
**JNCC Report**
**No: 475j**

# Isle of May seabird studies in 2014

**Newell, M., Harris, M.P., Gunn, C.M., Burthe, S., Wanless, S. & Daunt, F.**

Centre for Ecology and Hydrology
Bush Estate
Penicuik
Midlothian
EH26 0QB



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**For further information please contact:**

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough  PE1 1JY

www.jncc.defra.gov.uk

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# Summary

Following on from three mixed years, 2014 proved to be a good breeding season on the Isle of May NNR. After a late season in 2013, due largely to poor weather through much of the winter and early spring in the region, breeding in 2014 commenced on typical dates for most species.

Of the six study species, northern fulmars had the most successful season on record while European shags had an above average season and black-legged kittiwakes the most successful season since 1987. In contrast, razorbills had a poor breeding season. Return rates were similar to the long term average in all five study species. Sandeels (*Ammodytes sp.*) remained the main food of young Atlantic puffins, shags and kittiwakes. The diet of razorbills and common guillemots was dominated by clupeids. The main results are as follows:

- Northern fulmar breeding success (0.56 chicks per incubating pair) was the highest on record.

- European shags had an above average breeding season (1.58 chicks per pair). Return rate was normal at 77.7%. Diet was dominated by sandeel which occurred in 86% of samples.

- Black-legged kittiwakes had an excellent season with productivity (1.17 chicks per completed nest) being the highest since 1987. Adult return rate (78%) was close to the long term average. The proportion of sandeel in the diet (77% by biomass) was also typical as was the proportion of clupeid (19% by biomass).

- Guillemots had an average breeding season (0.72 chicks leaving per pair). Return rate of adults (88.7%) was also normal. Adults fed their chicks almost entirely on medium-sized sprats (94% by number).

- Razorbill breeding success (0.53 chicks leaving per pair) was poor but adult return rate (91.9%) was typical. Chick diet contained more clupeids (65% of loads) than sandeels (32%).

- Atlantic puffins had an average season with 0.68 chicks fledging per pair laying. The return rate for adults (83.4%) was normal. Chicks were fed mainly sandeels (84% by number) with Clupeidae (mainly sprats) and Gadiformes (mainly rockling) both contributing 8%.

# Contents

# 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 top predators in the area. In December 1999, EU Fishery Ministers agreed a ban on fishing for sandeels, effective for 2000 and still in place in 2014, in 20,000 square kilometres of sea off eastern Scotland (including the Wee Bankie grounds) and northeast England.

The breeding success of kittiwakes and shags, which had declined whilst the fishery was in operation, increased during the period 2000-2003, suggesting that the industrial fishery on the Wee Bankie had adversely affected this species (Daunt *et al* 2008). However, from 2004, breeding success and adult return rate declined in several species, including kittiwakes, despite the fishing ban still being in operation. The common guillemot was particularly hard hit, with the period 2004-2008 representing the five worst breeding seasons on record. Particularly poor breeding seasons were recorded in several species in 2004, 2007 and 2008 (Ashbrook *et al* 2008). Over the same period, there

were changes in seabird diet with the sudden appearance of snake pipefish *Entelurus aequoreus* the most dramatic. Although numerous, this prey is difficult to digest and of poor nutritional value (Harris *et al* 2008).

Whilst not universal across all species in all years, a marked improvement in breeding success and adult survival was observed in the following five years up to 2014. Continued monitoring of the Isle of May seabirds is vital to assess whether the period 2009-2014 is the beginning of a recovery after the setback of the previous few years, a short-term departure from a sustained period during which poor environmental conditions override any benefit of fishery closure, and catastrophic years such as 2004, 2007 and 2008 become commonplace.

Marine Scotland granted consent for the construction of four wind farms in the Forth/Tay region in October 2014. Offshore wind farms have the potential to impact on seabird populations, notably from collisions with turbine blades and through displacement from important habitat. However, the population consequences of wind farm effects are poorly understood. The long-term study of seabirds on the Isle of May will be invaluable in assessing the effects of the construction and operation of these wind farms on protected seabird populations by providing high quality baseline data on demography and behaviour enabling changes associated with wind farms to be partitioned from variation associated with other factors such as climate change and fisheries effects.

# 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). Average breeding success of each species was estimated in two ways, as the average across all nests (the pooled average) and as the average of plot averages (the plot average).

### Northern fulmar

The positions of apparently incubating birds in ten areas were marked on photographs on 3, 6, 9 and 11 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 4 July to determine those that had hatched eggs. A final check was made on 20 August, when chicks present were assumed to have fledged successfully.

### European shag

The positions of nests constructed in nine areas were marked on photographs and the state and contents of these nests were checked weekly from 26 March until 1 August. Young (medium-sized or larger) that remained on 1 August were assumed to have fledged successfully.

### Black-legged kittiwake

The positions of nests in 15 areas were marked on photographs and the presence or absence of an incubating bird, or the number of young present at each, was noted. 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 in 2005 with new plots also put in place at South Horn and Hide Face and these were continued in 2014. Checks of nests were made on 6 June when regular checks of sample areas showed that most pairs had constructed nests. The first fledged young was seen on 20 July and a complete check of nests was made on 21 July. Further checks of the nests with small chicks on 21 July were made on 24, 29 July and 1 August. Chicks alive on 1 August were assumed to have fledged.

### Common guillemot and razorbill

Daily checks of the state of breeding of numbered nest-sites were made from permanent hides at five study plots for common guillemots and four study plots for razorbills.

