

JNCC Report

No. 315

**Isle of May
seabirds studies in 2000**

J Bull, S Wanless and M P Harris

Centre for Ecology and Hydrology
Hill of Brathens
Banchory
Aberdeenshire
AB31 4BW

August 2001

This report should be cited as:
Bull J, Wanless S & Harris M P. 2001
Isle of May seabirds studies in 2000
JNCC Report No 315

© JNCC, Peterborough/CEH, Banchory. Year 2001

For further information please contact:
Joint Nature Conservation Committee
Dunnet House
7 Thistle Place
Aberdeen
AB10 1UZ

ISSN 0963-8091

JOINT NATURE CONSERVATION COMMITTEE
PETERBOROUGH
CEH, BANCHORY
AB31 4BW

Report number: 315

Contract number: F90-01-311 (CEH Project C00453)

Date received: September 2000

Report title: Isle of May seabird studies in 2000

Contract title: Seabird Monitoring Programme, Isle of May studies.

Contractor: Centre for Ecology and Hydrology (NERC)

Restrictions: None, but those wishing to quote are advised to contact the contractor, as some results will be updated in the light of future research.

Comments: The Isle of May is one of JNCC's Seabird Monitoring Programme key sites, and JNCC continued to fund aspects of CEH's work there in 2000 (in particular monitoring of breeding success, adult survival and food of a range of species). Scottish Natural Heritage carried out monitoring of the numbers of some species; the results of this work will be reported upon separately.

Distribution (50 copies in total):

Joint Nature Conservation Committee

JNCC report collection (Peterborough)	2 copies
Mark Tasker	1 copy
Jim Reid	1 copy
Seabirds and Cetaceans (Aberdeen)	1 copy + top copy + spares

English Nature

HQ library and Survey & Monitoring Services	2 copies
---	----------

Scottish Natural Heritage

Research & Advisory Services Library	1 copy
Dr. Andrew Douse, Research & Advisory Services	1 copy
Cupar (C. Gallacher, Library & Isle of May NNR)	3 copies

Countryside Council for Wales

HQ library and Senior Monitoring Ecologist	2 copies
--	----------

Others

AT Smail, Copyright libraries agent	5 copies
British Library, Legal Deposit Office, Boston Spa	1 copy
Chadwyck-Healey Ltd, Cambridge	1 copy
BIOSIS UK, York	1 copy
Natural History Book Service	5 copies
Iain Bainbridge, Scottish Office	1 copy
Dr Sarah Wanless/CEH library	5 copies
Forth Seabird Group	2 copies
RSPB Scotland HQ library	1 copy
RSPB Research Dept/HQ library, Sandy	2 copies
BTO library, Thetford	1 copy
Alexander library, EGI, Oxford	1 copy
Waterston library, SOC, Edinburgh	1 copy

cc cover note: JNCC publications

Contents

	Page
1. Summary	7
2. Background	8
3. Methods	9
4. Results	11
5. Conclusions	17
6. Acknowledgements	17
7. References	18
8. Further reading	18

Tables

Table 1	Breeding success of Northern fulmars on the Isle of May in 2000	19
Table 2	Breeding success of European shags on the Isle of May in 2000	19
Table 3	Breeding success of black-legged kittiwakes on the Isle of May in 2000	20
Table 4	Breeding success of auks on the Isle of May in 2000	20
Table 5	Breeding success (young reared per pair breeding) of seabirds on the Isle of May, 1989-2000	21
Table 6	Annual return rates of adult seabirds on the Isle of May 1987-2000	21
Table 7	Food of young black-legged kittiwakes and European shags on the Isle of May in 2000 during the chick-rearing period	22
Table 8 -	Food of young common guillemots on the Isle of May during chick-rearing in 2000	22
Table 9	Food of young razorbills on the Isle of May in 2000	23
Table 10	Food of young Atlantic puffins on the Isle of May, 28 May to 13 July 2000	23
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	24
Table 12 -	Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2000	24
Table 13	Black-legged kittiwake first-egg dates and clutch-sizes on the Isle of May, 1986-2000	25

1. Summary

In general 2000 was a highly productive season for Isle of May seabirds with many species breeding early and/ or successfully.

- European shags had an excellent breeding season. Breeding started early and new breeding attempts continued throughout the season. Overall breeding success (1.48 chicks per incubated nest averaged across plots) was the highest recorded since intensive monitoring began in 1986.
- Black-legged kittiwakes had their most successful season since 1989. Laying started earlier than in recent years, and few pairs failed. The average breeding success, averaged across plots, was 0.97 chicks per completed nest. Success expressed as the total number of chicks fledged from the total number of completed nests in the plots, i.e. the pooled average, was slightly lower (0.94).
- Razorbills and Atlantic puffins had average breeding seasons producing 0.68 and 0.73 chicks per laying pair respectively. Although the breeding success of common guillemots was higher than in 1999 it was still slightly below the long-term mean for this species.
- In contrast to the other species, Northern fulmars had a relatively poor year with breeding success estimated at 0.37 chicks per incubating pair.
- The return rate of colour-ringed shags (89.4%) in 2000 was much higher than in 1999. The return rate of kittiwakes (72.9%) was very similar to 1999 (73.1%). The return rates of guillemots (91.6%) was slightly below the long-term average (94.8%), whereas razorbill and puffin return rates (66.7% and 82.8% respectively) were within the normal range.
- Sandeels predominated in the diet of all species monitored in 2000 and feeding conditions appeared to be good.

