JNCC Report No. 475a

Isle of May seabird studies in 2005

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January 2013

ISSN 0963-8901

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This report should be cited as:

Newell, M., Harris, M.P., Daunt, F. & Wanless, S. (2013)

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Acknowledgements:

We are grateful to Therese Alampo and Gareth Bradbury of Scottish Natural Heritage for logistical support on the Isle of May. Sue Lewis, Morten Frederiksen, Chris Thaxter, Tom Reed, Ellie Owen, Meg Duhr-Shultz and Jenny Underhill made major contributions to the fieldwork and provided comments and assistance during the preparation of the report. Sheila and Debbie Russell, Adriana Vallarino, Toby Reynolds and Adam Boulton also helped with fieldwork and Lynne Robinson helped process food samples. We are grateful to Andy Easton for providing transport to and from the Isle of May throughout the season.

Summary

The 2005 seabird breeding season was one of the latest since detailed studies started in the 1980s. However, it did not result in catastrophic breeding failures for all the species. Indeed, breeding success of black-legged kittiwakes was one of the highest recorded. Return rates of black-legged kittiwake, shag, puffin and guillemot were all extremely low, suggesting that overwinter and spring conditions were bad for many species. Most species appeared to find conditions difficult early in the season with colony attendance being rather low. Although lesser sandeels remained the main food of young puffins, razorbills and kittiwakes, guillemots fed their young mainly clupeids and shags brought in a wide variety of bottom-living fish. Very few 1 group sandeels were present in food samples during the chick-rearing period.

- Northern fulmar breeding success (0.27 chicks per incubating pair) was one of the lowest recorded.

- Numbers of European shags were greatly reduced following a major wreck early in 2005. Return rate was therefore very low (36%), the second lowest recorded. Breeding was late and success was poor (0.48 chicks fledged per pair laying). As in 2004, the diet was unusually varied with sandeels making up only 40.6% by mass of the diet. Those sandeels that were eaten were mainly 0 group rather than the older (1+ group) fish normally taken.

- Black-legged kittiwakes had by far the latest season ever recorded. Despite this, the breeding success of 0.85 chicks fledged per active nest was the highest since 2000 and had been bettered in only three other previous seasons. Adult return rate (69.7%) was the second lowest recorded. All regurgitations contained sandeels that made up 92% of the diet by weight.

- Common guillemots had their lowest recorded return rate (83.9%), breeding numbers were depressed and breeding was very late and unproductive (0.63 chicks leaving per pair laying). As in 2004, many chicks were left unattended but surprisingly few were taken by gulls. Adults fed their chicks mainly on sprats with small gadoids being the main alternative. Sandeels made up only 1.2% of the diet by mass. Chicks grew slowly and all the evidence suggested that feeding conditions were poor.

- Razorbill breeding was late and breeding success (0.57 chicks leaving per pair) was well below the long-term average. In contrast to all the other species, adult return rate (84.6%) was higher than the long-term average. Chicks were fed mainly 0 group sandeels.

- Atlantic puffins had the latest breeding season since records began in 1972. Breeding success at 0.71 chicks per pair, although an improvement on 2004, was still one of the lowest recorded on the Isle of May. Chicks were mainly fed 0 group sandeels (92% by number, 71% by biomass). Adult return rate (77.0%) was well below normal.

The commercial sandeel fishery on the Wee Bankie has been closed since 2000. Seabird monitoring on the Isle of May indicated that breeding success of kittiwakes and shags improved during this period, although the situation was less clear for the auks. However, in 2004 all species had a disastrous breeding season despite the fishery remaining closed. Analyses of fish fed to young seabirds revealed that lipid levels were extremely low indicating that feeding conditions for mid trophic species such as sandeel and sprat were poor. These findings, and those from elsewhere in the North Sea, suggested major changes in the ecosystem, with climate change being a strong candidate as the driver. Results from

2005 provide further evidence of change with the whole of the North Sea sandeel fishery now closed, and some seabird breeding seasons shifting later. However, the 2005 year-class of sandeels in the Firth of Forth area appeared to be strong and benefited species reliant on 0 group sandeels for rearing their chicks in comparison with 2004.

Contents

List of tables

List of figures

1 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 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 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. In 2004, seabirds on the Isle of May did particularly poorly, despite the ban still being in operation. Continued monitoring of the Isle of May seabirds is vital to assess their performance, and in particular to determine whether 2004 was a one-off event or a temporary setback in the recovery recorded in some species since the fishery closure.

2 Methods

2.1 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 27 and 30 May, 3 and 8 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 12 July to determine those that had hatched eggs. A final check was made on 19 August, when chicks present were assumed to have fledged successfully.

European shag

The positions of nests constructed in 12 areas were marked on photographs and the state and contents of these nests were checked weekly from 10 May until 29 August. Medium-sized and large young still present on 29 August were assumed to have fledged successfully. Success was estimated both by averaging across the plots and summing over plots.

Black-legged kittiwake

The positions of nests in 17 areas were marked on photographs and the presence or absence of an incubating bird, or the number of young present at each, was noted. Because of the long-term decline in kittiwake numbers on the Isle of May, the extent of the plots at Greengates and Cornerstone were increased and new plots were put in place at South Horn and Hide Face. Checks of nests were made on 10 and 17 June. The earliest young was seen flying on 3 August and a complete check of chicks was made on 5 August. Further checks of nests with small chicks then were made on 8, 10 and 19 August. Chicks still alive on 19 August were assumed to have fledged. 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 50-60 burrows where an egg was present, were staked in each of four areas on 7-8 May (by when most pairs had laid). The staked burrows were re-checked on 18-19 July at the start of fledging and young present at this time were assumed to have fledged. Empty burrows where there were many droppings, moulted down and feather sheaths were also assumed to have been successful.