### Atlantic puffin

Samples of 50 burrows where an egg was present were staked in each of four areas on 28-29 April by when checks suggested that most pairs had laid. The staked burrows were re-checked on 2-3 July at the start of fledging.

## 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 periodically 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 many 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, Cornerstone and its nearby cliffs. The Little Hole plot no longer has any kittiwakes while a new plot was added at Kittiwake Gully where returning birds will be searched for in 2015.

## 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), and for shag and kittiwake regurgitates an initial estimate of diet composition made. Fish otoliths were extracted from regurgitates, identified and measured. The weights of the fish from which they came were calculated from otolith length/fish length and fish length/mass regression relationships from fish collected from birds on the island in 2014, otherwise from published relationships. Biomass proportions were derived from initial estimates of diet composition, with species confirmed from identification of bones, or from fish mass estimates from otoliths where initial assessments were unavailable. Observations were made of fish brought to young common guillemots and razorbills during two 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 guillemot diet, from which biomass proportions were estimated using fish length/mass regressions as outlined above. Fish sizes for razorbills were broadly assessed against the bird's bill but since it was not possible to collect samples directly from this species, fish were placed into size classes. Thus, biomass estimates are available for shags, kittiwakes, guillemots and puffins only.

# 3 Results

## 3.1 Breeding success

Appendix 1 contains species summaries in Table 1 and a comparison with recent years' results is shown in Table 2. Long-term averages presented do not include the current year.

### Northern fulmar

Breeding success at 0.56 chicks fledged per incubating pair (Table 1) was the highest on record. This compared to the long-term average of 0.38 (CI=0.34-0.42).

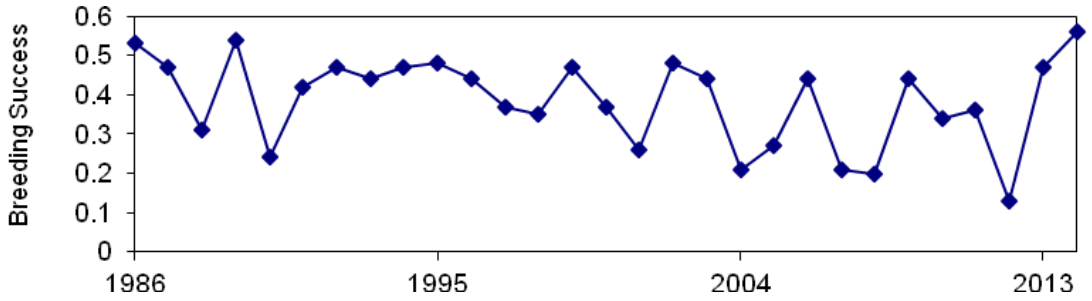


**Figure 1**. Breeding success (young reared per pair breeding) of northern fulmar on the Isle of May 1986 – 2014.

### European shag

A total of 87 chicks were raised to fledging from the 55 completed nests. The number of completed nests was the same as the 2013 total but half of the 2012 total (108) due to poor over winter survival of adults in the winter of 2012/2013. Productivity at 1.58 chicks per nest built was above average (Table 1, 1986-2013 average = 1.07; CI=0.88-1.27).

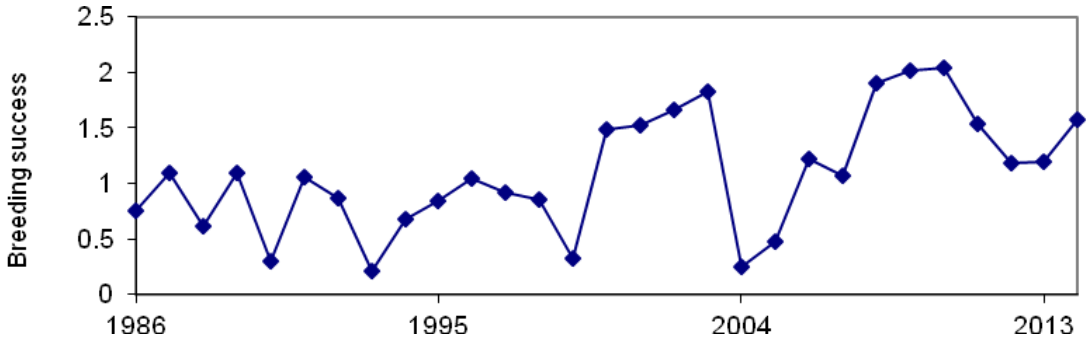


**Figure 2**. Breeding success (young reared per pair breeding) of European shag on the Isle of May 1986 – 2014.

### Black-legged kittiwake

Mean breeding success was 1.07 chicks per completed nest averaged across the plots and 1.17 after pooling plots (Table 1). This value was well above the 1986-2013 average (0.56, CI=0.42-0.69), having only been exceeded in two previous years. As in previous years, breeding success was very variable between plots which may have been a result of predation by gulls in some areas.