For the first time since 1989 there was no commercial sandeel fishery on the Wee Bankie. The two species with the highest reliance on sandeels (kittiwake and shag) had breeding success well above their long-term averages, and in the case of the kittiwake returned to the high levels typical of the pre-fishery period. The effect was less obvious in species like auks that are less reliant on sandeels, while breeding success of fulmars, for which sandeels do not appear to form an important item in the diet, was below the long-term average.

These results provide circumstantial evidence that the presence of an industrial fishery on the Wee Bankie might have an adverse effect on some components of the Isle of May seabird community and that closure of the fishery can potentially have an immediate and positive effect on seabird productivity. However, more intensive work on kittiwake diet throughout the season indicated that 0-group sandeels appeared early and grew fast. Thus we cannot rule out the possibility that environmental factors which affect the growth and life history strategy of sandeels, contributed to the enhanced success. A new EU funded project starting in 2001 aims to make progress in these issues.

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 be 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 kittiwakes, guillemots, razorbills and puffins. Monitoring of 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 shags, kittiwakes, guillemots, razorbills and puffins;
- 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 that lie 30-50 km east of the island. These are known to be important fishing grounds 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 north-eastern England in 2000. Data collected for the SMP in 2000 were therefore of key importance for assessing whether

1. there was any evidence of a rapid response to this management, and/or
2. the response varied between species.

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 positions of apparently incubating birds in ten areas were marked on photographs on 28 and 31 May and 3 June. At sites where birds appeared to be incubating on all three visits, or where an egg was seen, breeding was assumed to have occurred. These sites were checked again on 26 July (by M. Moeller-Holtkamp) to determine those which had hatched eggs. A final check was made on 23 August (by J. Wilson) when chicks present were assumed to have fledged successfully.

European shag

The positions of nests in fourteen areas were marked on photographs and the state and contents of these nests were checked weekly from 30 March until 10 August. On the last check, no eggs remained and one nest containing small young was assumed to have failed. All other nests contained medium size or large young that were assumed to fledge successfully. As some of the sample areas contained few breeding pairs, breeding success figures are given both averaged across the plots and summed over the plots.

Black-legged kittiwake

The positions of nests in fifteen areas were marked on photographs and the presence or absence of an incubating bird, or the number of young present at each were noted. Initial checks were made on 20 and 21 May and 3 June. The first check of chicks was on 11 July, two days after the first fledged young on the island was recorded. Three further checks were then made, the last being on 28 July when all remaining chicks were large and were assumed to have fledged successfully. As some of the sample areas contained few breeding pairs, breeding success figures are given both 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 marked with stakes in each of four areas on 29 and 30 April (earlier checks indicated that most pairs had laid by this date). The staked burrows were re-checked on 26 June (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 locate birds 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 puffins are concentrated at Little Hole (where most burrows are individually numbered). The overall reduction in kittiwake numbers on the island has resulted in there now being insufficient birds nesting at Tarbet and at Low Light to keep enough birds colour-ringed for adequate survival monitoring. Hence, the area used for monitoring survival of adults kittiwakes has been expanded to include Cornerstone and nearby cliffs.

Food of chicks

Food regurgitated by young shags, young kittiwakes and by adult kittiwakes feeding young, plus fish loads dropped by adult puffins caught in mist-nets were collected. These regurgitates and food loads were weighed, the fish identified and, where possible, measured (total length, snout to tip of tail). Fish otoliths were extracted from regurgitates and identified. 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 2000 or in published works.

Records were kept of fish brought to young guillemots and razorbills during two all-day watches and opportunistically on most other days. Uneaten fish were collected from breeding ledges to confirm identifications and size assessments for guillemots. Fish sizes for razorbills were also estimated by comparison with the bird's bill, but it was not possible to collect samples for 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 egg was seen on 21 May. Breeding success was 0.37 young per incubating pair (Table 1). This is slightly below the 95% Confidence Intervals for the 1986-99 average (0.43, CI=0.38-0.48). The methodology used is not designed to determine when breeding attempts fail, but most losses apparently occurred during incubation.

European shag

Year 2000 saw the highest productivity figure (1.48 ± 0.11 young per incubated nest averaged across the plots, Table 2) since monitoring began in 1986 and was well above the 95% Confidence Interval for the 1986-99 average (0.76, CI=0.59-0.94). Of 144 nests built in the study plots, 127 pairs laid and incubated eggs and a total of 194 chicks fledged, giving a pooled breeding success estimate of 1.53 chicks fledged per incubated nest. Twenty-two (23%) of 96 successful pairs raised three young.

The timing of breeding was relatively early, with the first egg laid on 22 March (back-calculation from hatch date of earliest brood on 23 April). All viable clutches in the monitoring plots had hatched by the time of the last check on 10 August, but a few clutches were still being incubated elsewhere on the island.