2.2 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 locate any individuals that had moved. Searches were also made of the whole island for birds that 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 East Tarbet, Rona (North Horn Gully), Low Light Gully, Little Hole, Cornerstone and its nearby cliffs.

2.3 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. 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 and measured. The lengths of the fish from which they came were calculated using regressions derived from the otoliths of fish of known length where possible collected from birds on the island in 2005, otherwise from previously published relationships. 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 directly from this species.

3 Results

3.1 Breeding success

Appendix 1 provides species summaries in Tables 1- 4 and a comparison with recent years' results in Table 5. Long-term averages presented do not include the current year nor, unless explicitly stated, 2004 since this was an extreme year for many parameters.

Northern fulmar

The first egg was seen on 16 May. Although an improvement over 2004 (0.21 young per incubating pair), breeding success at 0.27 (Figure 1) was 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 losses appeared to have been more-or-less equally divided between the egg and chick periods.

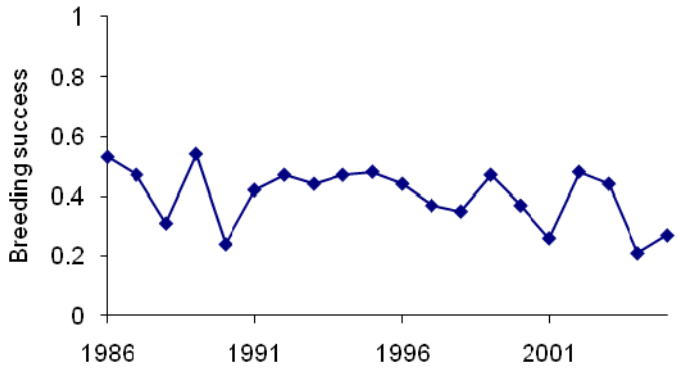

Figure 1. Breeding success (young reared per pair breeding) of Northern fulmar on the Isle of May 1986 – 2005

European shag

There was a major mortality of shags in early 2005 during which 146 birds previously ringed on the island were reported dead. These included many birds of breeding age so it was not surprising that the breeding population was dramatically reduced. In 2005, only 42 pairs laid eggs in the monitoring plots compared with 103 in 2004 (itself a poor year) and 156 in 2003.

Breeding was much later than in 2004 with the first egg not laid until 6 May (compared with 17 April in 2004 and the long-term average of 10 April between 1986-2003). Of 61 nests built in the study plots, 42 pairs laid and incubated eggs, of which 12 raised a total of 20 chicks to fledging. Productivity was thus low (0.48 chicks per pair laying or 0.33 per nest built) (Figure 2). The former estimate, although much higher than the value for 2004 (0.25) was nevertheless well below the 95% Confidence Interval for the 1986-2003 average (0.90, CI=0.69-1.11).

As far as we know, only a single brood of 3 young was reared on the island in 2005.

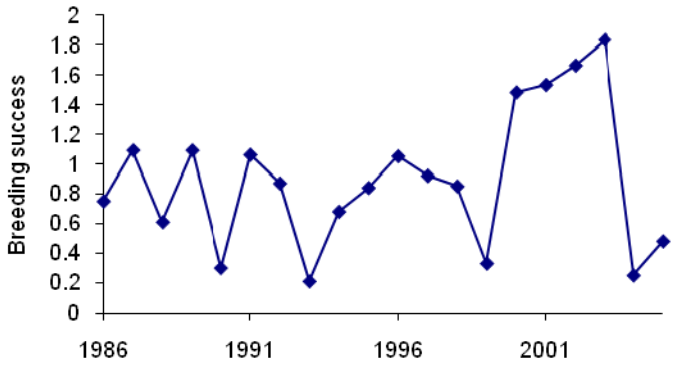

Figure 2. Breeding success (young reared per pair breeding) of European shag on the Isle of May 1986 – 2005

Black-legged kittiwake

Timing of breeding of black-legged kittiwakes in 2005 was by far the latest ever recorded, with the first courtship feed not observed until 9 May and the first egg not seen until 30 May. The first chick was recorded on 26 June and the first young fledged on 3 August. The mean clutch size, including complete nests where no eggs were laid, was 1.73 eggs, fairly typical for the Isle of May in recent years (Table 13). Only a single clutch of three eggs was recorded in the 636 nests checked for clutch-size.

Mean breeding success in 2005 was 0.83 (± se 0.11) chicks per completed nest, averaged across the plots, 0.85 after pooling areas (Figure 3). This was the highest value since 2000 (0.97) and on a par with figures from the late 1980s prior to the start of the sandeel fishery. The first neglected broods were noted on 17 July. The proportion of deserted broods of one young remained fairly constant at 4.5% until the end of the month, whereas the proportion of broods of two deserted increased gradually from 6.5% to 36.9%. During this period, the average daily rates of unattended chicks were 4.5% and 20.8% for broods of one and two chicks, respectively. No brood of 3 young fledged on the island.