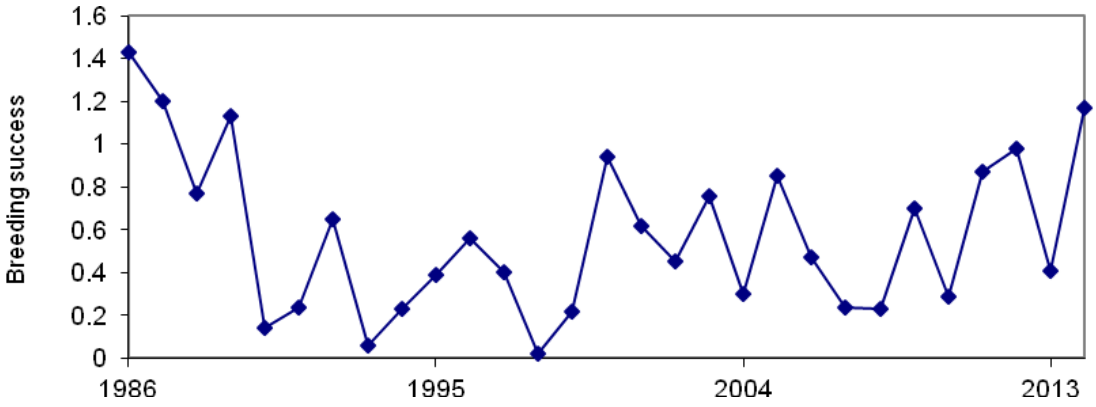


**Figure 3**. Breeding success (young reared per pair breeding) of black-legged kittiwake on the Isle of May 1986 – 2014.

## Common guillemot

Breeding success (0.73 young leaving per pair laying for the plot average and 0.72 for the pooled average; Table 4) was normal.

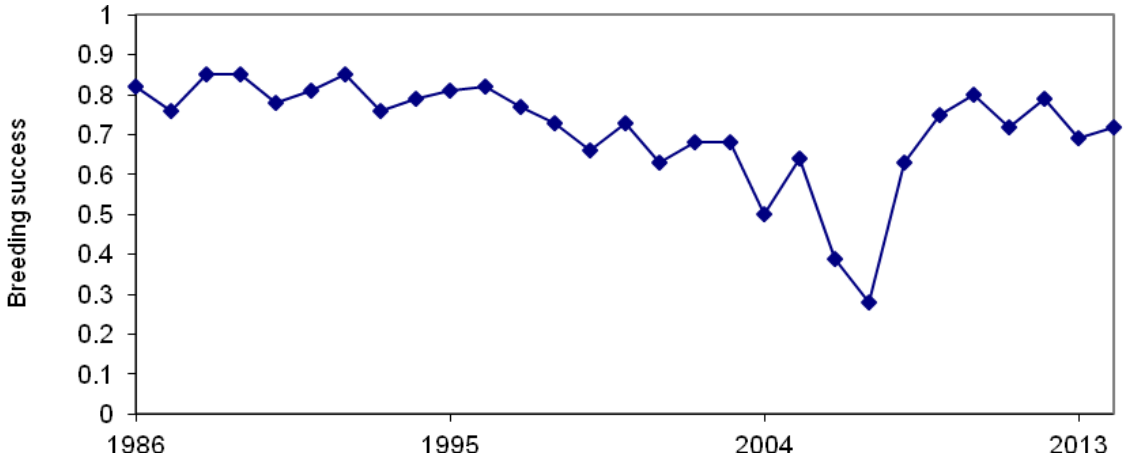


**Figure 4.** Breeding success (young reared per pair breeding) of common guillemot on the Isle of May 1986 – 2014.

## Razorbill

Mean breeding success (0.53 per pair laying for the plot average and 0.53 for the pooled average; Table 4), was poor.

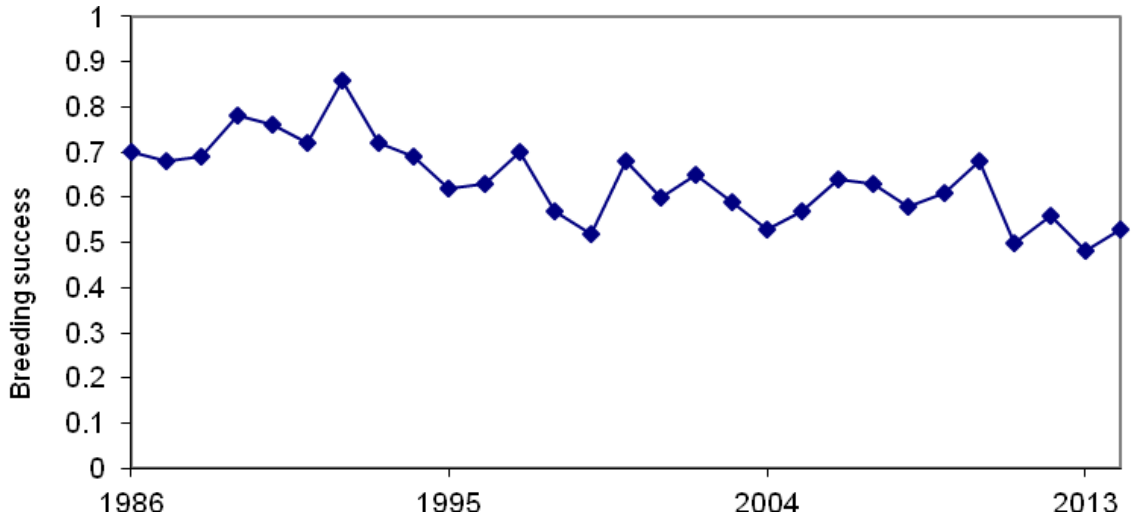


**Figure 5**. Breeding success (young reared per pair breeding) of razorbill on the Isle of May 1986 – 2014.

## Atlantic puffin

The mean breeding success of 0.68 chicks per egg laid based on chicks alive on 2-3 July, when the first fledgling had been recorded, was normal (Table 4).