Black-legged kittiwake

Conditions appeared very favourable for kittiwake breeding throughout the season. Breeding started earlier than in recent years and losses were low (Table 3). Nest building was rapid after heavy rain softened the ground on 25 and 26 April, and two single eggs were noted on 5 May. The first chick hatched on 4 June and the first young fledged on 9 July. Ninety-two percent of pairs initiating nest building completed a nest, however 13% of pairs occupying a site did not start a nest. The mean clutch size was 1.89 (Table 13).

Conditions during chick rearing appeared very good and brood neglect (2% of broods of one chick; 8 % of broods of two) was at its lowest level since 1986 (Table 11). Within the study plots, six pairs (2% of successful pairs) reared three young and elsewhere on the island several more broods of three also fledged successfully. Breeding success in 2000 was 0.97 ± 0.12 chicks per completed nest averaged across the plots but slightly lower, 0.94 chicks per nest, when the results from all areas were pooled. This was attributable to the very high success at Horse Hole where there were only three nests (Table 3). These values were substantially higher than all but one (1989) of the previous 12 years (Table 5). However, the total number of pairs breeding continued to decline, with only 545 nests being built in the study plots (616 in 1999). The pattern of decline was not uniform and the biggest proportion of losses between 1999 and 2000 occurred in the North Loch (46%) and Low Light (42%) plots.

Common guillemot

Although productivity (0.73 young per pair laying) was higher than in 1999 (0.66 young per pair laying) (Tables 4 and 5), the figure was still slightly lower than the 95% Confidence Interval for the previous 19 seasons (0.78 - 0.82). The first egg was laid on 21 April. The median laying dates in the earliest and latest areas followed were 4 and 14 May respectively. The first young left on the night of 16/17 June. Chick losses (8%) were closer to the 5-6% typically recorded prior to 1998 and weights of chicks near fledging were also close to the long-term mean.

Razorbill

Timing of breeding was normal for the Isle of May, with the first egg being laid on 29 April. Breeding success (0.68 young per pair laying) (Tables 4 and 5) was very similar to the long-term mean (0.69). As usual, most losses occurred at the egg-stage and survival of hatched chicks to fledging was high (95%).

Atlantic puffin

The first adults carrying fish were seen on 20 May, but the first young fledged on 29 June, 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 first week of April. The overall success rate (0.73 chicks fledged per egg laid) was the highest for three years (Tables 4 and 5), although still slightly below the long-term mean (0.76, 95% CI=0.69-0.83).

For several years the stability of certain puffin breeding areas was of major concern as vegetation grew poorly. However, the vegetation has recovered well over the last two seasons so that in most areas ground stability is now good and erosion is not a problem.

Adult survival 1999-2000

Not every adult alive is seen each year and thus the return rates in 2000 of birds seen in 1999 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 2000, 31 shags, 31 kittiwakes, nine puffins, four razorbills and 46 guillemots were newly colour-ringed.

European shag

The return rate of colour-ringed shags in 2000 (89.4%) was much higher than in 1999, but only two of 38 birds missing in 1999 were seen. Conditions were very favourable for breeding in 2000, and many first-time breeders recruited into the population. It is therefore probable that most birds not seen in 1999 are dead and that the previously suspected high over-winter mortality between 1998 and 1999 was real.

Common guillemot

The return rate of adult guillemots (91.6%) was a slight increase from 1999. However, even when allowing for an average of 1-2% of birds not seen in any year returning in later years, the survival between 1999 and 2000 still appears to be lower than the long-term average.

Black-legged kittiwake

The return rate of kittiwakes (72.9%) was very similar to the 1999 value and remains at a level below that needed to maintain a stable population.

Figure 1 Breeding success (young reared per pair breeding) of seabirds on the Isle of May, 1986 - 2000