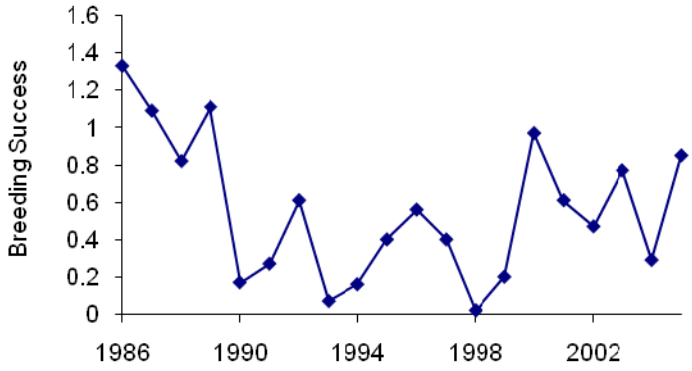

Figure 3. Breeding success (young reared per pair breeding) of black-legged kittiwake on the Isle of May 1986 – 2005

Common guillemot

Breeding numbers were depressed with a total of 945 pairs laying in the study plots compared with 983 in 2004 and 1014 in 2003.

The first guillemot eggs on the island, both in the study plots and elsewhere (Greenface), were not seen until 4 May, the latest date yet recorded on the Isle of May. Unusually, there was little difference in the timing of laying between the study areas, the earliest and latest median dates being only two days apart (16 and 18 May). In 2004, the corresponding dates were 11 and 17 May, respectively. The first young left on the night of 4-5 July. Breeding success (0.63 young per pair laying for both the plot average and summed total, Figure 4) was among the lowest ever recorded on the Isle of May. The lowest success (0.51) was in 2004. Thus values for the last two years have been well below the 95% Confidence Interval for the 1986-2003 average (0.77, CI=0.74-0.80). Both egg and chick losses (21% and 22% respectively) were lower than in 2004 (33% and 34%) but were still well above the long-term averages (16% and 8%).

Normally, one member of the pair is always present in the colony to guard the chick. However, in 2005 many chicks were left unattended, suggesting that adults were finding it hard to find food. Surprisingly, such neglected chicks were rarely eaten 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 just to die on the site, apparently of starvation. Measurements of chicks during ringing indicated that fledging weights were markedly lower than normal. As in 2004, many chicks fledged during the day rather than in the evening, but again predation rates appeared to be low and most losses at fledging were due to the failure of the chick to meet up with the male.

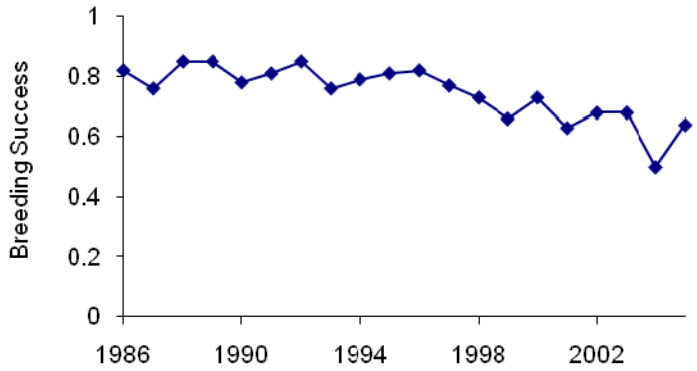

Figure 4. Breeding success (young reared per pair breeding) of common guillemot on the Isle of May 1986 – 2005

Razorbill

Timing of breeding of razorbills was late for the Isle of May, with the first egg not being laid until 4 May and the first young not seen until 9 June. Mean breeding success (0.57 and 0.55 young per pair laying for the plot average and total pairs laying; Figure 5), was well below the 1986-2003 mean (0.67, CI=0.63-0.70). Most losses occurred at the egg stage, but chick losses were also higher than normal with 21% of pairs failing at this stage. No unattended razorbill chicks were recorded.

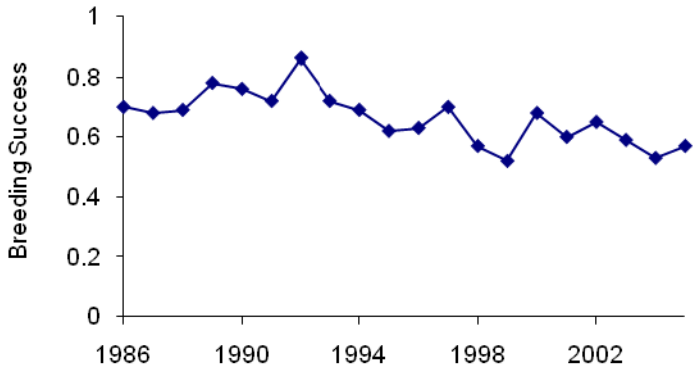

Figure 5. Breeding success (young reared per pair breeding) of razorbill on the Isle of May 1986 – 2005

Atlantic puffin

Breeding started very late but then appeared to be more synchronized than usual. None of 65 burrows examined on 30 April contained an egg, by 3-5 May 29% (n = 34) and 26% (n = 109) had eggs, and by 7-8 May virtually all pairs had laid. The first puffin carrying fish was seen on 3 June and the first young fledged on the night of 13-14 July. Back-calculation from these figures indicates that laying commenced around 23 April which was five days later than any year since observations stared in 1973.

The mean breeding success (0.71 chicks fledged per egg laid; Figure 6) was higher than in 2004 (0.60) but was nevertheless one of the lowest values recorded and well below the long-term mean (0.77, 95% CI=0.75-0.83). Monitoring of breeding success in puffins does not distinguish hatching and fledging success but additional work on chick growth indicated that few losses occurred at this stage suggesting that most failures occurred during incubation.

