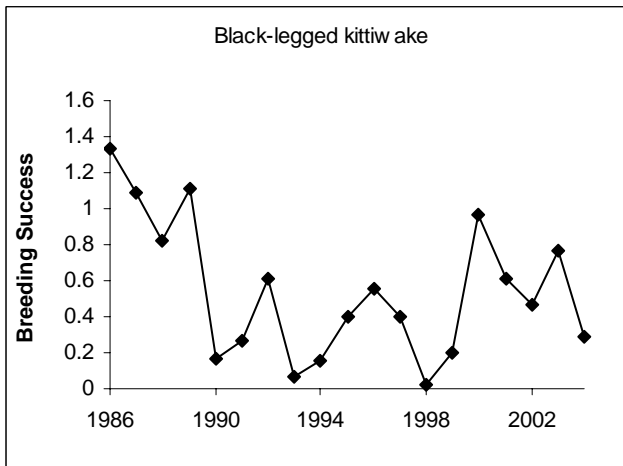
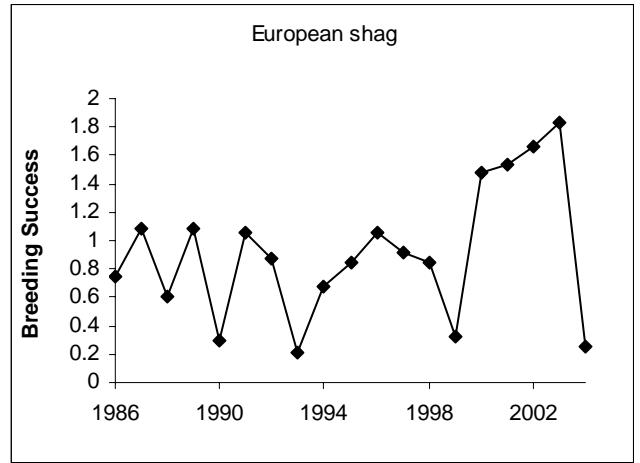
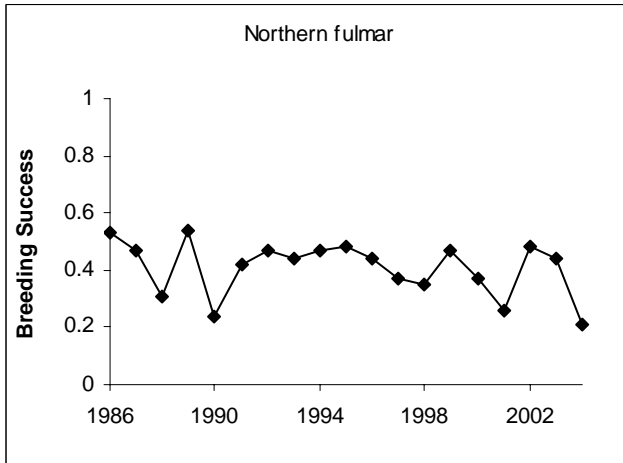


Figure 1. Breeding success (young reared per pair breeding) of seabirds on the Isle of May 1986 - 2004