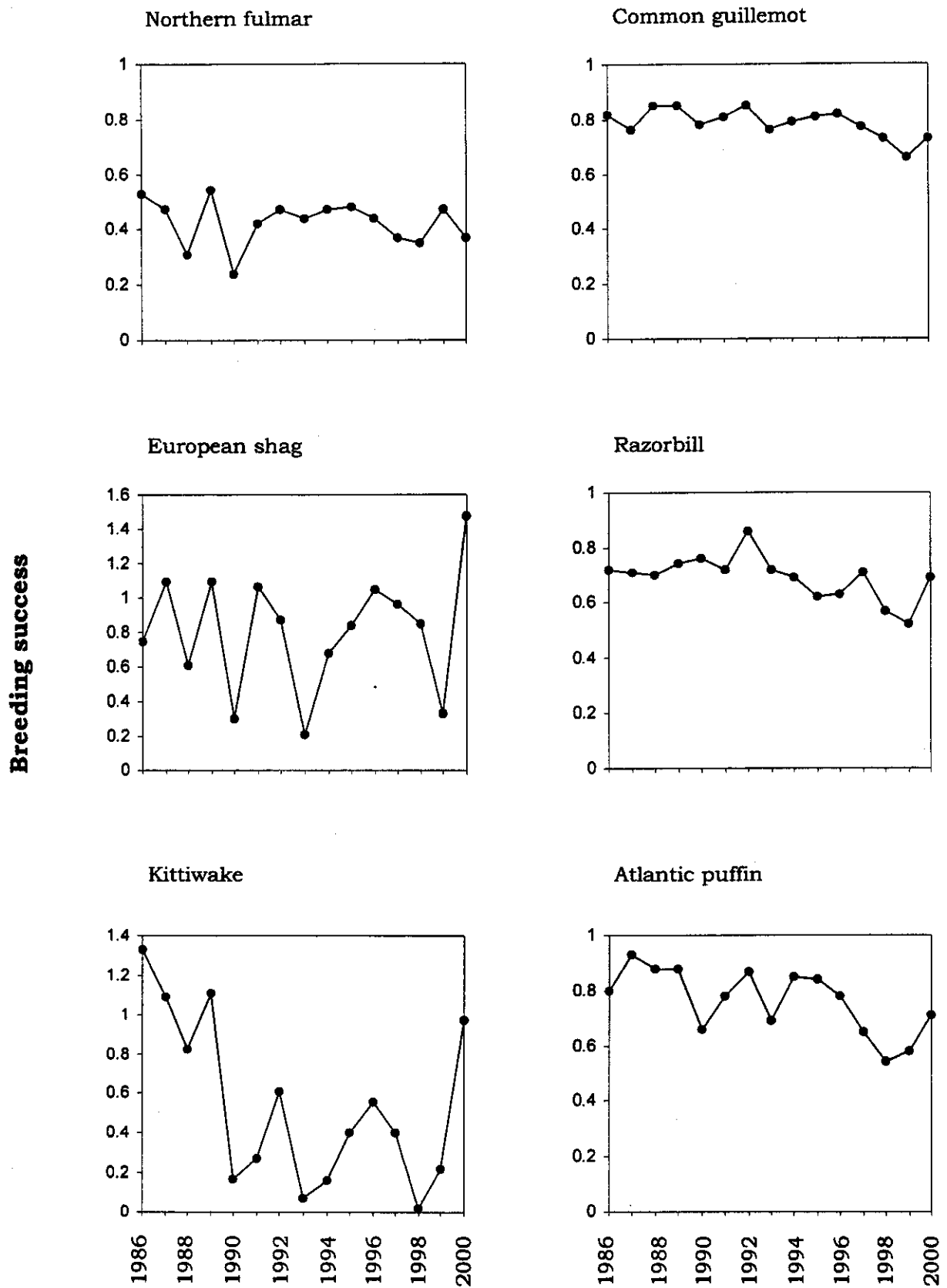
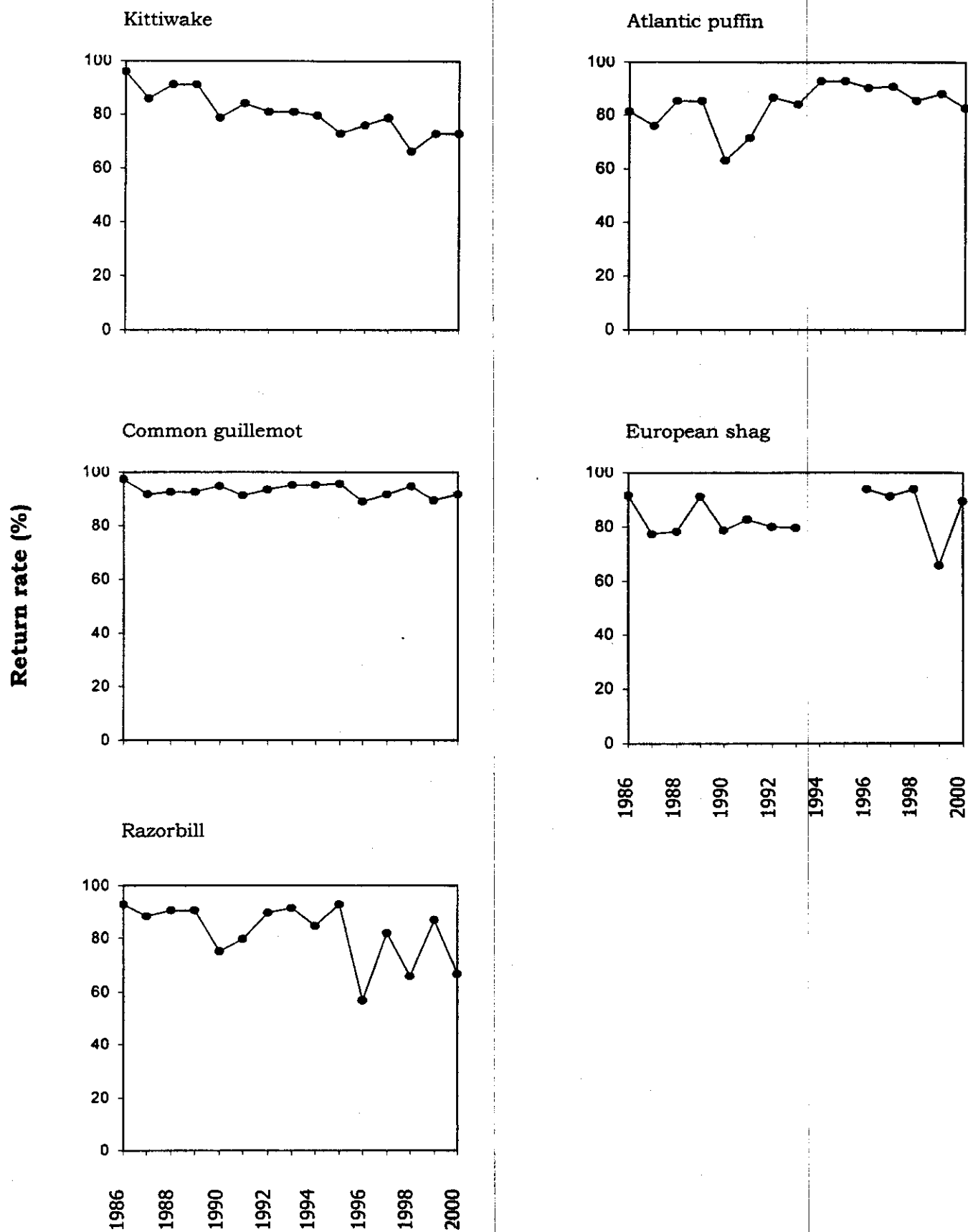