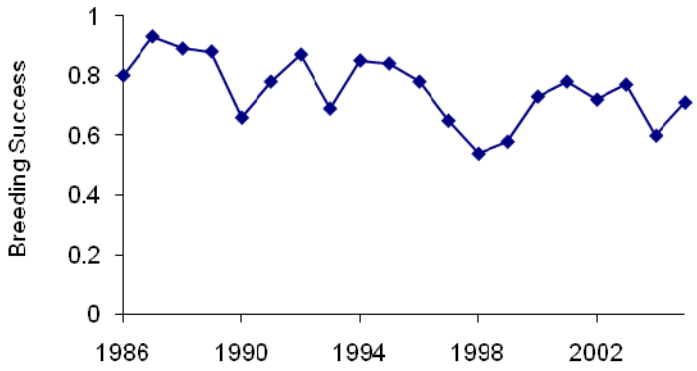

Figure 6. Breeding success (young reared per pair breeding) of Atlantic puffin on the Isle of May 1986 – 2005

3.2 Adult survival 2004-2005

Not every adult alive is seen each year and thus return rates for 2005 presented here need to be treated as minimum estimates of survival of birds seen in 2004. The results are compared with those of previous years in Table 6 and Appendix 2. During 2005, additional 53 European shags, 34 black-legged kittiwakes, 26 Atlantic puffins, 5 razorbills and 29 common guillemots were colour-ringed. The long-term averages presented in this section do not include the current year.

European shag

Large numbers of shags, including many Isle of May ringed birds, were found dead early in eastern Britain in 2005. This mortality was reflected in the low return rate on the Isle of May with only 55 (36.4%) of 151 colour-ringed European shags alive in 2004 resighted in 2005 (Figure 7). This was the second lowest value recorded since monitoring started, the only other comparable low figure being 13.4% over the winter of 1993-1994. The long-term average for this species on the Isle of May is 80.8% (95% CI = 70.9-90.6).

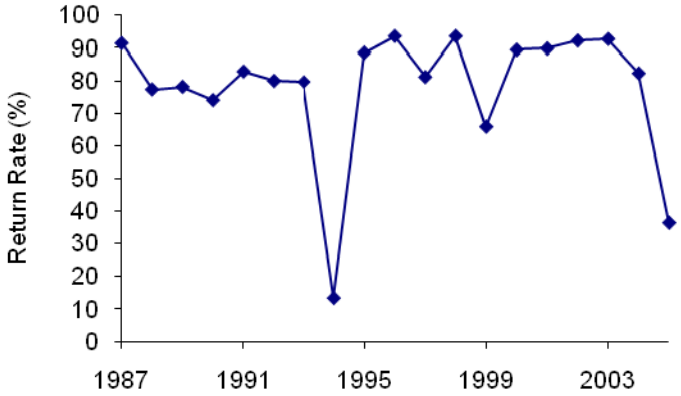

Figure 7. Annual return rates of adult European shag on the Isle of May 1987 – 2005

Black-legged kittiwake

The return rate of black-legged kittiwakes (69.7%) was the second lowest recorded and well below the 1986-2004 average (79.8, 95% CI =76.6-83.4) (Figure 8).

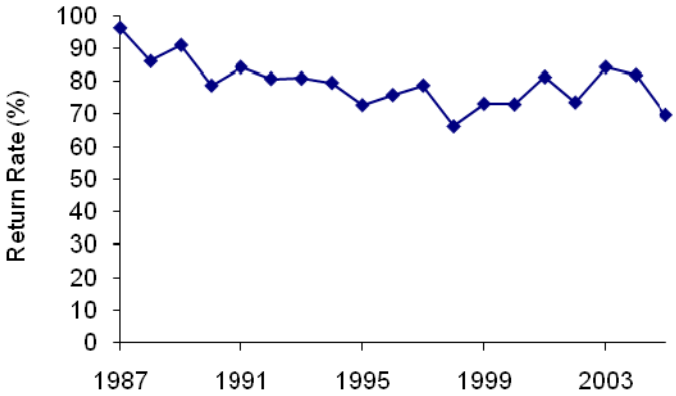

Figure 8. Annual return rates of adult black-legged kittiwake on the Isle of May 1987 – 2005

Common guillemot

The return rate of common guillemots (83.9%) was the lowest ever recorded on the Isle of May (Figure 9). Observer effort in 2005 was high with two intensive studies being undertaken so it was unlikely that any birds were overlooked. The value for 2005 therefore continues the recent decline and falls well outside the 95% Confidence Interval for the 1986-2004 average (92.1, 95% CI = 90.6-93.5).

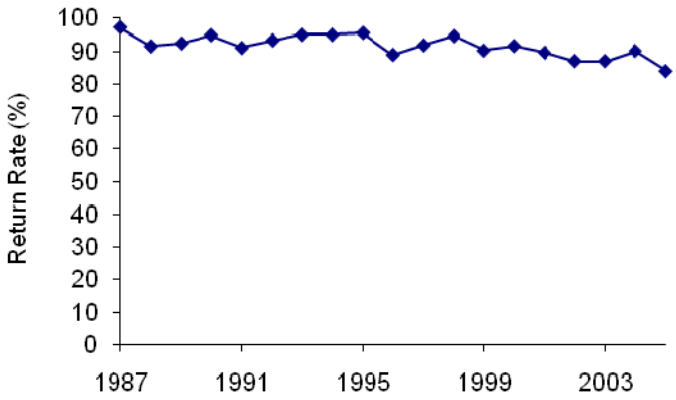

Figure 9. Annual return rates of adult common guillemot on the Isle of May 1987 – 2005

Razorbill

The return rate of razorbills (84.6%) was higher than the 1986-2004 average (81.7, 95% CI = 76.6-86.7).

Atlantic puffin

The return rate of Atlantic puffins (77.0%) was the lowest recorded since the winter of 1990-91 and well below the 1986-2004 average (84.4, 95% CI = 80.6-88.2) (Figure 10).