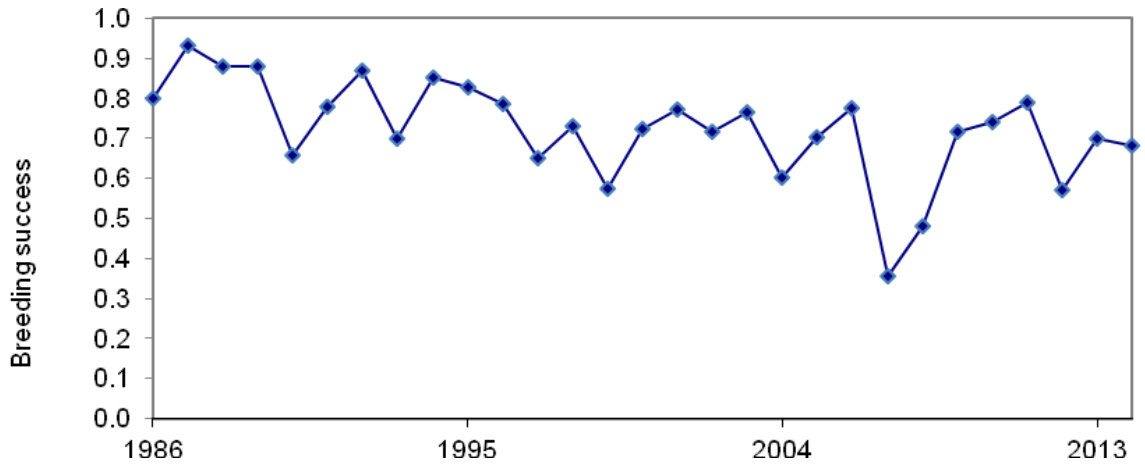


**Figure 6**. Breeding success (young reared per pair breeding) of Atlantic puffin on the Isle of May 1986 – 2014.

## 3.2 Adult survival 2013-2014

Not every adult alive is seen each year and thus return rates for 2014 presented here need to be treated as minimum estimates of survival of birds seen in 2013. The results are compared with those of previous years in Table 3 in Appendix 2. During 2014, 40 European shags, 24 black-legged kittiwakes and 32 common guillemots were newly colour-ringed. The long-term averages presented in this section do not include the current year.

### European shag

The return rate for 2014 (77.7%) was normal (long-term average 78.1%, 95% CI = 71.0-85.9).

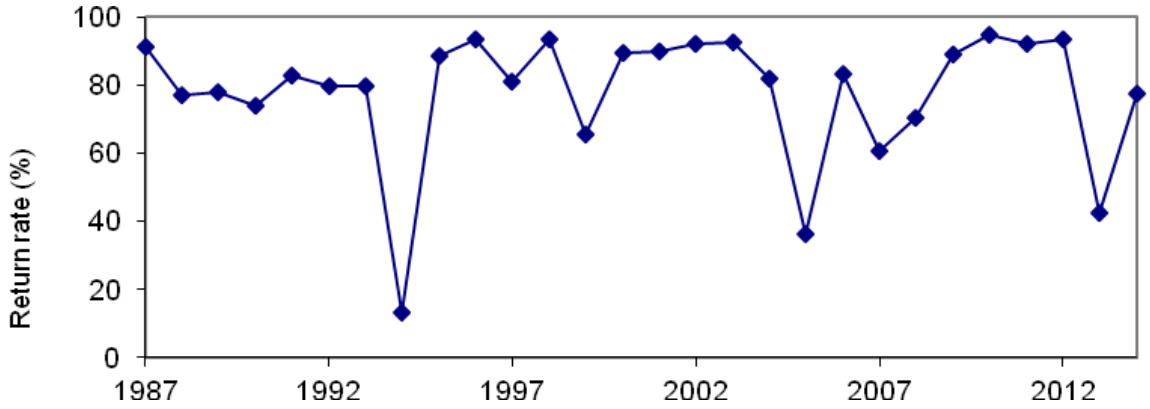


**Figure 7**. Annual return rates of adult European shag on the Isle of May 1987 – 2014.

### Black-legged kittiwake

The return rate of black-legged kittiwakes (78.4%) was average (1986-2013 average 78.3%, 95% CI =75.5-81.3).

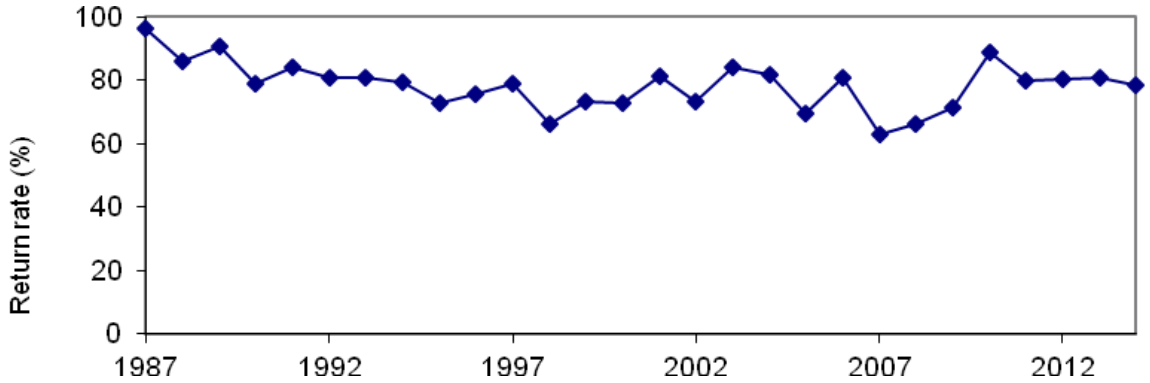


**Figure 8**. Annual return rates of adult black-legged kittiwake on the Isle of May 1987 – 2014.

## Common guillemot

The return rate for common guillemot at 88.7% (180/203) was normal.