Figure 2 Annual return rates of adult seabirds on the Isle of May 1986 – 2000

Atlantic puffin

The return rate of puffins (82.8%) was slightly lower than in 1999 and remains below the long-term average.

Razorbill

The return rate of razorbills (66.7%) was lower than in 1999 and seems to continue the trend of year to year fluctuations that have been apparent throughout the study period.

Food of young

Species accounts are given in Tables 7-9 and 10, and a comparison of sandeel biomass data with recent years' results is given in Table 12 and Figure 3.

European shag

In contrast to 1999, when there were problems obtaining regurgitates from shags, food samples were readily obtained in 2000. In marked contrast to 1999, these consisted mainly of sandeels *Ammodytes* spp. Of 37 regurgitates obtained between 2 June and 7 July, 92% contained sandeels and in terms of biomass sandeels accounted for 87% of the total (Tables 7 and 12). Two percent of sandeels were 0-group and 98% were older age classes. Butterfish *Pholis gunnellus* (8 - 16 cm long) accounted for 6% of biomass whilst sprats *Sprattus sprattus* (6 - 17 cm long) and dragonet *Callionymus* spp. (9 cm long) accounted for 4% and 3% respectively.

Black-legged kittiwake

All kittiwake food samples collected during the chick-rearing period contained sandeels (Table 7). Of 5,059 otoliths examined, 98% were from sandeels. Of these, 98% were 0-group fish with an estimated length range of 3 - 13 cm ($n = 4553$ otoliths examined). In terms of biomass, sandeels contributed 92% by weight of the diet with clupeids (mostly sprat) and gadoids contributing only 4%. All of the gadoids were whiting *Merlangius merlangus* (16 - 19 cm long) and were presumably trawler discards.

Common guillemot

In contrast to the previous two seasons, over half (58%) of 938 fish delivered to young guillemots were sandeels. The majority of these were assigned to the small and medium size categories corresponding to fish averaging 9 and 13 cm long respectively. (Table 8). The remaining fish were mostly clupeids (42% by number); predominantly in the small size category corresponding to fish averaging 9 cm long. Most clupeids were probably sprat, but one 15 cm long herring *Clupea harengus* was collected from a ledge. Gadoids accounted for less than 1% of food items by number. The average weight of a prey item (calculated from lengths) was 3.9 g. This was rather low compared to the long-term average of 7.4 g (19 years), but had little effect on the chicks as they fledged at normal weights. In biomass terms, sandeels comprised 43% of the diet.