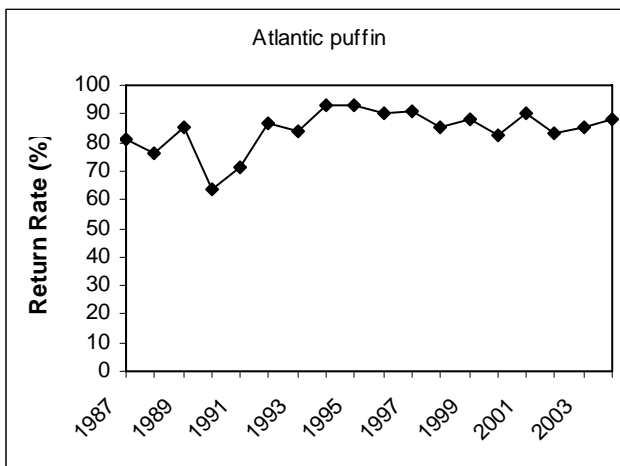
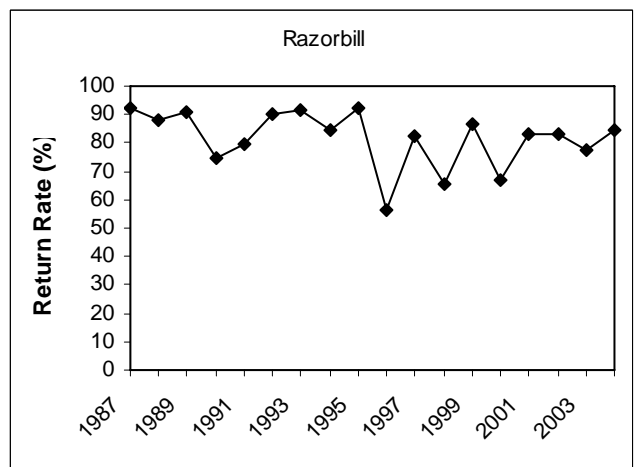
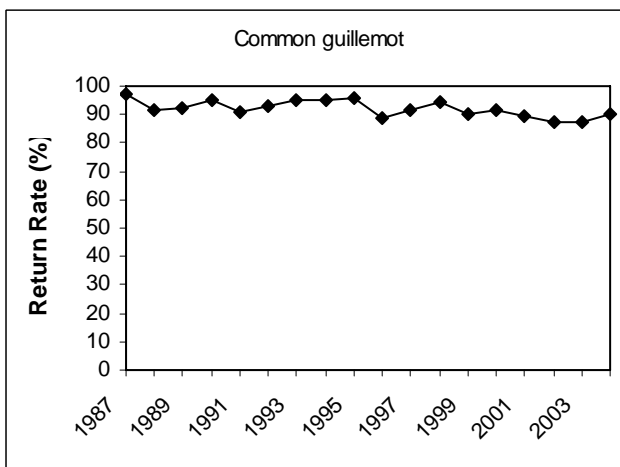
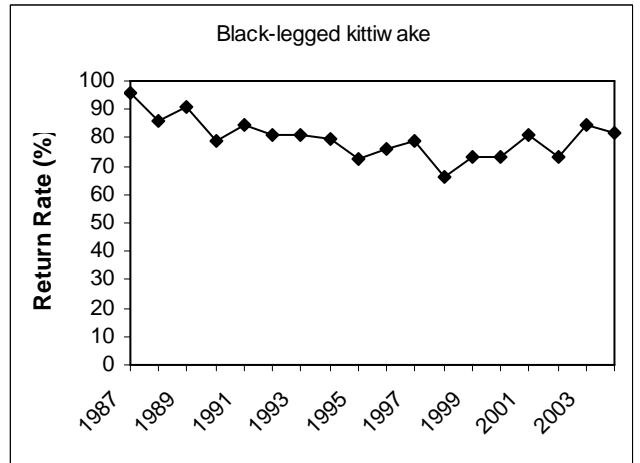
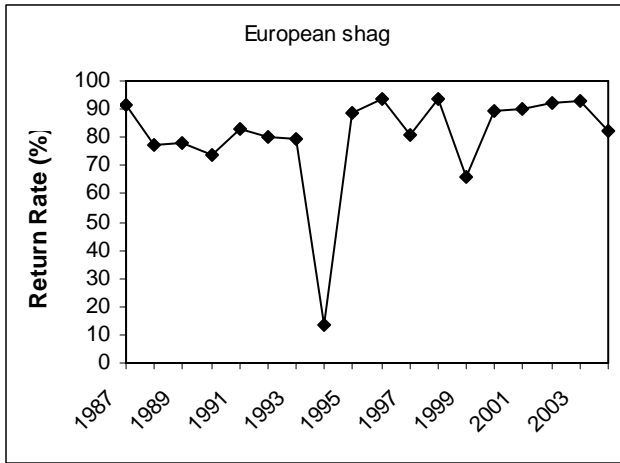


Figure 2. Annual return rates of adult seabirds on the Isle of May 1987 – 2004

4.3 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

Due to the very poor breeding season only 9 regurgitations were obtained from chicks. Two-thirds of these contained sandeels but overall this species made up only 49% of the diet by biomass (Tables 7 and 12). In only one previous year (1999) have sandeels contributed less than 50% of the diet, and again this was associated with an unsuccessful breeding season. Based on otoliths, 6% of sandeels were 0-group and 94% were older. Detailed examination of sandeel otoliths also indicated that the macrostructure of those at the end of the breeding season differed markedly from the last samples from kittiwakes and puffins. The reason for this is currently unknown. One possibility is that shags had switched to feeding on *Ammodytes tobianus* as well as *A. marinus* but it could also reflect some temperature-induced change in otolith macrostructure. Most of the rest of the diet consisted of long-spined sea-scorpion *Myxocephalus scorpius*, butterfish *Pholis gunellus* and small, unidentified Gadidae.