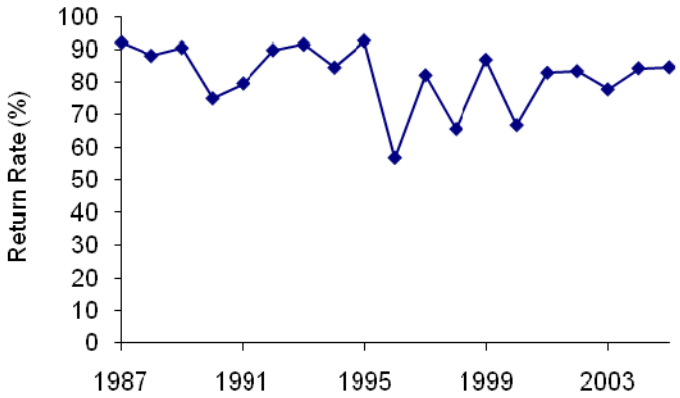

Figure 10. Annual return rates of adult Atlantic puffin on the Isle of May 1987 – 2005

3.3 Food of young

Appendix 3 provides species accounts in Tables 7-10, and a comparison of sandeel biomass data with recent years' results in Table 12.

European shag

Due to the small breeding population and poor breeding season, only 16 regurgitations were obtained from chicks or adults attending chicks. The most frequent prey (by occurrence in a regurgitate) were small individuals of a range of species of Gadidae including whiting *Merlangius merlangus* and butterfish *Pholis gunnellus,* both of which occurred in nine regurgitates (56%) (Table 7). Sandeels also occurred in nine (56%) regurgitates (and constituted 40.5% of the biomass) but, due to their small size they made up a much higher percentage (76.6%) of the 821 items identified (Figure 11). All but three of the sandeels were 0 group. Two regurgitates contained a few very small flatfish (possibly long rough dab *Hippoglossoides platessoides*) and Clupeidae (probably sprat *Sprattus sprattus*). Another had the remains of a single large Cottidae.

This is the second year running that sandeels (normally the most important prey species for shags) have contributed less than half the food fed to young birds. 2005 was also unusual in that the majority of sandeels obtained from shags were 0 group with only three older fish being found. Normally such older (1+) sandeels make up the bulk of the diet of shags on the Isle of May.

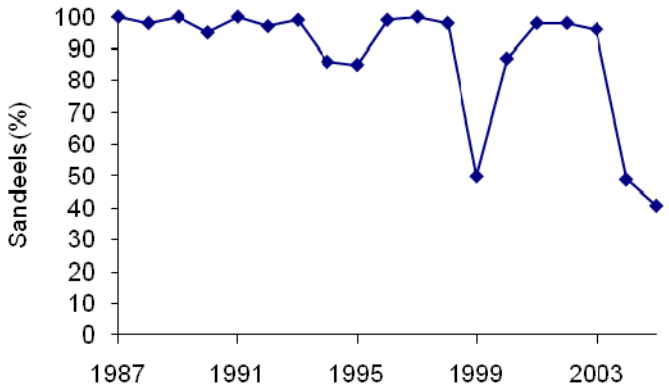

Figure 11. Percentage of sandeels (by weight) in the diet of young European shag on the Isle of May, 1987-2005

Black-legged kittiwake

All the black-legged kittiwake food samples (n = 116) collected during the chick-rearing period contained sandeels (Table 7). Of 7,198 otoliths examined, 92.6% were from sandeels (Figure 12), with 7198 (99.9%) from 0 group. Most sandeels eaten were about 6 cm long. In terms of biomass, 0 group and older sandeels contributed 88.6% and 3.7% by mass of the diet, respectively. Clupeids (mainly sprat *Sprattus sprattus*) contributed 7.8% of the biomass and occurred in 44% of regurgitations. The remains of other items found were Gadidae (in 14 regurgitates), small crustacea (3), gobies Gobidae (2), pipefish Syngnathidae (2) and polychaete worms (1).

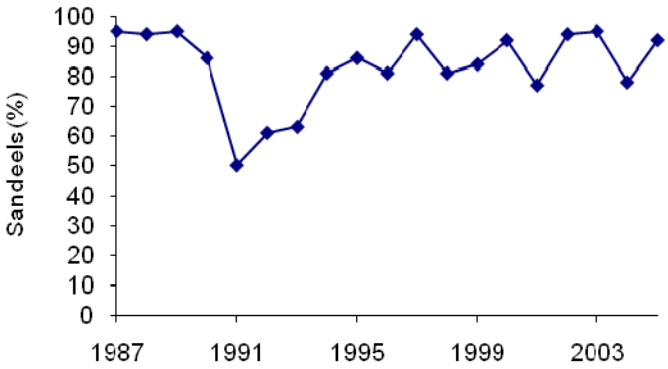

Figure 12. Percentage of sandeels (by weight) in the diet of young black-legged kittiwakes on the Isle of May, 1987-2005

Common guillemot

About 91% of the 2,898 fish delivered to chicks were clupeids. Those that could be identified to species were all sprats and it seems likely that this species made up the bulk of the diet. Most clupeids were assigned to the medium (10.5 cm) size category (Table 8). Small or medium sized Gadidae were the next commonest prey making up 151 (5.3%) of feeds. Identification of Gadidae in the field is extremely difficult but both saithe *Pollarchius virens* and whiting *Merlangius merlangus* were specifically identified. A total of 120 sandeels was recorded with most being 8-10 cm long. In biomass terms, sandeels comprised only 1.2% of the diet (Figure 13). Guillemots were regularly seen feeding with other seabirds near to the island, apparently on concentrations of 0 group sandeels. 0 group were occasionally brought ashore for display but were not fed to chicks. However, this age class does contribute a major component of adult diet (Wilson *et al* 2004). A single butterfish *Pholis gunellus* was recorded as a display fish. Two very large sandeels, 16 and 21 cm long, were found dropped on the ledges but nothing approaching this size was seen fed to a chick. The average weight of a prey item (estimated from body length) was 7.3 g, slightly above the 1986-2004 average of 6.1 g.

