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ISLE OF MAY SEABIRD STUDIES IN 1992

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Annual Report to Joint Nature Conservation Committee

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C O N T E N T S

SUMMARY

1. Breeding success of puffin, guillemot and razorbill was high, that of fulmar, shag, terns and puffin moderate to good. The kittiwake had a better season than in 1990 and 1991 but production was still low and many chicks died at or soon after fledging.

2. Adult survival of shag, kittiwake, guillemot and razorbill were high, that of the puffin was better than over the last two winters but still lower than in the 1970s.

3. An investigation of the effects of timing and number of checks on the calculated value for annual survival rate of colour ringed kittiwakes indicated that checks in the pre-laying period gave the best estimate of survival rate. Checks of study colonies during the chick-rearing in 1992 did not improve the estimate of survival although such checks in 1991 had found some individuals not seen at other times. In 1992, seven adults which had bred in the study areas were found elsewhere on the island. More time may have to be given over to increasing coverage of these other places.

4. Sandeels predominated by number in the diet of all species. However, 61% (by weight) of the regurgitations collected from kittiwake were Gadidae

or Clupeidae and Clupeidae made up 47% of the diet of young guillemots.

1. BACKGROUND

The Joint Nature Conservation Committee (formerly the Nature Conservancy Council) has a responsibility to advise on the condition of the natural marine environment. Seabirds are one of the more important components of this environment, and Britain has internationally important populations of several species. JNCC has designed a programme that will allow the numbers of selected species of seabirds to be monitored at several colonies. In addition, selected colonies have been targetted for more detailed monitoring of reproductive performance and annual survival rates. These selected colonies are geographically spread in order to give as full a coverage as possible of British waters. The Isle of May NNR is a very suitable site in East Britain.

The Institute of Terrestrial Ecology (ITE) has had a long-term interest in seabirds on the Isle of May. Since 1986, ITE has received NCC/JNCC support for a more formalised seabird monitoring programme. Long-term studies on numbers, breeding success, adult survival, chick growth and chick food are underway on up to 8 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, NCC/JNCC has placed a contract with ITE to:

(a) ensure that the breeding success of fulmar *Fulmarus glacialis*, shag *Phalacrocorax aristotelis*, kittiwake *Rissa tridactyla*, common tern *Sterna hirundo*, arctic tern *S. paradisaea*, guillemot *Uria aalge*, razorbill *Alca torda* and puffin *Fratercula arctica* is monitored.

(b) monitor adult survival of shag, kittiwake, guillemot, razorbill and puffin.

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

(d) assess feeding frequency of guillemot and puffin chicks.

(e) undertake special studies on species agreed between the nominated officer and the contractor. The Department of the Environment, BP Exploration, and Scottish Natural Heritage also supply funds for the seabird studies on the Isle of May.

2. METHODS

2.1 Breeding success

The standardized methods used involved minimal disturbance of birds and are described in detail in 'Development of monitoring of seabird populations and performance' - Final Report to NCC for contract HF3-08-15.

Fulmar: The positions of apparently incubating birds were marked on photographs on 26 and 30 May and 3 June; sites where birds appeared to be incubating on all three visits, or where an egg was seen, were assumed to have been bred at. These sites were checked again on 15 July, and on 16 August when those with a large chick were assumed to have been successful.

Shag: The positions of nests in 14 areas were marked on photographs and the state and contents of these nests were checked weekly from mid-March until 1 September. I assumed that all the single nest with eggs at the last check failed and that all the few remaining large young survived.

Kittiwake: The position of nests in 15 areas were marked on photographs and the presence or absence of an incubating bird, or the number of young present at each was checked on 20 May, 11 June and on 11 July - the day that the first young had fledged. A severe gale on 12/13 July resulted in some chicks being lost and the check was repeated on 16 July. A final check of nests which had small or medium chicks on 16 July was made on 21 July by when most of the chicks had died. Many recently-fledged young died at the end of July so my estimate of production will be slightly too high.

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

Puffin: In each of four areas, samples of 50 burrows where an egg could be felt on 1 - 3 May (when most pairs had laid) were staked and re-checked on 2 - 4 July (when chicks were near fledging). All large young were assumed to have fledged as were young from empty burrows where there were many droppings, moulted down and feather sheaths.

Common and arctic terns: Nests with eggs were staked and counted on several dates in May and the cumulative total was taken as an estimate of the population. Regular checks were made of the number of fledged young at the fringe of the colony.

2.2 Adult survival rates

For all species these were based on sightings of individually colour-ringed birds. The areas in which birds were originally marked were checked regularly throughout the season and adjacent areas were also searched from time to time in an attempt to pick up birds which had moved. Searches were made for birds which had moved out of the study areas. These later searches are extremely time consuming, and superficially unrewarding, but they are essential if accurate estimates of survival are to be obtained.

To investigate how the number and timing of checks influenced the total number of colour-ringed kittiwakes seen during the season, the two study plots were visited 13 and 6 times during the pre-laying and chick rearing periods, respectively. During each check the observer remained until all the birds present had been checked. The actual number of birds alive was taken as all those ever seen during the breeding season, that is during these 19 checks, some checks in March and opportunistic observations at other times.