To increase the diet sample for shags we collected regurgitated pellets from around active nests between mid-June and mid-July. Examination of 98 pellets containing food remains indicated that 42% contained sandeel otoliths. The frequency of occurrence of sandeels at this time of year is typically double this (70-98%, n=10 years) suggesting that in 2004 Isle of May shags were having difficulty in obtaining lesser sandeels.

Black-legged kittiwake

Ninety-two percent of black-legged kittiwake food samples collected during the chick-rearing period contained sandeels (Table 7). Of 7,622 otoliths examined, 80% was from sandeels, with 97% from 0 group fish. Estimated lengths of sandeels eaten ranged from 4-6 cm. In terms of biomass, sandeels contributed 78.6% by weight of the diet. This percentage fell below the average value of 83% recorded over the monitoring period. Clupeids (mainly sprat *Sprattus sprattus*) contributed 17% of the biomass and occurred in 32% of regurgitations, with both values being well above those typically recorded on the Isle of May. A total of 40 regurgitations contained small numbers of other items: 33 had very small round otoliths; most, perhaps all, came from transparent gobies *Aphia minuta* (Mardik Leopold pers. comm.).

Common guillemot

Almost 98% of the 1,341 fish delivered to chicks were clupeids with most, probably all, being sprats. The majority were assigned to the small (9.5 cm) size category (Table 8). In addition, 21 sandeels and 7 small Gadidae were also recorded. The average weight of a prey item (estimated from body lengths) was 6.3 g, just below the long term average of 6.6 g. In biomass terms, sandeels comprised only 2% of the diet.

Razorbill

In contrast to all previous seasons, where sandeels were the main prey, most (74%) of the 252 loads of fish seen brought to razorbill chicks consisted of clupeids (Table 9). This is more than twice the previous highest annual proportion and dramatically above the long-term average of 17% (95% CI = 10-25%). In relation to razorbill beak size, the clupeids were classified as medium to large; these almost certainly corresponded to the small category of fish brought in by the much larger guillemots. All but one of the 66 loads of sandeels were comprised of small, presumably 0 group fish; some of these too might have contained small clupeids.

Atlantic puffin

Sandeels made up 92% by number and 86% by biomass in the diet of young Atlantic puffins (Table 12). Most sandeels were 0 group, between 5 and 7 cm long, with only 11 (0.3%) greater than 10 cm (Table 10). The average length of 0 group sandeels increased very little over the 56 day sampling period, suggesting that growth rate of the fish was extremely poor and survival of 0 group sandeels over the 2004-05 winter might be compromised. Most of the small clupeids that could not be identified to species were probably sprats. The mean load size of 6.3 g was well below the long-term average (9.2 g) for puffins on the Isle of May. In contrast the number of fish per load (14.9) was twice the long term average (6.7).