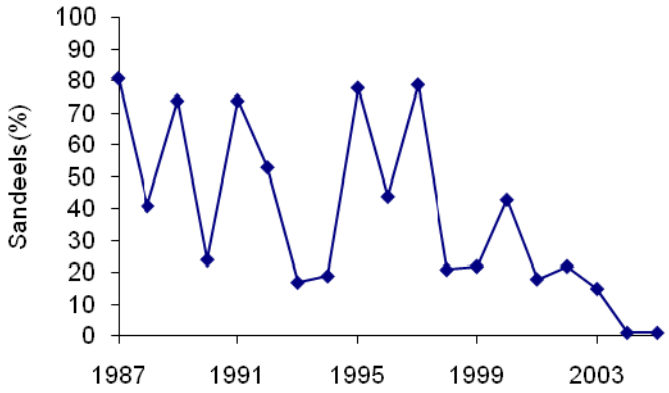

Figure 13. Percentage of sandeels (by weight) in the diet of young common guillemot on the Isle of May, 1987-2005

Razorbill

Sandeels made up the bulk of the fish brought in by razorbills, being the only species recorded in 692 (93.0%) of the 744 feeds where the fish were clearly visible (Table 9). Virtually all the sandeels were 0 group. Clupeids were present in 67 (9.0%) of loads; with most appearing to be sprats of a similar size to those brought in by puffins and guillemots i.e. 10 cm long. In 2004 chicks were fed mainly small sprats, thus 2005 brought a return to the normal situation of a diet dominated by sandeels.

Atlantic puffin

Sandeels made up 92% by number and 71% by biomass in the diet of young Atlantic puffins (Figure 14). Most sandeels were 0 group, between 4 and 7 cm long, with only 8 (0.3%) fish longer than 10 cm being recorded (Table 10). Most of the remainder of the diet was made up of small sprats. The mean load size of 9.5g was well above that of 2004 (6.3 g) and close to the long-term average (9.2 g) for puffins on the Isle of May. In contrast, the number of fish per load (13.4), although only just below that of 2004 (14.9), was double the long term average (6.7).

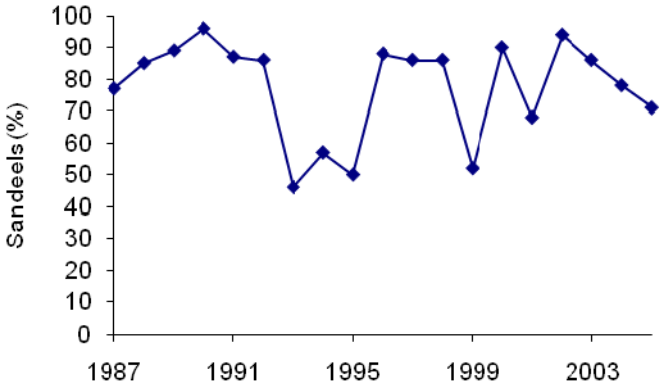

Figure 14. Percentage of sandeels (by weight) in the diet of young Atlantic puffin on the Isle of May, 1987-2005

4 Conclusions

The 2004 breeding season was the worst on record for Isle of May seabirds and even more severe failures were recorded further north in the North Sea. Since the commercial fishery for sandeels down the east coast of Britain had been closed since 2000 the problems could not be directly attributed to conflict with the fishery and climate change was the strongest candidate. Some of the best evidence supporting this conclusion came from analyses of fish brought in by Isle of May seabirds showing that lipid levels were extremely low in 2004 (Wanless *et al* 2005). This indicated that poor food quality was a proximate cause of the seabird breeding failure and that feeding conditions for animals further down the food web were also very poor in 2004. While the effects could not be unequivocally attributed to climate change, they were indicative of bottom-up, climate-mediated effects rather than top-down, fishery-induced changes.

The below-average return rates and delayed start to the breeding season recorded for many seabird species on the Isle of May in 2005, suggest that birds continued to experience problems over the 2004/05 winter and spring. The precise reasons for this have still to be elucidated, and will probably vary between species, but weather conditions in February and March 2005 were poor with prolonged periods of strong onshore winds and North Sea sandeel stocks were so low that the entire area was closed to commercial fishing in July. However, while conditions early in the season were unfavourable, they appeared to improve markedly from mid-June onwards once the 0 group sandeels became available and kittiwakes, that rely on 0 group to feed their chicks, bred successfully, demonstrating that a late breeding season need not necessarily be an unsuccessful one.

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6 Further reading

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7 Appendices

Appendix 1: Breeding success

Table 1. Breeding success of northern fulmars on the Isle of May in 2005

Area	*Incubating birds*	*No. probably hatched*	*Young fledged*
Cleaver	8	3	1
Pilgrim's Haven	2	1	0
Cornerstone	2	2	0
Loch (S)	31	17	8
Greengates	56	41	14
Horse Hole	8	6	4
Tarbet	15	12	7
Low Light	8	5	3
Colm's Hole	4	1	0
Rona	1	1	0
Total	**135**	**89**	**37**
Overall mean			**0.27 fledged/ pair**

Notes:

Incubating birds were those sitting tight on three checks or where an egg was seen. Chicks present on 19 August were assumed to have fledged.