2.3 Food of chicks

Food regurgitated by young shags and kittiwakes and loads of fish dropped by adult puffins caught in mist-nest were collected, weighed and the fish identified and, where possible measured (total length to tip of tail). Where necessary, fish otoliths were extracted and examined. Records were kept of fish brought to young guillemots and razorbills and uneaten fish were collected from breeding ledges.

2.4 Feeding frequency

All-day watches were made of marked sites/burrows of guillemot, razorbill and puffin from permanent hides. Observers took 2 - 3 hr shifts, recorded the number of feeds brought to each chick and where possible, noted the species and size of the fish.

3. RESULTS

3.1 Breeding success

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

Fulmar: Breeding success was 0.47 young per incubating pair.

Shag: This was a very early breeding season but severe gales washed many nests away on several dates in March and April. Therefore breeding was very extended with eggs being laid from mid-March until early August. Breeding success was 0.87 young per incubating pair (Table 2).

Kittiwake: Breeding success varied greatly from plot to plot (0.27 - 1.04 young fledged per completed nest; Table 3). The overall mean succes, 0.61, was double that recorded in 1991 and treble that in 1990, but was still well below the figures found when monitoring commenced in the late 1980s (Table 5).

The whole island nest count was c. 6% higher than that in 1991 (see report to NCCS). This appeared to be due to many pairs not breeding in 1991. The clutch-size (mean = 1.83, n = 110) was similar to that in recent years - 1991 1.86 (n = 125), 1989 2.04 (n = 130) and 1990 1.82 (n = 98). The first egg was seen on 30 April, which compares with 6 May 1991, 2 May 1990 and 27 April 1989. Many dead recently

fledged young were found in the second half of July but it is not possible to determine the proportion. Despite the improved nesting-success, more broods were left unattended (13% of single chicks, 28% of two chicks) compared with 1991 (2% and 13%; Table 12).

Guillemot: Laying commenced early (first egg 15 April) and the first young left on the night of 7/8 June. Success was high (0.85 young leaving per pair laying).

Razorbill: Breeding appeared normal and success was high (0.86 young leaving per pair laying).

Puffin: Breeding appeared normal, although laying was protracted with some pairs not hatching chicks until mid-July. The success rate of 0.87 chicks per egg laid although higher than that in 1990 (0.66) and 1991 (0.78) was about normal.

Terns: A total of 585 nests were counted. Observations of incubating birds indicated a ratio of arctic:common terns of 5.3:1. Fledging success was difficult to assess with most young apparently leaving the island, with adults, soon after capable of flight, but was thought to be fairly good and certainly better than in recent years. For more details see Wardens' Report.

3.2 Adult survival

Not every adult alive is seen each year and thus the survival rates between 1991 and 1992 of 79.9% for shag, 80.7% for kittiwakes, 93.3% for guillemot, 89.8% for razorbill and 86.8% for puffin must be minimum estimates. Sample sizes are given in Table 6.

The figure for puffins was low despite considerable effort being put into looking for colour-rings and Chris Wernham attempting to catch all the puffins nesting in the main study colony in front of Little Hide. Time will tell whether these missing birds had indeed died or missed a year's breeding. The fact that in 1992 we recorded 10 (15% of those missing) puffins not seen in 1991 suggests (a) that some established breeders may not breed annually and (b) mortality of adults was high in the 1990-91 winter. The 1991-92 survival was higher but still not up to the levels recorded during the 1970s.

In 1992, 3 (out of 26) kittiwakes seen in 1990 but not seen in 1991 were recorded, as were 7 (of 27) missing shags and 10 (of 65) missing puffins. Incorporating these records increases the 1990-91 survival figures for these three species to 86.0% (from 84.2%), 87.2% (from 82.8%) and 75.8% (from 71.4%), respectively (Table 15). A single missing guillemot was also found which increased the 1990-91 survival to 92%.

During 1992 a further 15 kittiwakes, 12 shags, 30 puffins and 56 guillemots were colour-ringed.

3.2.1 A check on the efficiency of finding colour-rings - M.P. Harris & J. Calladine

In general, seabirds have high rates of adult survival from one year to the next. Therefore even small differences in annual survival rate can have important consequences in how long an individual lives, and hence how many offspring it produces during its life-time (Coulson & Wooler 1976). The determination of accurate survival rates is time consuming as colonies must be checked repeatedly to find which birds have survived overwinter. Each year since 1986, we have monitored the survival of breeding kittiwakes *Rissa tridactyla* on the Isle of May, Firth of Forth, Scotland. This note reports on the results of repeated visits to our study areas to determine at which stage of the breeding season it would be most efficient to check our marked birds.

Methods

Between 1986 and 1992, between 4800 and 8100 pairs of kittiwakes bred on the Isle of May (personal counts). Starting in 1986 we have colour-ringed breeding adults in two groups totalling 150 - 200 pairs, 200 m apart among the 1000 pairs breeding on the east side of the island. Birds were caught with a noose on the end of a 7 m-long fishing pole during the late-incubation or early brooding period. Each was ringed with a BTO ring and given a unique

combination of three colour rings. Individuals were sexed from their head-and-bill measurement (Coulson *et al.* 1983) but, as we could not detect any differences in the frequency or patterns of re-sighting of males and females in either area, we have pooled results.