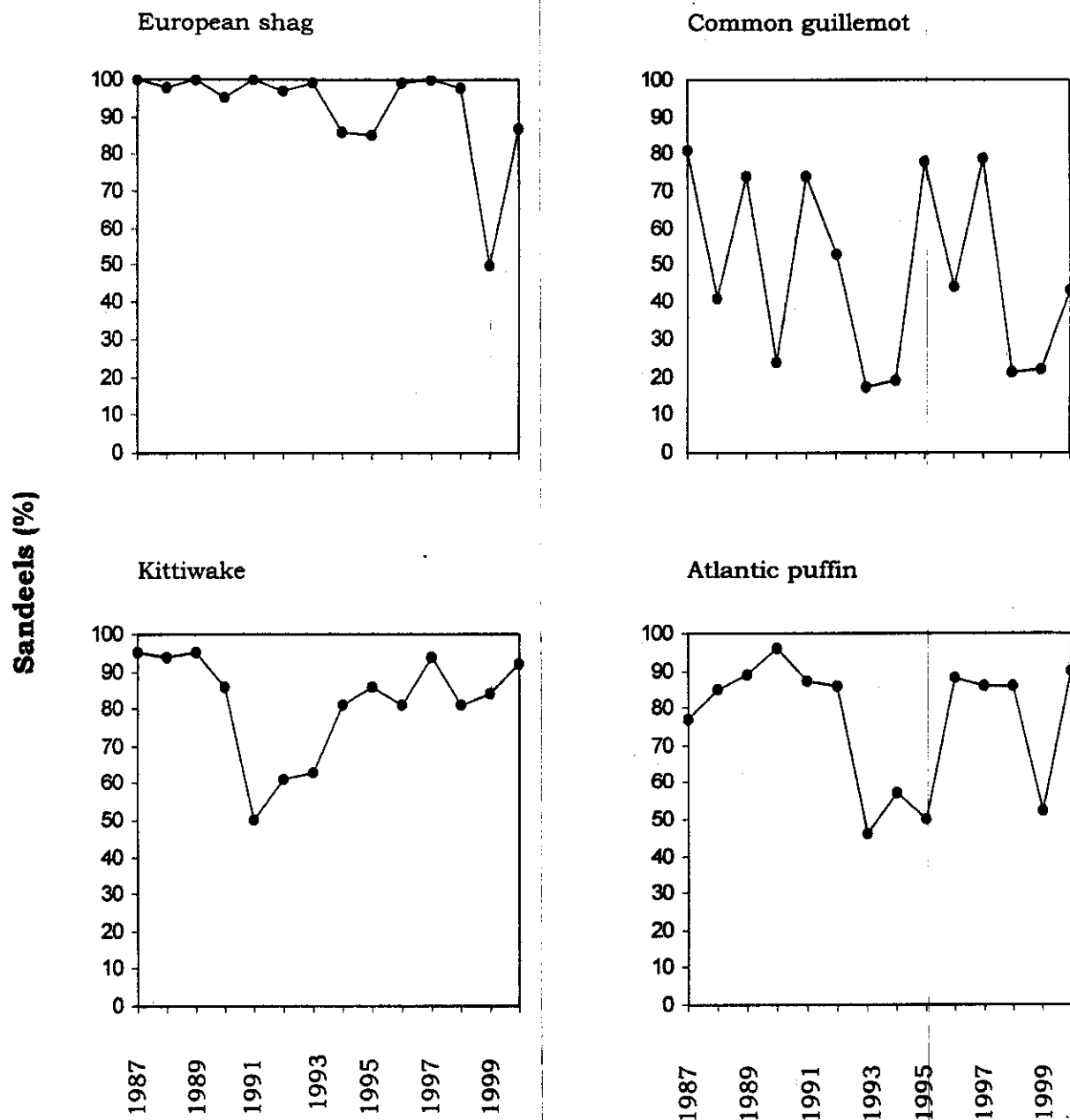
Razorbill

Most loads of fish brought to razorbill chicks were made up of several small sandeels, although some food loads contained clupeids (Table 9).

Atlantic puffin

Sandeels made up 91% by number of the diet of young puffins with the proportion in biomass terms being 90% (Table 12). Most sandeels were 0-group with a mean length of 7 cm; only 60 (3%) were longer than 10 cm (Table 10). Many of the clupeids were small, and thus difficult to identify, but most appeared to be sprat. The mean load size of 9.87 g was close to the normal weight for this species.

Figure 3 Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2000



5. Conclusions

For the first time since 1989 there was no commercial sandeel fishery on the Wee Bankie. Breeding success figures for the two species with the highest reliance on sandeels (kittiwake and shag) were well above long-term averages, and in the case of the kittiwake returned to the high levels typical of the pre-fishery period (Figure 1). The effect was less obvious in species such as auks that are less reliant on sandeels, while breeding success of fulmars, for which sandeels do not appear to form an important item in the diet, was below the long-term average.

These results provide circumstantial evidence that the presence of an industrial fishery on the Wee Bankie might have an adverse effect on some components of the Isle of May seabird community and that closure of the fishery can potentially have an immediate and positive effect on seabird productivity. However, more intensive work on kittiwake diet throughout the season indicated that 0-group sandeels appeared early and grew fast. Therefore, we cannot rule out the possibility that environmental factors e.g. hydrographic conditions, affecting the growth and life history strategy of sandeels, were involved. This uncertainty will be addressed in a new multi-disciplinary EU project scheduled to start in 2001 that aims to investigate Interactions between the marine environment, predators and prey: implications for sustainable sandeel fisheries (IMPRESS)¹. This short-term, highly intensive, project will complement the long-term approach of the SMP.

6. Acknowledgements

We are grateful to Andy Easton for providing transport to and from the Isle of May throughout the season, and to Jared Wilson and Ian Patterson of Scottish Natural Heritage. We are also grateful to Suki Finney, Liz Humphreys, Robin Cox, Sheila and Debbie Russell, Mark Newell, Tom and Ann Dudney for providing help during the 2000 field season. We are especially grateful to Mareike Moeller-Holtkamp and Tracey Begg.

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

8. Further reading

The following is a list of additional papers on Isle of May seabirds published or in press since publication of the 1999 report.