Table 2. Breeding success of European shags on the Isle of May in 2005

	Total incubated	*Other nests*	*Young fledged*			*Total*	*Fledging success per completed nest*
			1	*2*	*3*		
Maidens	3	1	1	0 0		1	0.33
Pilgrim's Haven	2	1	0	0 0		0	0
Mill Door (N)	4	5	0	1 0		2	0.50
Mill Door (S)	5	2	0	2 0		4	0.80
Horse Hole	8	2	1	0 1		4	0.50
North Horn	13	4	3	1 0		5	0.38
Tarbet	5	1	0	2 0		4	0.80
Low Light	2	3	0	0 0		0	0
Mean ± se							**0.42±0.11**
Total	**42**	**19**	**5**	**6 1**		**20**	**0.48**

Notes:

No nests were built in the plots at South Ness, Lady's Bed Stack, South Horn, Chatterstanes, North of Pilgrim's Haven, South Face, Bishop's Cove or Colm's Hole in 2005.

Two large young on 22 August were assumed to have fledged.

Table 3. Breeding success of black-legged kittiwakes on the Isle of May in 2005

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	28	5	3	15	9	4	0	17	0.61
South Horn	59	3	6	14	24	21	0	66	1.12
Pilgrim's Haven	23	1	0	6	7	10	0	27	1.17
South Face	20	3	1	3	10	7	0	24	1.20
Colony 4	54	0	2	11	19	24	0	67	1.24
Hide Face	29	2	6	7	9	13	0	35	1.21
Cornerstone	111	7	2	28	37	46	0	129	1.16
Lock (S)	21	0	0	21	0	0	0	0	0
Loch (N)	76	4	4	63	11	2	0	15	0.20
Greengates	52	0	5	22	8	22	0	52	1.00
Bishop's Cove	31	0	20	12	12	7	0	26	0.84
Horse Hole	8	0	3	3	2	3	0	8	1.00
Iron Bridge	34	0	13	6	15	13	0	41	1.21
Rona	38	1	7	7	12	19	0	50	1.32
Tarbet	62	3	19	54	7	1	0	9	0.15
Low Light	14	0	1	14	0	0	0	0	0
Colm's Hole	15	0	0	9	1	5	0	11	0.73
Mean ± se									**0.83± 0.11**
Total	**675**	**29**	**92**	**295**	**183**	**197**	**0**	**577**	**0.85**

Notes:

The extent of the plots at Greengates and Cornerstone were increased and new plots were put in place at South Horn and Hide Face.

Table 4. Breeding success of auks on the Isle of May in 2005

Species	*Area*	*Pairs laying*	*Young hatched*	*Young "fledged"*	*Young leaving / pair*
Guillemot	Dense	293	236	180	0.61
	Hide / White Ledge	103	80	60	0.58
	Colony 4	254	200	151	0.59
	South	44	36	31	0.70
	Cornerstone	251	204	164	0.65
	Mean ± se				**0.63±0.02**
	Total	**945**	**756**	**586**	**0.62**
Razorbill	Hide / White Ledge	33	24	22	0.67
	Colony 4	64	37	27	0.42
	South	23	16	14	0.61
	Cornerstone	80	66	48	0.60
	Mean ± se				**0.57±0.05**
	Total	**200**	**143**	**111**	**0.55**
Puffin	Lady's Bed	46		31	0.67
	Kirkhaven	62		41	0.66
	Burrian	35		24	0.69
	Rona	41		33	0.80
	Mean ± se				**0.71±0.03**
	Total	**184**		**129**	**0.70**

Notes:

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, 1992-2005

Species	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Northern fulmar	0.47 (129)	0.44 (121)	0.47 (122)	0.48 (126)	0.44 (135)	0.37 (136)	0.35 (120)
European shag	0.87 (181)	0.21 (80)	0.68 (74)	0.84 (131)	1.05 (105)	0.92 (109)	0.85 (125)
Black-legged kittiwake	0.61 (1062)	0.07 (1034)	0.16 (861)	0.40 (874)	0.56 (825)	0.40 (822)	0.02 (683)
Common guillemot	0.85 (745)	0.76 (797)	0.79 (775)	0.81 (805)	0.82 (786)	0.77 (842)	0.73 (852)
Razorbill	0.86 (105)	0.72 (119)	0.69 (134)	0.62 (143)	0.63 (140)	0.71 (132)	0.57 (134)
Atlantic puffin	0.87 (184)	0.69 (182)	0.85 (189)	0.84 (180)	0.78 (173)	0.65 (166)	0.54 (179)
	1999	*2000*	*2001*	*2002*	*2003*	*2004*	***2005***
Northern fulmar	0.47 (115)	0.37 (143)	0.26 (134)	0.48 (131)	0.44 (109)	0.21 (97)	**0.27 (135)**
European shag	0.33 (58)	1.48 (127)	1.53 (135)	1.66 (130)	1.83 (156)	0.25 (103)	**0.48 (42)**
Black-legged kittiwake	0.20 (616)	0.97 (545)	0.61 (459)	0.47 (477)	0.77 (423)	0.29 (476)	**0.85 (675)**
Common guillemot	0.66 (870)	0.73 (942)	0.63 (975)	0.68 (955)	0.68 (1014)	0.50 (984)	**0.63 (945)**
Razorbill	0.52 (142)	0.68 (149)	0.60 (167)	0.65 (167)	0.59 (177)	0.54 (190)	**0.55 (200)**
Atlantic puffin	0.58 (181)	0.73 (132)	0.78 (185)	0.72 (174)	0.77 (195)	0.60 (196)	**0.71 (184)**

Notes:

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.