Kittiwakes on the Isle of May are extremely tame and viewing conditions of birds in the breeding area are good. Re-sightings of birds were made using binoculars and a telescope on a tripod from ranges varying from 10 to 30 m. All checks were made by J.C. He remained in the area until he had identified all the birds present which were standing or could be made to stand up by reasonable disturbance. This took up to 1 hr. Checks were spread throughout the day.

We divided the breeding season into three - the pre-laying period (up to the time the first eggs were laid), incubation and chick-rearing (after the first young had hatched). The number of counts made in each period are given in Table 1. During the pre-laying period in 1991, we only recorded whether or not a bird had survived overwinter and not on which days it had been seen.

Table 1. Number of checks of colour-ringed kittiwakes

	1991		1992	
	n	Range	n	Range
Pre-laying period	15	1 - 30 April	13	7 April - 1 May
Incubation period	5	10 - 30 May	-	
Chick-rearing period	9	1 - 20 June	6	17 June - 10 July

Within each breeding period we examined the effect of increasing the number of counts on the accumulated total of individuals which would be recorded. We did this by selecting 20 combinations of counting dates at random and expressing the mean of the 20 totals of birds recorded as a percentage of all birds known to have been present that season. Each mean is plotted in Figure 1. Where 20 combinations were not possible (e.g. for the 13 counts in the pre-laying period of 1992) we used all possible counts.

Breeding success was monitored by regular checks of nests (Harris 1987). Data on the proportions of broods left unattended were based on daily checks of 50 - 100 broods during the middle of the day from when the first neglected chicks were seen until the start of fledging (Wanless & Harris 1989).

Results

In 1991, 147 kittiwakes colour-ringed in previous years were recorded in the study area. Of these, 136 (92.5%)

were seen prior to the birds laying, 118 (80%) during chick-rearing and 57 (39%) during incubation. Of the 11 birds alive but not seen before laying, one was seen only during incubation, three only during chick-rearing and seven during both periods. Breeding success was very low in 1991, with only 7 (3%) of 153 nests in the area rearing any chicks.

A total of 134 colour-ringed individuals were recorded in 1992. All but one of these was seen at least once during the 13 pre-laying season checks. The missing bird had been present in March but then disappeared. The six checks during chick-rearing recorded 81 individuals - 60% of the total. Breeding success in 1992 was moderate with 88 (43%) of 205 nests rearing at least one chick.

During June and July 1992, seven "missing" adults were discovered elsewhere on the island; three were definitely breeding, three could have been breeding (as they were seen on empty nests) and one was at a roost. Three of the seven had been last recorded in the study area in 1991, one in 1990, two in 1989 and one (which has lost one colour-ring) in either 1989 or 1990.

As expected, the more checks which were made, the more colour-ringed birds were detected. Figure 1 suggests that at least 8 - 10 checks are needed to detect the bulk of birds present at any particular stage of breeding. Checks