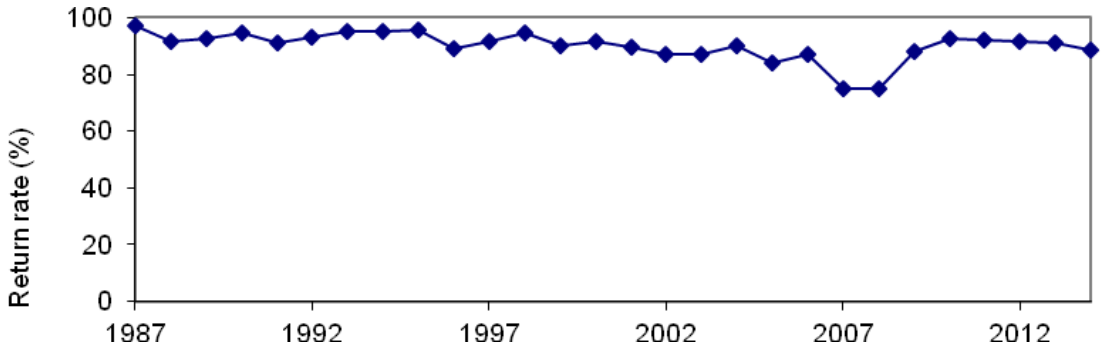


**Figure 9**. Annual return rates of adult common guillemot on the Isle of May 1987 – 2014.

## Razorbill

The return rate of razorbills (34/37 or 91.9%) was above average.

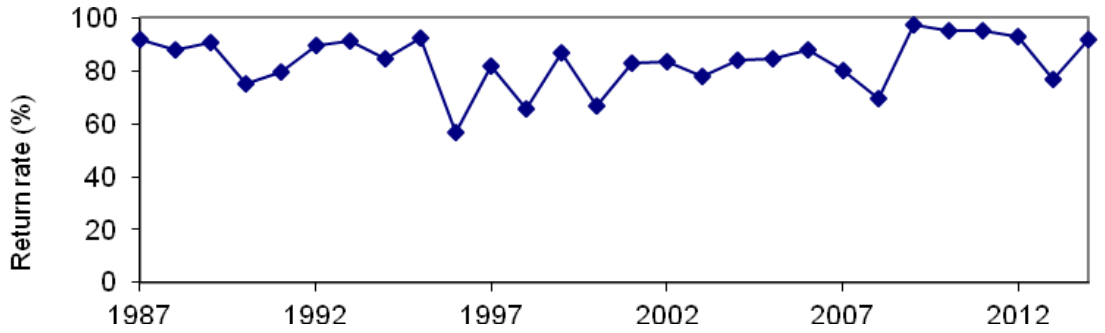


**Figure 10**. Annual return rates of adult razorbill on the Isle of May 1987 – 2014.

## Atlantic puffin

The return rate of Atlantic puffins (83.4%) was average (1986-2013 average 82.7%, 95% CI =79.0-86.2).

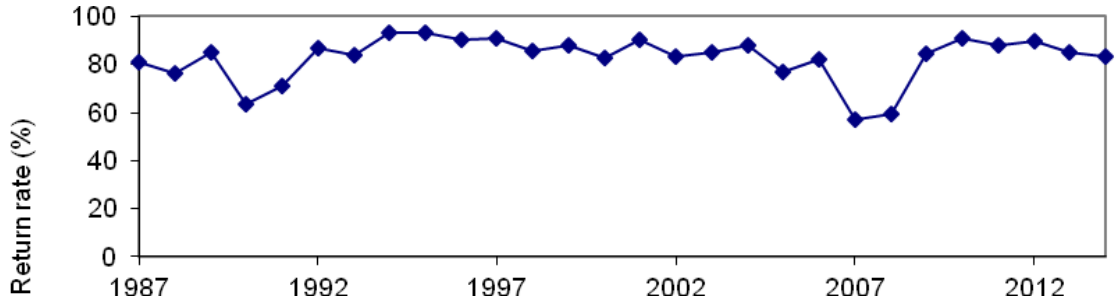


**Figure 11**. Annual return rates of adult Atlantic puffin on the Isle of May 1987 – 2014.

## 3.3 Food of young

Species summaries are given in Tables 4-7, and a comparison of sandeel biomass data with recent years' results is given in Table 8 in Appendix 3.

### European shag

The most frequent prey (by occurrence in a regurgitate) in the 21 regurgitations was sandeel which occurred in 85.7% of samples (Table 4) and contributed 80.3% of the biomass, a proportion that was close to the long term average. The remains of other items found were Gadidae (4 samples), Cottidae (3), crustacea (2), flatfish (2), Clupeid (1), dragonet (1) and Gobiidae (1).