Appendix 2: Annual return rates

Table 6. Annual return rates of adult seabirds on the Isle of May, 1990-2005

Species	*No. seen in 2004*	*No. seen in 2005*	*Return rate (%)*						
			2004-05	*2003-04*	*2002-03*	*2001-02*	*2000-01*	*1999-00*	*1998-99*
Kittiwake	152	106	69.7	81.8	84.2	73.5	81.2	72.9	73.1
Guillemot	360	302	83.9	90.1	87.0	87.0	89.6	91.6	90.2
Razorbill	52	44	84.6	84.3	77.8	83.8	82.9	66.7	86.9
Puffin	222	171	77.0	87.9	85.2	83.5	90.5	82.8	88.2
Shag	151	55	36.4	82.2	92.7	92.2	89.8	89.4	65.8
	1997-98	*1996-97*	*1995-96*	*1994-95*	*1993-94*	*1992-93*	*1991-92*	*1990-91*	*1989-90*
Kittiwake	66.2	78.7	75.8	72.7	79.5	80.8	80.7	84.2	78.7
Guillemot	94.6	91.8	88.9	95.6	95.0	95.0	93.3	91.0	94.9
Razorbill	65.5	82.1	56.6	92.6	84.5	91.5	89.8	79.6	75.0
Puffin	85.5	90.7	90.1	93.0	93.1	84.0	86.8	71.4	63.3
Shag	93.6	91.1	93.6	88.5	13.4	79.6	79.9	82.8	74.0

Notes:

Only birds which had definitely bred in 2004 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.

Appendix 3: Chick diet

Table 7. Food of young black-legged kittiwakes and European shags on the Isle of May during chick-rearing in 2005

	Black-legged kittiwake	*European shag*
No. of regurgitations	116	16
Range of dates	26 June-1 August	3 July-4 August
Total weight (g)	1417	606
% regurgitations with sandeels	100	56.3
with Gadidae	12	56.3
with Clupeidae	44	12.2
with flatfish	0	6.3
with butterfish	0	56.3
with Cottidae	0	6.3
% (by weight) of sandeels in sample	92	40.6
% (by number) of sandeels in sample	93	76.6
Lengths of most sandeels (cm)	6	7-8
Other remains identified	Small crustacea (3 samples), Gobidae (2), pipefish Syngnathidae (2), polychaete worms (1)	Eelpout *Zoarces viviparus,* sea mouse *Aphrodite,* small crab

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.

Table 8. Food of young common guillemots on the Isle of May in 2005

	No. of sandeels				*No. of Clupeidae*				*No. of Gadidae*		
	minute	*small*	*medium*	*large*	*minute*	*small*	*medium*	*large*	*minute*	*small*	*medium*
Length (cm)		8	10	13		8	10.5	12		6	8
All-day watches											
20 June		2	1			3	34			3	
23 June		1				19	66	2		3	1
24 June		1	4			17	218	5			
27 June						23	88	1		1	
30 June		3				9	66	2		3	
4 July			1			10	84	5			
7 July						8	89	5		2	6
Other records											
11 June - 22 July		69	36	2		67	1774	32		97	35
Total		**76**	**42**	**2**		**156**	**2419**	**52**		**109**	**42**

Notes:

There was also a single small squid on 18 June.

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 2005

	Sandeels			*Single Clupeidae*			*Several Clupeidae*		
	small	*medium*	*large*	*small*	*medium*	*large*	*Small*	*medium*	*large*
All-day watches									
24 June	56	4			1	1		1	
30 June	22				2	1			
Other records									
14 June – 22 July	578	31	1	6	31	1	8		
Total	**656**	**35**	**1**	**6**	**34**	**3**	**8**	**1**	

Notes:

All the small sandeels appeared to be 0 group.

Fifteen loads of small sandeels also had a 1-2 small clupeids and 1 load of small clupeids also contained a few small sandeels.

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

Most data were collected by Chris Thaxter and Sue Lewis

Table 10. Food of young Atlantic puffins on the Isle of May, June to August 2005

	Sample size	*Mean*	*s.e*
a) Load weight (g)	226	9.52	0.17
b) Fish/load	229	13.4	0.49
c) Numbers and lengths of fish (mm)			
Sandeels *Ammodytes sp*.	2799	55.7	0.17
Unidentified Clupeid (*Clupeidae)*	105	45.2	0.71
Sprat *Sprattus sprattus*	55	102.8	1.96
Cod *Gadus morhua*	3	53.0	1.53
Saithe *Pollachius virens*	45	48.3	1.64
Goby *(Gobiidae)*	14	39.6	1.24
Unidentified Gadid (Gadidae)	1	50.0	
Rockling *sp*. (Gadidae)	18	34.8	0.96
Whiting (Merlangius merlangus)	2	62.5	5.5

Note:

Most of the Clupeidae category were probably small sprat, most of the Gadidae were probably whiting. The gobies were probably crystal gobies *Crystallogobius linearis*. In addition, 1 sample contained a small squid (23 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, 1986-2005

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
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
2005	4.5	21

Notes:

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). In 2005 observations were made on 100-300 broods between 17 and 31 July.

Table 12. Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2005

	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*	*2005*
Shag	99	100	98	<50	87	95	98	96	49	41
Kittiwake	81	94	81	84	92	76	94	91	79	92
Guillemot	44	79	21	22	43	18	22	15 2		1
Puffin	88	86	86	52	90	68	94	86	78	71

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 al l years except 2004, 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, 1986-2005

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
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
2005	30 May	1.73