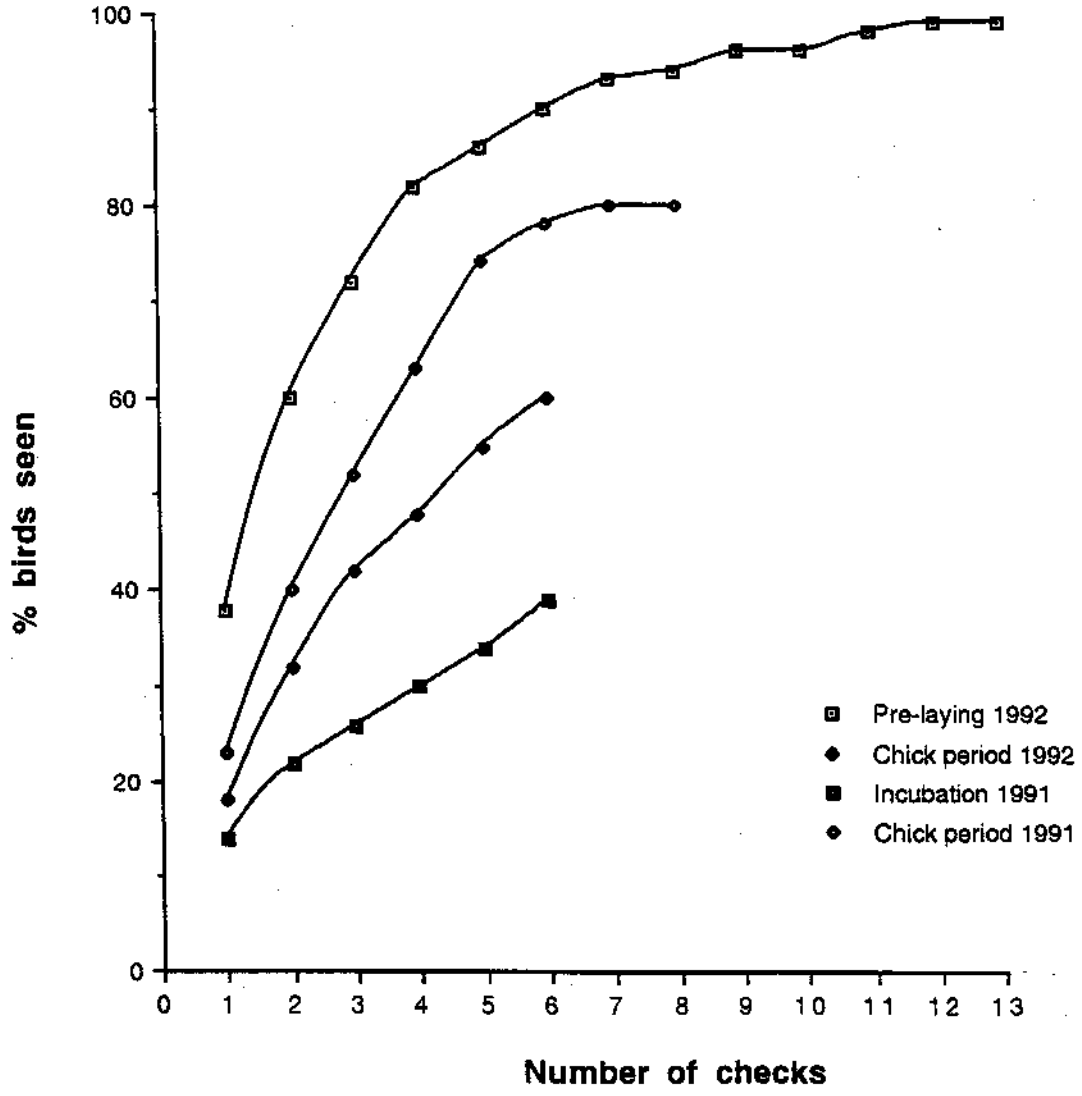

Figure 1. The percentage of adult kittiwakes known to be present in the study area recorded by increasing numbers of checks in 1991 and 1992.

during incubation resulted in very few colour-ringed birds being seen, whereas checks prior to laying were much more productive.

Discussion

The most efficient time to check for colour-rings was before the birds started to lay. During this period, both members of a pair were often present as were some birds which had lost nest-sites and which later disappeared, presumably to breed elsewhere on the island. In 1991, but not 1992, a few additional birds were detected by making additional checks later in the season. The low rate of sightings during the chick-rearing period was presumably due to birds spending much time away. Feeding trips of Isle of May kittiwakes can be longer than a day and when a feeding bird returns its mate often leaves the colony within 1 - 2 minutes (Wanless 1992, Wanless & Harris in press). We could, perhaps have increased the totals of birds seen by lengthening the time that we spent at the colony, e.g. on Fair Isle checks last two hours (Harvey & Orsman 1991), but as with most fieldworkers, we have other calls on our time in June.

The difference in the sighting rates during chick-rearing in 1991 and 1992 were presumably associated with differences in breeding success - 1991 being a poor breeding season, 1992 much better. In 1991, we wondered whether some adults which had failed might have left the

colony during June and were surprised therefore, that we found a lower proportion of adults in 1992. The situation would appear to be more complicated as despite the breeding success over the whole island being much lower in 1991 than 1992 (0.27 cf 0.61 young per nest, personal data), fewer broods were left unattended in the latter year (broods of one chick 2% cf 13%; broods of two young 13% cf 28%).

Breeding kittiwakes are usually considered to have a very high colony fidelity (Coulson & Wooler 1976) but in any colour-ringing study it is inevitable that over a period of years some birds will move and breed outwith the study area. Even so, to find six such birds either breeding or possibly breeding in a single season was unexpected. These birds were all seen during the chick-rearing period. This was partly due to intensification of searching then but, and perhaps as important, it is easier to see colour-ringed kittiwakes when many of the guillemots *Uria aalge*, with which they share these cliffs, have finished breeding and have left the colony. Between 1986 and 1992 the mean annual survival of breeding kittiwakes on the Isle of May was 89.0% ± SE 2.8 (n = 6, annual samples of birds varied 161-176), so the missing of even one or two birds will have a noticeable impact on the calculated survival values. There has been significant decline in annual survival rate during the period of the study from 98.7% in 1986-87 to 80.1% in 1991-92 (r^2 = 0.85, P <0.01, after arcsine transformation). Part, but probably not all, of this may

be due to a greater chance of "missing" birds from the earliest years being detected subsequently.

We consider that the most efficient use of time in trying to find the maximum number of birds is to check as frequently as possible early in the season, to make a few visits later to check for late-returning birds and, during the late chick phase to search for missing individuals in nearby areas or colonies.