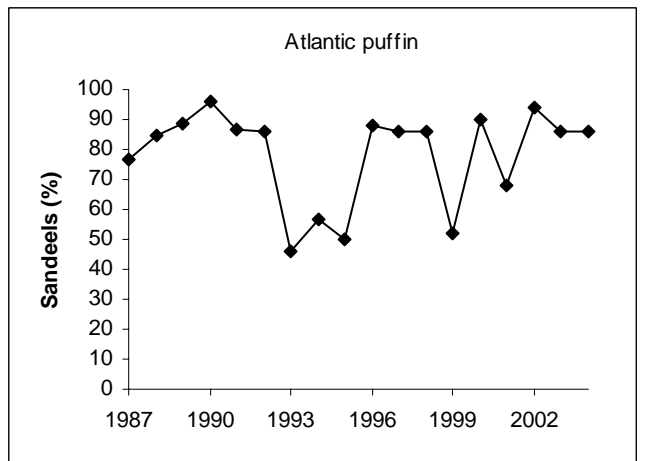
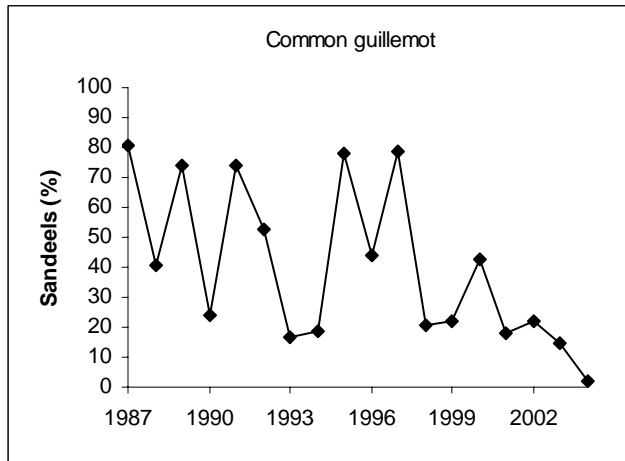
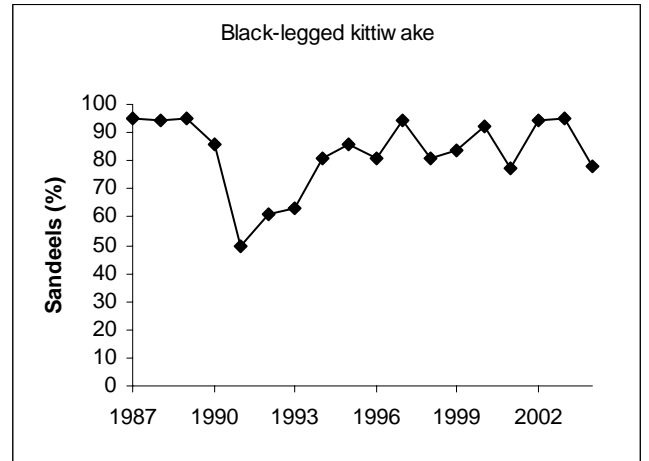
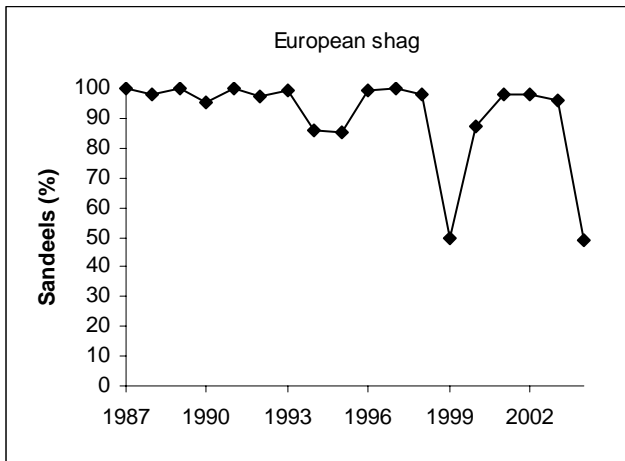


Figure 3. Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2004

5. Conclusions

Despite the fact that the ban on commercial sandeel fishing on the Wee Bankie remained in place, the 2004 breeding season was the worst on record for Isle of May seabirds with, northern fulmar and common guillemot having their worst seasons since monitoring started and success of European shags, black-legged kittiwakes, razorbills and Atlantic puffins all being well below the long term average. Severe weather conditions at the end of June clearly played a part in the poor performance, particularly in the case of shags and puffins. However, attendance and chick growth data suggest that feeding conditions were very bad and dietary data suggest that 1+ sandeels were scarce and 0 group were of poor quality in terms of size.

To date the main threat to Isle of May seabirds has been considered to be the sandeel fishery. However, concern is now being expressed that dramatic changes in the North Sea ecosystem, particularly the plankton community, are occurring (Beaugrand 2004). This has led to intense media interest as to whether these changes are cascading through to the top predators and causing the widespread breeding failures.

A recent analysis of Isle of May kittiwakes has indicated that poor breeding performance and adult survival are both associated with warmer winters and the presence of the Wee Bankie fishery (Frederiksen *et al.* in press). Further work as part of the EU Framework V project IMPRESS has developed this approach further to show that the temperature effect operates via the timing of the spring bloom (Scott *et al.* in press). Clearly in order to fully understand the seabird breeding failures there is an urgent need to carry out similar analyses on additional species and broaden the geographic scale.