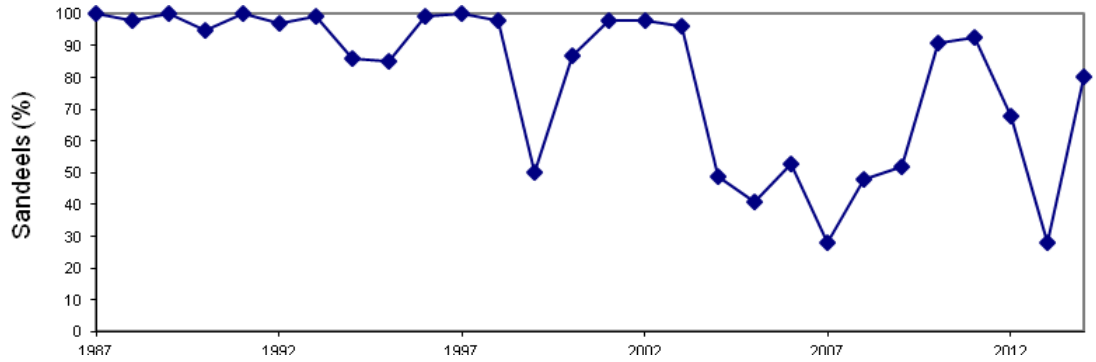


**Figure 12**. Percentage of sandeels (by weight) in the diet of young European shags on the Isle of May, 1987-2014.

### Black-legged kittiwake

Of the 67 food samples obtained, 94% contained sandeels (Table 4). In terms of biomass, sandeels contributed 76.6% to the diet, which is similar to the long term average (77.2%). Clupeidae (mainly sprat *Sprattus sprattus*) contributed 19.4% of the biomass and occurred in 50.7% of regurgitations. Gadidae contributed 1.4% and Lotidae (rockling sp.) 1.8% of the biomass.

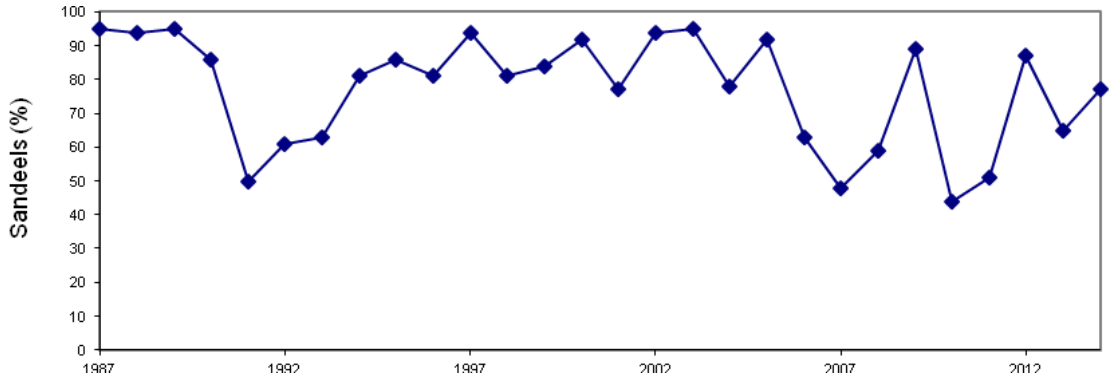


**Figure 13**. Percentage of sandeels (by weight) in the diet of young black-legged kittiwakes on the Isle of May, 1987-2014.

## Common guillemot

Of the 760 food items delivered to chicks, 717 (94.3%) were Clupeidae (most thought to be sprat) and 39 (5.1%) were sandeels. There were also 3 Gadidae and one small unidentified fish.

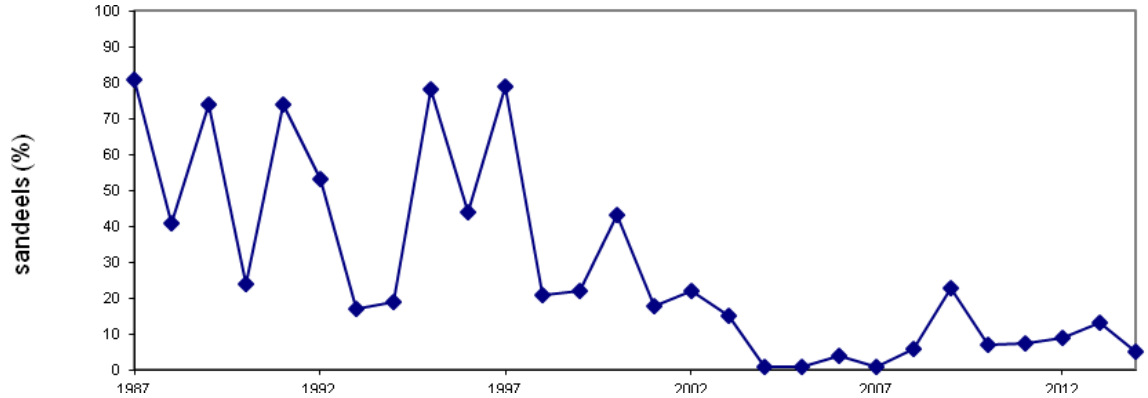


**Figure 14**. Percentage of sandeels (by weight) in the diet of young common guillemot on the Isle of May, 1987-2014.

## Razorbill

Of the 62 loads seen clearly, 20 (32%) contained sandeels and 40 (65%) clupeids. There was also one load of rockling and one load of small gadids, probably saithe.

## Atlantic puffin

Sandeels predominated the diet of puffins making up 84% of the 1642 fish collected. Clupeidae (mainly sprat) made up 8%, Lotidae (rockling) 6% and Gadidae 2% (Table 7).