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3.3 Food of young

Sandeels made up the bulk of the food items recorded from young shags, other items were a butterfish, a small Gadidae and a small squid. Sandeels were the commonest food of young kittiwakes (88% by number) (Table 7). Most sandeels in kittiwake regurgitates were 7 - 10 cm long (i.e. 0-group or young of the year) while those from shags were slightly longer at 10 - 12 cm. Sandeels contributed c. 61% by

weight of the kittiwake regurgitations, the remainder being two whiting (12 cm long) and a 10 cm sprat.

Of 637 fish delivered to young guillemots, 371 (58%) were sandeels (Table 8); most of these were 10 - 12 cm long and it was calculated that sandeels made up 53% of the diet by weight. The remainder was made up of a wide size range of herring and sprat.

Razorbills brought mainly medium to large loads of sandeels 6 - 10 cm long with a few very small Clupeidae and unidentifiable fish (Table 9).

Puffins fed their young on small sandeels, augmented by small saithe early in the season and small rockling late in the season (Table 10). No sprats and few herring (all small) were recorded. The mean weight of a load of fish was 8.2 g, which is the lowest annual mean recorded since 1976.

3.4 Feeding frequency

Two all-day watches were made on different groups of guillemot and razorbill chicks, and 15 watches of puffin burrows (Table 11). On average, young guillemots received 4.3 feeds per day, young razorbills 2.9 feeds per day and young puffins 5.0 feeds per day.

4. CONCLUSIONS

4.1 Shags had their earliest ever first-egg dates in 1992 and guillemots also started early. However, whereas guillemots had, overall, an early season many shags lost nests and clutches in gales during March and April which resulted in an exceptionally prolonged laying period (almost 5 months). Indeed, some shags were laying a month after the first young had fledged. Puffins also had a longer-than-normal laying period of ca 3 months.

When compared with recent years and studies elsewhere, the 1992 breeding season was very good for puffin, guillemot and razorbill, moderate to good for shag, terns and fulmar.

In 1991, flocks of kittiwakes and gannets *Sula bassana* were again seen feeding around the island after an absence of many years. A few such feeding flocks were recorded in 1992 but were far from regular. More kittiwake broods were neglected in 1992 than had been in 1991 but breeding success was higher, at least up to the time the young fledged.

The general impression is that whereas conditions in the 1980s appeared uniformly good for breeding, they are now more variable or unpredictable. Evidence from several sources suggests that although these seabirds are breeding satisfactorily, they are fairly close to the food limit.

4.2 Assuming that the normal proportion of 1992 missing birds of all species are found in future years, the adult survival rates of guillemot, razorbill, kittiwake and shag from 1991 to 1992 were normal.

Updated estimates of survival rates for these few species in recent years are given in Table 15. Those for shag range 79.8 - 92.5, close to the average of 85.4% calculated for 1965 - 82 (Aebischer 1986; J. Anim. Ecol. 55, 613 - 629). The figures for kittiwake 80.1 - 98.7 are markedly higher than the 30 year mean of 78% for males and 82% for females and a combined-sex annual mean of 65% for 1982-85, at North Shields (Aebischer & Coulson 1990; J. Anim. Ecol., 59, 1063 - 1071). The few comparable data for guillemot and razorbill suggest that the Isle of May survival rates are also high.

4.3 The current estimates of annual survival rates of breeding puffins are 80 - 90%. These compare with an average figure of 96% in the 1970s which was obtained by the same methods in the same study areas. Simple modelling indicates that the species is unlikely to be able to maintain its numbers on the Isle of May unless (a) immature survival has increased substantially, (b) the age of first breeding has declined or (c) there is substantial immigration. The available data suggest that none of these has occurred. A separate project is addressing this problem.

4.4 It is easy to colour-mark large numbers of adult seabirds but much sustained effort is needed to find them again. In birds with high survival rates even a few missed individuals can result in great proportional error in the estimated survival. My approach is to make a major effort (by daily searches) to find colour-rings early in the season when birds are easily seen and to carry out searches for specific missing birds later in the season. As many of these birds nest in front of permanent hides and/or are used for other studies many areas are under daily surveillance. There is a growing amount of evidence which suggests that, although it is impossible to be sure that a bird is not present, a small (and annually variable) proportion of adults which have bred at least once do not breed each year, although some may visit the colonies later in the season or, in the case of the shag, return to roost during the subsequent autumn.

It is difficult to assess objectively the effort put into searching for colour-rings but our check on kittiwakes suggests that <u>at least</u> 10 thorough checks must be made to obtain a reasonable survival estimate.

4.5 Sandeels accounted for at least 85% (by weight) of the food fed to young of shag and puffin and 50 - 60% of that to young kittiwake and guillemot. There is a suggestion that sandeels are becoming less dominant in the diet of young kittiwakes (Table 13) which might conceivably be

linked with lower nesting success. The rest of the diet of young kittiwakes and puffins consisted of Gadidae and Clupeidae. The alternative prey of guillemots was Clupeidae.

Although the feeding frequency of auks has been fairly high in 1986 - 92, there has been a marked reduction in the food intake of young guillemots (Table 14). As yet this has not been mirrored in a reduction in breeding success but there is little scope for any further reduction before breeding must be adversely effected.