6. Acknowledgements

We are grateful to Therese Alampo and Gareth Bradbury of Scottish Natural Heritage for logistical support on the Isle of May. Francis Daunt, Morten Frederiksen, and Sue Lewis made major contributions to the fieldwork and provided comments and assistance during the preparation of the report. Sheila Russell, Mark Newell, Michelle du Toit, Colin Beale, Adriana Vallarino, Ruedi Nager, Larissa Lee, Anna and Stephen Sutcliffe helped with various aspects of the fieldwork. We are grateful to Andy Easton for providing transport to and from the Isle of May throughout the season.

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8. Further reading

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Table 1. Breeding success of northern fulmars on the Isle of May in 2004

<i>Area</i>	<i>Incubating birds</i>	<i>No. probably hatched</i>	<i>Young fledged</i>
Cleaver	7	5	3
Pilgrim's Haven	2	0	0
Cornerstone	3	0	0
Loch (S)	20	8	5
Greengates	42	15	7
Horse Hole	7	1	1
Tarbet	9	2	1
Low Light	4	2	2
Colm's Hole	3	2	1
Rona	0	0	0
Total	97	35	20
Overall mean			0.21 fledged/ pair

Note:

Incubating birds were those sitting tight on three checks or where an egg was seen. Chicks present on 17 August were assumed to have fledged.

Table 2. Breeding success of European shags on the Isle of May in 2004

<i>Area</i>	<i>Total incubated</i>	<i>Other nests</i>	<i>Young fledged</i>			<i>Total young fledged</i>	<i>Mean young fledged per incubated nest</i>
			<i>1</i>	<i>2</i>	<i>3</i>		
Maidens	7	3	1	0	0	1	0.14
Chatterstones	4	2	1	0	0	1	0.25
Pilgrim's Haven	16	1	3	0	0	3	0.19
North Pilgrims	1	0	0	0	0	0	0
South Face	2	0	1	0	0	1	0.50
Mill Door (N)	9	2	4	0	0	4	0.44
Mill Door (S)	10	6	4	1	0	6	0.60
Horse Hole	13	6	1	1	0	3	0.23
North Horn	26	8	1	1	0	3	0.12
Tarbet	5	3	0	0	0	0	0
Low Light	4	3	2	1	0	4	1.00
Colm's Hole	6	2	0	0	0	0	0
Mean ± se							0.29±0.09
Total	103	36	18	4	0	26	0.25

Note:

No nests were built in the plots at South Ness, Lady's Bed Stack, South Horn or Bishop's Cove in 2004.

Table 3. Breeding success of black-legged kittiwakes on the Isle of May in 2004

Area	Completed nests	Trace nests	Other pairs with site	Fledged young per completed nest				Total young produced	Fledging success per completed nest
				0	1	2	3		
Cleaver	29	4	2	23	6	0	0	6	0.21
Pilgrim's Haven	21	2	1	7	13	1	0	15	0.71
South Face	14	7	4	8	6	0	0	6	0.43
Colony 4	34	4	1	17	15	2	0	19	0.56
Cornerstone	72	3	11	28	33	1	0	35	0.47
Loch (S)	10	1	2	10	0	0	0	0	0
Loch (N)	70	1	2	59	11	0	0	11	0.16
Greengates	48	1	3	48	0	0	0	0	0
Bishop's Cove	28	4	6	24	3	1	0	5	0.18
Horse Hole	5	0	0	5	0	0	0	0	0
Iron Bridge	33	0	6	14	19	0	0	19	0.58
Rona	37	0	7	16	21	0	0	21	0.57
Tarbet	54	0	9	54	0	0	0	0	0
Low Light	9	6	1	9	0	0	0	0	0
Colm's Hole	12	4	0	10	2	0	0	2	0.17
Mean ± se									0.27 ± 0.07
Total	476	52	84	332	129	5	0	139	0.29

Note:

Some pairs with sites and trace nests may have been overlooked in Greengates

Table 4. Breeding success of auks on the Isle of May in 2004

Species	Area	Pairs laying	Young hatched	Young "fledged"	Young leaving / pair
Guillemot	Dense	301	231	152	0.51
	Hide / White Ledge	105	84	56	0.53
	Colony 4	269	201	127	0.46
	South	52	42	24	0.47
	Cornerstone	257	201	142	0.53
	Mean ± se				0.50 ± 0.01
Razorbill	Hide / White Ledge	22	24	18	0.56
	Colony 4	64	39	28	0.44
	South	24	15	12	0.50
	Cornerstone	70	50	47	0.67
		Mean ± se			
Puffin	Lady's Bed	51	?	34	0.67
	Kirkhaven	51	?	24	0.47
	Burrian	47	?	21	0.45
	Rona	47	?	39	0.83
		Mean ± se			

Note:

For the puffin, the number of young that hatched was unknown.

Table 5. Breeding success (mean number of young reared per breeding pair) of seabirds on the Isle of May, 1990- 2004

<i>Species</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1997</i>
Northern fulmar	0.42 (100)	0.47 (129)	0.44 (121)	0.47 (122)	0.48 (126)	0.44 (135)	0.37 (136)
European shag	1.06 (187)	0.87 (181)	0.21 (80)	0.68 (74)	0.84 (131)	1.05 (105)	0.92 (109)
Black-legged kittiwake	0.27 (1172)	0.61 (1062)	0.07 (1034)	0.16 (861)	0.40 (874)	0.56 (825)	0.40 (822)
Common guillemot	0.81 (754)	0.85 (745)	0.76 (797)	0.79 (775)	0.81 (805)	0.82 (786)	0.77 (842)
Razorbill	0.72 (104)	0.86 (105)	0.72 (119)	0.69 (134)	0.62 (143)	0.63 (140)	0.71 (132)
Atlantic puffin	0.78 (153)	0.87 (184)	0.69 (182)	0.85 (189)	0.84 (180)	0.78 (173)	0.65 (166)
	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>
Northern fulmar	0.35 (120)	0.47 (115)	0.37 (143)	0.26 (134)	0.48 (131)	0.44 (109)	0.21 (97)
European shag	0.85 (125)	0.33 (58)	1.48 (127)	1.53 (135)	1.66 (130)	1.83 (156)	0.25 (103)
Black-legged kittiwake	0.02 (683)	0.20 (616)	0.97 (545)	0.61 (459)	0.47 (477)	0.77 (423)	0.29 (476)
Common guillemot	0.73 (852)	0.66 (870)	0.73 (942)	0.63 (975)	0.68 (955)	0.68 (1014)	0.50 (984)
Razorbill	0.57 (134)	0.52 (142)	0.68 (149)	0.60 (167)	0.65 (167)	0.59 (177)	0.54 (190)
Atlantic puffin	0.54 (179)	0.58 (181)	0.73 (132)	0.78 (185)	0.72 (174)	0.77 (195)	0.60 (196)

Note:

The number of pairs followed 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, 1988-2004

<i>Species</i>	<i>No. seen in 2004</i>	<i>No. seen in 2003</i>	<i>Return rate (%)</i>						
			<i>2003-04</i>	<i>2002-03</i>	<i>2001-02</i>	<i>2000-01</i>	<i>1999-00</i>	<i>1998-99</i>	<i>1997-98</i>
Kittiwake	143	117	81.8	84.2	73.5	81.2	72.9	73.1	66.2
Guillemot	374	337	90.1	87.0	87.0	89.6	91.6	90.2	94.6
Razorbill	51	43	84.3	77.8	83.8	82.9	66.7	86.9	65.5
Puffin	207	182	87.9	85.2	83.5	90.5	82.8	88.2	85.5
Shag	152	125	82.2	92.7	92.2	89.8	89.4	65.8	93.6
	<i>1996-97</i>	<i>1995-96</i>	<i>1994-95</i>	<i>1993-94</i>	<i>1992-93</i>	<i>1991-92</i>	<i>1990-91</i>	<i>1989-90</i>	<i>1988-89</i>
Kittiwake	78.7	75.8	72.7	79.5	80.8	80.7	84.2	78.7	90.9
Guillemot	91.8	88.9	95.6	95.0	95.0	93.3	91.0	94.9	92.4
Razorbill	82.1	56.6	92.6	84.5	91.5	89.8	79.6	75.0	90.5
Puffin	90.7	90.1	93.0	93.1	84.0	86.8	71.4	63.3	85.2
Shag	91.1	93.6	88.5	13.4	79.6	79.9	82.8	74.0	78.1

Note:

Only birds which had definitely bred in 2003 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.