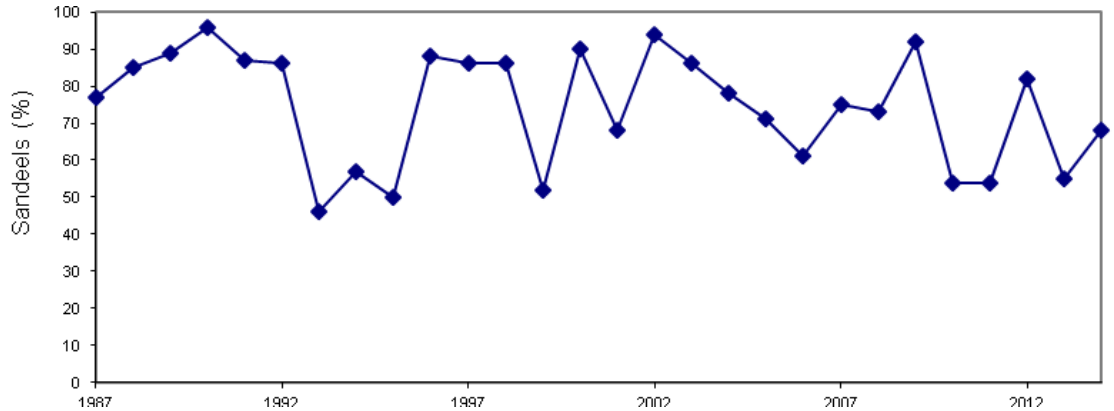


**Figure 15**. Percentage of sandeels (by weight) in the diet of young Atlantic puffin on the Isle of May, 1987-2014.

# 4 Acknowledgements

We are grateful to David Pickett and Bex Outram of Scottish Natural Heritage for logistical and occasional fieldwork support on the Isle of May. Sheila and Debbie Russell, John Harrison, Amanda Kuepfer, Polly Phillpot, Liz Mackley, Richard Hesketh, Julie Black, Holly Pickett, Jenny Sturgeon, Evanthia Thanou and Maria Bogdanova all helped with fieldwork. We are grateful to Alex Gardner and the crew of the May Princess and Roy Giles with RIB Osprey for providing transport to and from the Isle of May throughout the season.

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# 6 Further reading

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# 7 Appendices

## 7.1 Appendix 1: Breeding success

**Table 1**: Breeding success of seabirds on the Isle of May in 2014.

| | Plots | Plot average | Total nests | Total success |
|---|---|---|---|---|
| Northern fulmar | 11 | 0.49±0.09 | 142 | 0.56 |
| European shag | 9 | 1.66±0.23 | 55 | 1.58 |
| Black-legged kittiwake | 15 | 1.07±0.09 | 403 | 1.17 |
| Common guillemot | 5 | 0.73±0.03 | 826 | 0.72 |
| Razorbill | 4 | 0.53±0.05 | 213 | 0.53 |
| Atlantic puffin | 4 | 0.67±0.03 | 192 | 0.68 |

**Table 2.** Breeding success (mean number of young reared per breeding pair; pooled average across nests) of seabirds on the Isle of May, 2003-2014.

| Species | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|
| Northern fulmar | 0.44 (109) | 0.21 (97) | 0.27 (135) | 0.44 (139) | 0.21 (141) | 0.20 (121) |
| European shag | 1.83 (156) | 0.25 (103) | 0.48 (42) | 1.22 (81) | 1.07 (57) | 1.90 (60) |
| Black-legged kittiwake | 0.77 (423) | 0.30 (466) | 0.85 (675) | 0.47 (613) | 0.24 (609) | 0.23 (485) |
| Common guillemot | 0.68 (1014) | 0.50 (984) | 0.63 (945) | 0.41 (932) | 0.28 (850) | 0.63 (807) |
| Razorbill | 0.59 (177) | 0.54 (190) | 0.55 (200) | 0.62 (190) | 0.63 (188) | 0.58 (170) |
| Atlantic puffin | 0.77 (195) | 0.60 (196) | 0.71 (184) | 0.68 (166) | 0.29 (158) | 0.48 (179) |

| Species | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| Northern fulmar | 0.44 (147) | 0.34 (176) | 0.36 (149) | 0.13 (157) | 0.47 (167) | 0.56 (142) |
| European shag | 2.02 (61) | 2.04 (77) | 1.54 (104) | 1.18 (108) | 1.20 (55) | 1.58 (55) |
| Black-legged kittiwake | 0.70 (491) | 0.29 (494) | 0.87 (449) | 0.98 (470) | 0.41 (351) | 1.17 (403) |
| Common guillemot | 0.75 (824) | 0.80 (846) | 0.72 (858) | 0.79 (812) | 0.69 (797) | 0.72 (826) |
| Razorbill | 0.61 (180) | 0.68 (177) | 0.50 (175) | 0.56 (195) | 0.48 (191) | 0.53 (213) |
| Atlantic puffin | 0.72 (176) | 0.74 (169) | 0.79 (173) | 0.57 (167) | 0.70 (163) | 0.68 (192) |

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.