5. THE FUTURE

5.1 During the 1970s and for most of the 1980s conditions were very favourable for seabirds in the North Sea. Conditions started to change in the north in the early 1980s with reductions in numbers and/or breeding success of a range of species. There is good evidence that, at least for guillemots (Harris (1991): Population changes in Common Murres), that change started in the north and gradually moved south. Population declines started significantly earlier and were fastest in northern colonies.

5.2 Conditions appear to be changing in the Firth of Forth as shown by low survival of adult puffins, low recruitment of some cohorts of young guillemots, poor breeding of kittiwakes, delayed (and ?irregular) breeding of shags,

reduction in the intake of young guillemots and sporadic food shortage in several species.

5.3 The seabird studies on the Isle of May were sometimes criticized in the past as being 'too academic' as they were concerned with populations which were expanding. However, we now have a solid base against which to assess changes in biology and survival which are occurring in a range of species. Only by detailed studies in such circumstances can we hope to understand the processes, and hence the likely causes, involved in population declines and breeding failure.

5.4 BP Exploration and NERC are supporting research into the puffin, and a major part of this is a new initiative into the recruitment of the puffin.

5.5 A separate study on guillemot recruitment has shown that this is the critical link in the population dynamics of the species on the Isle of May. This work was carried out by Duncan Halley in 1990 and 1991 but he is now writing up his PhD. Additional funding must be found to continue this work.

5.6 In 1991 several Danish fishing vessels were trawling for sandeels at the Marrs and Cockenzie Banks to the northeast of the Isle of May. Many more were reported to be fishing there in 1992. There is no evidence that such

fishing has an adverse effect on the availability of food for seabirds. However, if such a fishery develops it will be important to continue the monitoring of seabird breeding and food of seabirds on the Isle of May.

5.7 SNH are now financing the monitoring of the breeding populations of all seabird species on the Isle of May. The Isle of May is one of JNCC's main seabird biological monitoring sites. Hopefully both will continue to give adequate financial support for it to continue.

6. ACKNOWLEDGEMENTS

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7. PUBLICATIONS ON ISLE OF MAY SEABIRDS

The following have either been published since the last report or are <u>in press</u>.

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Table 1. Fledging success of fulmars on the Isle of May in 1992.

	Area	Incubating birds	No. probably hatched	Young fledged
1.	Cleaver	9	9	4
2.	Pilgrim's Haven	3	3	1
3.	Cornerstone	8	8	4
4.	Loch (S)	49	36	22
5.	Greengates	27	20	11
6.	Horse Hole	10	9	6
7.	Rona	1	0	0
8.	Tarbet	15	15	9
9.	Low Light	5	4	3
10.	Colm's Hole	2	1	1
	Total	**129**	**105**	**61**

0.47 fledged/pair

Notes: Incubating birds were those sitting tight on three checks or where an egg was seen. Chicks present on 16 August were assumed to have fledged.

Checks were made by J. Calladine.

Table 2. Fledging success of shags on the Isle of May in 1992. The last check was made on 1 September.

	Area	Total incubated	Young fledged 1	2	3	Other nests	Total young fledged	Mean young fledged per incubated nest
1.	Lady's Bed (South)	4	0	0	1	3	3	0.75
2.	Lady's Bed (Mid)	6	1	1	0	2	3	0.50
3.	Maidens	14	0	4	0	6	8	0.57
4.	South Horn	5	0	3	0	1	6	1.20
5.	Chatterstanes	5	2	1	0	1	4	0.80
7.	South Face	3	2	0	0	1	0	0.67
8.	Mill Door (N)	20	4	2	3	0	17	0.85
9.	Mill Door (S)	28	3	7	1	6	20	0.71
10.	Bishop Cove	3	0	2	1	0	7	2.33
11.	Rona	14	1	1	2	3	9	0.64
12.	Tarbet	40	6	10	1	8	29	0.73
13.	Colm's Hole (S)	9	3	2	0	2	7	0.78
14.	Colm's Hole (N)	30	3	7	2	6	23	0.77
	Mean ± SE =							**0.87 ± 0.13**

Notes: (1) No pairs bred in Plot 6

(2) On the last check there were still five broods each with one large young (which were assumed to be going to fledge) and one clutch still being incubated (which was assumed to have failed).

Table 3. Fledging success of kittiwakes on the Isle of May in 1992.

	Area	Completed nests	Trace nests	Fledged young/ nest			Total young produced	Fledging success per completed nest	Fledging success all nests (incl. trace)
				0	1	2			
1.	Cleaver	42	0	22	11	9	29	0.69	0.69
2.	Pilgrim's Haven	27	0	13	9	5	16	0.70	0.70
3.	South Face	33	2	17	7	9	25	0.76	0.71
4.	Colony 4	118	9	61	42	15	72	0.61	0.57
5.	Cornerstone*	102	2	35	44	23	90	0.88	0.87
6.	Loch (S)	104	3	76	22	6	34	0.32	0.32
7.	Loch (N)	112	3	55	39	18	75	0.67	0.65
8.	Greengates*	98	1	24	46	28	102	1.04	1.03
9.	Bishop's Cove	74	0	34	30	10	50	0.68	0.68
10.	Horse Hole	7	0	5	2	0	2	0.29	0.29
11.	Iron Bridge	49	0	25	12	12	36	0.73	0.73
12.	Rona	62	2	35	20	7	34	0.55	0.53
13.	Tarbet	153	0	75	58	20	98	0.64	0.64
14.	Low Light	52	2	42	6	4	14	0.27	0.26
15.	Colm's Hole	29	2	21	7	1	9	0.31	0.29
							Mean	**0.61**	**0.60**
							SE	**0.05**	**0.06**

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

* slightly different to area covered in 1991

On the last check (21 July) there were 6 small or medium young (which were assumed to have failed, and 7 large young which were assumed to have fledged.