- Bull, J, Lewis, S, Wanless, S, Harris, M P, Hammond, D J and Wright, P J (2000) Interactions between kittiwakes and sandeels in an area exploited by a sandeel fishery. *Poster presented at both the BES Winter 1999/2000 and Seabird Group 2000 Conferences*
- Finney, S K, Wanless, S, Harris, M P, Monaghan, P (in press) The impact of gulls on puffin reproductive performance: an experimental test of two management strategies. *Biological Conservation*
- Harris, M P, Wanless, S and Webb, A (in press) 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*
- Harris, M P, Wanless, S, Darling, I and Gallagher, C (2000) Breeding birds of the Isle of May, Firth of Forth, 1972-99. *Scottish Birds*, **21**, 6-14
- Harris, M P, Wanless, S and Rothery, P (in press) Adult survival rates of shag, guillemot, razorbill, puffin and kittiwake on the Isle of May 1986-96. *Atlantic Seabirds*
- Harris, M P, Wanless, S, Rothery, P, Swann, R L, and Jardine, D (2000) Survival of adult Common guillemots *Uria aalge* at three Scottish colonies. *Bird Study*, **47**, 1-7
- Harris, M P and Tasker, M (1999) Conservation value of ringing seabirds in Britain and Ireland. *Ringing and Migration*, **19** (suppl.), S95 - 106
- Rindorf, A, Wanless, S and Harris M P (2000) Effects of changes in sandeel availability on the reproductive output of seabirds. *Marine Ecology Progress Series*, **202**, 241-252
- Wanless, S, Finney, S K, Harris, M P and McCafferty, D (1999) Effect of the diel light cycle on the diving behaviour of two bottom feeding marine birds: the blue-eyed shag *Phalacrocorax atriceps* and the European shag *P. aristotelis*. *Marine Ecology Progress Series*, **188**, 219-224

Table 1 Breeding success of Northern fulmars on the Isle of May in 2000

Area	Incubating birds	No. probably hatched	Young Fledged
1. Cleaver	11	7	3
2. Pilgrim's Haven	3	2	1
3. Cornerstone	10	6	4
4. Loch (S)	50	25	21
5. Greengates	33	16	11
6. Horse Hole	7	3	3
8. Tarbet	19	8	6
9. Low Light	7	5	4
10. Colm	3	0	0
Totals	143	72	53
		Overall mean	0.37 fledged/ pair

Notes:

No pairs bred in plot 7 (Rona) in 2000.

Incubating birds were those sitting tight on three checks or where an egg was seen. Chicks present on 23 August were assumed to have fledged. M. Moeller- Holtkamp and J. Wilson made hatching and fledging checks, respectively.

Table 2 Breeding success of European shags on the Isle of May in 2000

Area	Total incubated	Other nests	Young fledged			Total young Fledged	Mean young fledged per incubated nest
			1	2	3		
3. Maidens	13	2	3	6	1	18	1.38
4. South Horn	0	1	0	0	0	0	0
5. Chatterstones	3	0	1	1	0	3	1.00
15. Pilgrims Haven (S)	15	1	2	6	4	26	1.73
8. Mill Door (N)	9	3	1	7	1	18	2.00
9. Mill Door (S)	14	2	4	4	1	15	1.07
10. Bishop's Cove	0	1	0	0	0	0	0
16. Horse Hole	25	4	3	7	7	38	1.52
17. North Horn	19	2	3	12	3	36	1.89
12. Tarbet	10	0	1	3	1	10	1.00
18. Low Light	8	1	1	3	2	13	1.63
14. Colm's Hole	11	0	1	5	2	17	1.55
						Mean \pm se	1.48 \pm 0.11
Total	127	17	20	54	22	194	1.53

Notes:

No nests were built in Colony A or South Face in 2000

The mean of plots was calculated excluding plots 4 and 10 where no birds were recorded incubating

Table 3 Breeding success of black-legged kittiwakes on the Isle of May in 2000

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		
1. Cleaver	28	7	2	17	5	6	0	17	0.61
2. Pilgrim's Haven	17	1	4	1	11	5	0	21	1.24
3. South Face	24	1	3	2	7	15	0	37	1.54
4. Colony 4	66	5	0	14	21	30	1	84	1.27
5. Cornerstone	68	3	11	12	17	38	1	96	1.41
6. Loch (S)	25	6	15	18	4	3	0	10	0.40
7. Loch (N)	76	5	10	31	25	18	2	67	0.88
8. Greengates	30	1	4	13	10	7	0	24	0.80
9. Bishop's Cove	40	3	13	15	9	16	0	41	1.03
10. Horse Hole	3	1	0	0	0	3	0	6	2.00
11. Iron Bridge	43	2	11	25	10	7	1	27	0.63
12. Rona	29	3	1	23	4	2	0	8	0.28
13. Tarbet	71	9	10	36	21	13	1	50	0.70
14. Low Light	11	2	4	5	5	1	0	7	0.64
15. Colm's Hole	14	1	3	4	4	6	0	16	1.14
								Mean \pm se	0.97 \pm 0.12
Total	545	50	91	216	153	170	6	511	0.94

Note:

Fledging success is also expressed as the total number of chicks fledged divided by the total number of completed nests in order to take account of the low number of sites at Horse Hole.