## 7.2 Appendix 2: Annual return rates

**Table 3**. Annual return rates of adult seabirds on the Isle of May, 1998-2014.

| **Species** | | | **Return rate (%)** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **No. seen in 2013** | **No. seen in 2014** | **2013-14** | **2012-13** | **2011-12** | **2010-11** | **2009-10** | **2008-09** | **2007-08** |
| Kittiwake | 111 | 87 | **78.4** | 80.6 | 80.2 | 80.0 | 89.0 | 71.3 | 66.4 |
| Guillemot | 203 | 180 | **88.7** | 91.3 | 93.4 | 92.1 | 92.4 | 88.1 | 75.0 |
| Razorbill | 37 | 34 | **91.9** | 76.9 | 92.9 | 95.2 | 95.2 | 97.3 | 69.4 |
| Puffin | 169 | 141 | **83.4** | 85.4 | 89.7 | 87.9 | 90.9 | 84.7 | 59.4 |
| Shag | 112 | 87 | **77.7** | 42.7 | 93.4 | 92.1 | 95.0 | 89.0 | 70.3 |
| | **2006-07** | **2005-06** | **2004-05** | **2003-04** | **2002-03** | **2001-02** | **2000-01** | **1999-00** | **1998-99** |
| Kittiwake | 62.9 | 80.9 | 69.7 | 81.8 | 84.2 | 73.5 | 81.2 | 72.9 | 73.1 |
| Guillemot | 75.2 | 86.9 | 83.9 | 90.1 | 87.0 | 87.0 | 89.6 | 91.6 | 90.2 |
| Razorbill | 80.0 | 88.2 | 84.6 | 84.3 | 77.8 | 83.8 | 82.9 | 66.7 | 86.9 |
| Puffin | 56.9 | 81.8 | 77.0 | 87.9 | 85.2 | 83.5 | 90.5 | 82.8 | 88.2 |
| Shag | 60.8 | 83.3 | 36.4 | 82.2 | 92.7 | 92.2 | 89.8 | 89.4 | 65.8 |

Notes:
Only birds which had definitely bred in 2013 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.

## 7.3 Appendix 3: Chick diet

**Table 4**. Food of young black-legged kittiwakes and European shags on the Isle of May during chick-rearing in 2014.

| | **Black-legged kittiwake** | **European shag** |
|---|---|---|
| No. of regurgitations | 67 | 21 |
| Range of dates | 21 June - 18 July | 31 May -22 July |
| Total weight (g) | 848 | 677 |
| % regurgitations with sandeels | 94.0 | 85.7 |
| with Gadidae | 6.0 | 19.0 |
| with Lotidae | 9.0 | 0 |
| with Clupeidae | 50.7 | 4.8 |
| with flatfish | 0 | 9.5 |
| with butterfish | 0 | 0 |
| with Cottidae | 0 | 14.3 |
| % (by number) of sandeels in sample | 83.6 | 95.1 |
| Other remains identified | Mackerel (7 samples), crustacea (3), mollusc (1), octopus (1) | Crustacea (2 samples), dragonet (1), Gobiidae (1). |

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 5.** Food of young common guillemots on the Isle of May in 2014.

| | **Sandeels** | **Clupeidae** | **Gadidae** |
|---|---|---|---|
| All-day watches | | | |
| 23 June | 6 | 220 | 1 |
| 26 June | 2 | 88 | 0 |
| Other records | | | |
| 2 June – 10 July | 31 | 409 | 2 |
| **Total** | **39** | **717** | **3** |

Note:
There was also a minute fish from some other unidentifiable family.

**Table 6**. Food of young razorbills on the Isle of May in 2014.

| | **Sandeels** | **Clupeidae** | **Gadidae** |
|---|---|---|---|
| All-day watches | | | |
| 23 June | 6 | 19 | 5 |
| 26 June | 3 | 6 | 2 |
| Other records | | | |
| 10 July- 6 July | 11 | 6 | 2 |
| **Total** | **20** | **31** | **9** |

Note:
There were additional single loads of rockling and saithe.

**Table 7**. Food of young Atlantic puffins on the Isle of May, 29 May to 16 July 2014.

| | **Sample size** | **Mean** | **s.e.** |
|---|---|---|---|
| Sandeel *Ammodytes sp*. | 1380 | 61.6 | 0.27 |
| Sprat *Sprattus sprattus* (large) | 63 | 86.9 | 1.89 |
| Sprat *Sprattus sprattus* (small) | 21 | 45.5 | 0.66 |
| Herring *Clupea harengus* | 40 | 54.6 | 0.59 |
| Rockling *sp*. (Lotidae) | 105 | 36.6 | 0.38 |
| Whiting *Merlangius merlangus* | 2 | 51.0 | 3.00 |
| Cod *Gadus morhua* | 7 | 41.3 | 1.08 |
| Unidentified Gadidae | 1 | 64 | |
| Saithe *Pollachius virens* | 15 | 59.8 | 3.13 |
| Mackerel *Scomber scombrus* | 7 | 54.1 | 3.04 |

Notes:
All clupeids with lengths >80mm were sprat.
For smaller individuals, where separation from herring is less obvious and based on counts of vertebrae, identification was based on ordering on size and vertebral counts. This showed that there was a group of fish 50-61mm that were herring and everything smaller or larger than this size range were sprats.

**Table 8**. Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1994-2014.

| Species | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|
| Shag | 86 | 85 | 99 | 100 | 98 | <50 | 87 | 95 | 98 | 96 |
| Kittiwake | 81 | 86 | 81 | 94 | 81 | 84 | 92 | 76 | 94 | 91 |
| Guillemot | 19 | 78 | 44 | 79 | 21 | 22 | 43 | 18 | 22 | 15 |
| Puffin | 57 | 50 | 88 | 86 | 86 | 52 | 90 | 68 | 94 | 86 |

| Species | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Shag | 49 | 41 | 53 | 28 | 48 | 52 | 91 | 92 | 68 | 28 | 80 |
| Kittiwake | 79 | 92 | 63 | 48 | 59 | 89 | 44 | 51 | 87 | 65 | 77 |
| Guillemot | 2 | 1 | 4 | 1 | 6 | 23 | 7 | 8 | 9 | 8 | 4 |
| Puffin | 78 | 71 | 61 | 75 | 72 | 92 | 54 | 54 | 82 | 55 | 68 |

Notes:
Dates and sample sizes can be found in the contract reports for the respective years.
Sandeels also made up the bulk of the food of young razorbills in most years but it is extremely difficult to assess proportions in terms of biomass.