Table 4. Breeding success of auks on the Isle of May in 1992.

Species	Area	Pairs laying	Young hatched	Young 'fledged'	Young leaving/ pair
Guillemot	Dense	275	246	229	0.83
	Hide/White	84	71	69	0.82
	Colony 4	199	188	177	0.89
	South	46	42	39	0.85
	Cornerstone	141	127	123	0.87
	Mean ± S.E.				0.85 ± 0.01
Razorbill	Hide/White	17	16	15	0.88
	Colony 4	35	27	27	0.77
	South	12	10	10	0.83
	Cornerstone	41	38	38	0.93
	Total	105	91	90	0.86
Puffin	Lady's Bed	46	?	37	0.80
	Kirkhaven	49	?	41	0.84
	Burrian	45	?	40	0.89
	Rona	44	?	42	0.95
	Total	184	?	160	0.87

Table 5. Breeding success (young reared per pair breeding) of some seabirds on the Isle of May 1986 - 92.

Species	1986	1987	1988	1989	1990	1991	1992
Fulmar	0.53 (79)	0.47 (69)	0.31 (64)	0.54 (93)	0.24 (66)	0.42 (100)	0.47 (129)
Shag	0.75 (223)	1.09 (288)	0.61 (221)	1.09 (234)	0.30 (154)	1.06 (187)	0.87 (181)
Kittiwake	1.33 (1133)	1.09 (1291)	0.82 (1278)	1.11 (1327)	0.17 (1095)	0.27 (1172)	0.61 (1062)
Guillemot	0.82 (785)	0.76 (800)	0.85 (732)	0.85 (757)	0.78 (748)	0.81 (754)	0.85 (745)
Razorbill	0.72 (84)	0.71 (64)	0.70 (98)	0.74 (97)	0.76 (100)	0.72 (104)	0.86 (105)
Puffin	0.80 (136)	0.93 (62)	0.89 (157)	0.88 (164)	0.66 (176)	0.78 (153)	0.87 (184)

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

Table 6. Annual survival of adult seabirds on the Isle of May 1986 - 92.

Species	No. alive in 1991	No. seen in 1992	% Survival 1991/92	1990/91	1989/90	1988/89	1987/88	1986/87
Shag	184	147	79.9	82.8	74.0	78.1	77.3	91.4
Kittiwake	161	134	80.7	84.2	78.7	90.9	86.0	96.1
Guillemot	403	376	93.3	91.0	94.9	92.4	91.5	97.3
Razorbill	59	53	89.8	79.6	75.0	90.5	88.1	92.1
Puffin	287	249	86.8	71.4	63.3	85.2	76.1	81.2

Notes: (1) Only birds which had definitely bred in 1991 or earlier are included.

(2) Directly comparable figures for adult survival in earlier seasons are given. These have not been corrected for missing birds seen in later years, and so are serious under-estimates of survival.

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

(3) Details of earlier estimates are given in previous reports to NCC/JNCC.

Table 7. Food fed to young kittiwakes and shags on the Isle of May in 1992.

	Kittiwake	**Shag**
No. of regurgitations	26	33
Range of dates	6 June - 11 July	21 June - 22 July
Total weight (g)	320	1522
% regurgitations with sandeels	81	94
with Gadidae	12	6
with Clupeidae	12	0
% (by weight) of sandeels in sample	61	97
% (by numbers) of sandeels in sample	88[2)]	99 (n = 764)
Lengths (cm) of majority of sandeels	7 - 10[2)]	10 - 12
Non-sandeel remains identified	2 whiting (12 cm)	1 Gadidae (14 cm)
	1 sprat (10 cm)	1 butterfish (10 cm)
		1 squid (mantle 3.8 cm)

Notes: (1) Samples collected from chicks or adults with chicks.

(2) Counts and lengths of fish in kittiwake samples were based on otoliths in the regurgitations.

Table 8. Food of young guillemots on the Isle of May in 1992.

	Number of sandeels				Number of Clupeidae			Number of Gadidae
	minute/larval	small	medium	large	small	medium	large	
Length (cm)	**6**	**10**	**12**	**15**	**7**	**10**	**13**	**4 - 10**
All-day watches								
10 June	2	60	84	10	2	75	18	1
17 June	2	25	40	4	6	23	9	1
Other days								
12 May - 20 July	5	59	65	15	35	77	18	1
TOTAL	**9**	**144**	**189**	**29**	**43**	**175**	**45**	**3**

Note: Lengths were based on visual estimates gainst the bird's bill checked by samples of dropped fish collected from the breeding ledges.