Table 7. Food of young black-legged kittiwakes and European shags on the Isle of May during chick-rearing in 2004

	<i>Black-legged kittiwake</i>	<i>European shag</i>
No. of regurgitations	120	9
Range of dates	18 June – 27 July	2 – 16 July
Total weight (g)	1392	365
% regurgitations with sandeels	92	67
with Gadidae	8	44
with Clupeidae	32	0
with flatfish	0	11
with butterfish	0	22
with Cottidae	0	22
% (by weight) of sandeels in sample	78.6	49
% (by numbers) of sandeels in sample	80.4	73
Lengths of most sandeels (cm)	4-6	9-11.5
Other remains identified	Larval crustacea (1 sample), minute swimming crabs (1), pipefish (2), Nereis (1)	

Note:

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.

Table 8. Food of young common guillemots on the Isle of May during chick-rearing in 2004

	<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>minute</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>very large</i>	<i>small</i>
Mean length (cm)		9	12	16	6	9.5		15	17	8
All-day watches										
23 June	0	0	0	0	1	176	0	0	0	1
27 June	0	1	1	0	0	317	0	4	0	2
28 June	0	1	1	2	1	95	0	3	0	0
4 July	0	0	3	0	0	80	0	1	0	0
Other records										
2 June - 12 July	0	0	12	0	0	619	0	12	4	4
Total	0	2	17	2	2	1287	0	20	4	7

Note:

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

Table 9. Food of young razorbills on the Isle of May in 2004

	<i>Sandeels</i>			<i>Single Clupeidae</i>			<i>Several Clupeidae</i>		
	<i>small</i>	<i>medium</i>	<i>large</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>small</i>	<i>medium</i>	<i>large</i>
All-day watches									
23 June	1	4	1	2	3	13	1	0	8
27 June	6	2	0	1	6	12	1	12	13
28 June	5	4	0	1	10	2	3	10	0
4 July	3	5	0	1	10	0	0	13	1
Other records									
1 June - 14 July	33	1	1	2	30	11	4	11	5
Total	48	16	2	7	59	38	9	46	27

Note:

Figures are numbers of loads of various types of food
 Some loads of sandeels may also have had a few small clupeids included
 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, 29 May to 24 July 2004

	<i>Sample size</i>	<i>Mean</i>	<i>s.e</i>
a) Load weight (g)	271	6.3	0.21
b) Fish/load	271	14.9	0.55
c) Numbers and lengths of fish (mm)			
Sandeels <i>Ammodytes sp.</i>	3,552	49.8	0.2
Unidentified Clupeid (<i>Clupeidae</i>)	107	39.9	0.6
Sprat <i>Sprattus sprattus</i>	56	88.5	1.8
Cod <i>Gadus morhua</i>	2	44.0	5.0
Saithe <i>Pollachius virens</i>	5	38.6	2.7
Goby (<i>Gobidae</i>)	14	39.0	1.6
Unidentified Gadid (<i>Gadidae</i>)	17	37.3	1.0
Rockling <i>sp.</i> (<i>Gadidae</i>)	77	32.7	0.7
Whiting (<i>Merlangius merlangus</i>)	11	43.3	2.1

Note:

Most of the Clupeidae category were probably small sprat, most the Gadidae were probably whiting. The gobies were probably crystal gobies *Crystallogobius linearis*. In addition, 1 sample contained a small squid (25 mm).

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 on the Isle of May, 1986-2004

<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
2002	6	19
2003	0.2	7
2004	31	48

Note:

Figures are based on 87-196 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). The small values for 2003 were due the small sample size, as the first chick seen neglected was not until 9 July, and the first fledged chicks in the area were 13 July; including checks until 30 July, the percentage of broods of 1 and 2 neglected were 8 and 24 respectively.

Table 12. Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2004

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

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Shag	99	100	98	<50	87	95	98	96	49
Kittiwake	81	94	81	84	92	76	94	91	79
Guillemot	44	79	21	22	43	18	22	15	2
Puffin	88	86	86	52	90	68	94	86	78

Note:

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, 1986-2004

<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
2002	10 May	1.87
2003	9 May	1.49
2004	22 May	1.65