Table 4 Breeding success of auks on the Isle of May in 2000

Species	Area	Pairs laying	Young hatched	Young 'fledged'	Young Leaving/pair
Guillemot	Dense	299	242	226	0.76
	Hide/White Ledge	104	76	70	0.67
	Colony 4	261	213	201	0.77
	South	49	40	36	0.73
	Cornerstone	229	182	167	0.73
	Mean \pm se				0.73 \pm 0.02
Razorbill	Hide/White Ledge	25	16	16	0.64
	Colony 4	52	33	30	0.58
	South	11	9	9	0.82
	Cornerstone	61	47	42	0.69
	Mean \pm se				0.68 \pm 0.05
Puffin	Lady's Bed	43	?	31	0.72
	Kirkhaven	46	?	33	0.72
	Burrian	48	?	37	0.77
	Rona	45	?	31	0.69
	Mean \pm se				0.73 \pm 0.02

Table 5 Breeding success (young reared per pair breeding) of seabirds on the Isle of May, 1989-2000

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

Notes:

The number of pairs followed is given in brackets. See text for details of methods.

Table 6 Annual return rates of adult seabirds on the Isle of May 1987-2000

Species	No. seen in 1999	No. alive in 2000	Return rate (%)					
			1999-2000	1998-1999	1997-98	1996-97	1995-96	1994-95
Kittiwake	133	97	72.9	73.1	66.2	78.7	75.8	72.7
Guillemot	370	339	91.6	90.2	94.6	91.8	88.9	95.6
Razorbill	33	22	66.7	86.9	65.5	82.1	56.6	92.6
Puffin	209	173	82.8	88.2	85.5	90.7	90.1	93.0
Shag	123	110	89.4	65.8	93.6	91.1	93.6	?

Species	Return rate (%)						
	1993-94	1992-93	1991-92	1990-91	1989-90	1988-89	1987-88
Kittiwake	79.5	80.8	80.7	84.2	78.7	90.9	86.0
Guillemot	95.0	95.0	93.3	91.0	94.9	92.4	91.5
Razorbill	84.5	91.5	89.8	79.6	75.0	90.5	88.1
Puffin	93.1	84.0	86.8	71.4	63.3	85.2	76.1
Shag	?	79.6	79.9	82.8	78.7	90.9	86.0

Notes:

Only birds that had definitely bred in 1999 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. Hence, 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 in 2000 during the chick rearing period.

	<i>Kittiwake</i>	<i>Shag</i>
No. of regurgitations	138	37
Range of dates	4 June - 26 July	2 June - 7 July
Total weight (g)	2658	1647
% regurgitations with sandeels	100	92
with Gadidae	7	0
with Clupeidae	20	3
% (by weight) of sandeels in sample	92	87
% (by numbers) of sandeels in sample	98	88
Lengths of majority of sandeels (cm)	6 - 9	9 - 12
Other remains identified	Sprat (88 otoliths, 1 - 6cm) Whiting (4 otoliths, 16 - 19cm) Small pelagic crustacea (1 sample)	Sprat (43 otoliths, 6 - 17cm) Dragonet (1 fish, 9cm) Butterfish (9 fish, 8 - 16cm)

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 2000

	<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	13	16	9	10	15	5
All day watches								
21 June	0	142	51	0	144	11	1	0
25 July	1	88	6	1	78	11	1	0
Other records								
30 May - 8 July	1	192	64	0	113	28	3	2
Total	2	422	121	1	335	50	5	2

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 2000

	<i>Single sandeel</i>			<i>Several sandeels</i>			<i>Clupeidae</i>
	<i>small</i>	<i>medium</i>	<i>large</i>	<i>small</i>	<i>medium</i>	<i>large</i>	
<i>All day watches</i>							
21 June	0	4	2	37	2	0	2
24 July	1	0	0	15	1	0	13
<i>Other records</i>							
4 June - 2 July	4	3	3	22	3	1	3
Total	5	7	5	74	6	1	18

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, 28 May to 13 July 2000

	<i>Sample size</i>	<i>Mean</i>	<i>s.e.</i>
a) Load weight (g)	230	9.87	0.26
b) Fish/load	230	8.8	0.30
c) Numbers and lengths of fish (mm)			
Sandeels <i>Ammodytes</i> sp.	1812	72.9	0.30
Clupeidae	102	67.3	1.47
Cod <i>Gadus morhua</i>	8	43.3	2.55
Rockling	55	39.3	0.47
Saithe <i>Pollarchius virens</i>	1	52.0	-
Gadidae	4	49.3	4.37
Squid <i>Alloteuthis</i> sp.	1	12.0	-

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.

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

Notes:

Figures are based on 50-200 broods in the same areas each year and are the means of checks made on alternate days between the dates the first neglected chick was noted and close to the start of fledging in the areas. (Details of methods are given in Wanless & Harris, *Scottish Birds* 15 (1989):156-161). Checks in 2000 were made by R. Cox between 22 June and 5 July.

Table 12 Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1987-2000

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

	1994	1995	1996	1997	1998	1999	2000
Shag	86	85	99	100	98	<50	87
Kittiwake	81	86	81	94	81	84	92
Guillemot	19	78	44	79	21	22	43
Puffin	57	50	88	86	86	52	90

Notes:

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, 1986-2000

<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

Note:

Data for 2000 collected by E. Humphreys and R. Cox