Table 9. Food of young razorbills on the Isle of May in 1992.

	Number of loads of							
	Single sandeel			Several sandeels				
	large	medium	small	large	medium	small	Clupeidae	Small[1] fish
All-day watches								
10 June	12	0	2	12	4	7	0	5
17 June	8	7	0	12	9	0	2	3
Others								
29 May - 20 July	2	0	0	0	3	1	2	1[2]
TOTAL	**22**	**7**	**2**	**24**	**16**	**8**	**4**	**9**

Notes: (1) Apparently all non-sandeels

(2) Larval fish

Table 10. Food of young puffins on the Isle of May in 1992.

		Sample size	Mean	S.E.
a)	Load weight (g)	126	8.2	0.4
b)	Fish/load	126	6.7	0.4
c)	Numbers and lengths of fish (mm)			
	Sandeels *Ammodytes* sp.	670	71.3	0.9
	Herring *Clupea harengus**	9	64.3	4.3
	Rockling probably *Gaidropsarus ciliata*	73	42.6	1.0
	Saithe *Pollarchius virens*	76	54.3	0.9

* includes some unidentifiable small Clupeidae

Table 11. Feeding frequencies of young auks on the Isle of May in 1992.

Species	Date	No. of young	Mean (± S.E.) feeds/chick/day
Guillemot	10 June	88	4.0 ± 0.2
	17 June	28	4.7 ± 0.2
Razorbill	10 June	15	2.8 ± 0.4
	17 June	13	3.0 ± 0.6
Puffin (a)	16 June	14	3.1 ± 0.7
	25 June	17	1.8 ± 0.4
	5 July	21	5.1 ± 1.8
	13 July	22	3.7 ± 0.4
	18 July	21	5.4 ± 1.0
	22 July	20	6.6 ± 0.7
	27 July	16	10.4 ± 0.6
	31 July	14	8.1 ± 1.1
	4 August	13	5.5 ± 1.2
	8 August	9	4.8 ± 1.3
(b)	13 June	20	4.7 ± 0.6
	21 June	20	4.1 ± 1.7
	27 June	20	4.3 ± 1.9
	8 July	20	3.0 ± 0.5
	16 July	11	4.5 ± 1.1

Notes: (1) Based on all-day watches by observers taking 2 - 3 hr shifts.

(2) Puffin feeding frequencies were from watches organised by C. Wernham as part of her own research and the study funded by BP and NERC.

(3) Puffin (b) is an area not watched in previous years.

Table 12. Proportions of kittiwake broods of one and two chicks which had no adults present during daily checks in the middle of the day.

	% Unattended broods of	
Year	**One young**	**Two young**
1986	1	7
1988	31	66
1989	13	32
1990	21	45
1991	2	13
1992	13	28

Note: Figures are based on 50 - 100 broods in the same areas each year. These are means of daily checks made between the dates the first neglected chick was noted and the start of fledging in the areas. In 1992, the counts were made 24 June - 14 July. (Details of methods are given in Wanless & Harris, *Scott. Birds* 15 (1989): 156 - 161.)

Table 13. Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1986 - 92.

	1986	1987	1988	1989	1990	1991	1992
Shag	97	100	98	100	95	100	97
Kittiwake	98	95	94	95	86	50	61
Guillemot	90	81	41	74	24	74	53
Puffin	83	77	85	89	96	87	86

Notes: (1) Dates and sample sizes can be found in the contract report for respective years.

(2) Sandeels also made up the bulk of the food of young razorbills in all years but it is extremely difficult to assess the proportions in terms of biomass.

Table 14. Annual measures of daily feeding frequency and food intake (g) of seabirds on the Isle of May 1986 - 92.

		1986	1987	1988	1989	1990	1991	1992
Guillemot	Feeds/day	3.9	3.7	3.5	6.2	6.1	4.1	4.3
	Intake/day	33	37	39	25	20	17	23
Razorbill	Feeds/day	2.0	2.8	-	5.1	6.9	4.0	2.9
Puffin	Feeds/day	4.0	3.9	5.1	5.7	4.9	3.7	5.0
	Intake/day	36	43	47	53	42	31	41

Table 15. Updated estimates of survival of breeding seabirds on the Isle of May 1986 - 92.

	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Shag	92.5 (146)	83.9 (168)	87.5 (152)	83.4 (170)	87.2 (157)	79.9 (184)
Kittiwake	98.7 (176)	92.0 (176)	93.2 (163)	83.7 (179)	86.0 (165)	80.1 (161)
Guillemot	99.9 (327)	92.5 (385)	96.2 (373)	95.9 (363)	92.0 (381)	93.3 (403)
Razorbill	96.4 (56)	92.4 (61)	93.4 (61)	82.2 (62)	83.7 (49)	89.8 (59)
Puffin	90.2 (175)	86.5 (163)	91.0 (145)	82.5 (177)	75.8 (227)	86.8 (287)