



**JNCC Report No. 475e**

**Isle of May seabird studies in 2009**

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## Summary

After a series of very poor breeding seasons for seabirds on the Isle of May NNR, it was especially pleasing to see species doing markedly better in 2009, and overall the season was the most successful in recent years. Of the six species studied intensively, European shag had its highest productivity on record with only razorbill having productivity below average. All other species studied had their most productive season for at least four years. Return rates were much higher than the previous two seasons for all species with only black-legged kittiwake below the long-term average. Although lesser sandeels remained the main food of young Atlantic puffins, razorbills and black-legged kittiwakes, common guillemots fed their young mainly on clupeids, while European shags brought in a wide variety of bottom-living fish. Comparatively few 1+ group sandeels were present in food samples during the chick-rearing period, however 0 group appeared in large numbers and were substantially longer than in recent years. No snake pipefish were noted in the seabird diet having been conspicuous in the previous four years.

- Northern fulmar breeding success (0.44 chicks per incubating pair) was a large increase on the previous two years and slightly above average.
- European shags had the most successful season on record (2.02 chicks per pair), eclipsing the previous record set last year. Return rate was high at 89.6%, well above average and the highest for six years. As in the previous three years, the food was unusually varied with sandeels making up 51.6% by mass of the diet. Examination of sandeel otoliths indicated that 91% were from the 0 group age class.
- Black-legged kittiwakes had a good season with productivity (0.70 chicks per incubated nest) the highest since 2005 and well above the long-term average. Adult return rate (71.3%) was an improvement after two very poor years but was still below the long-term average. The proportion of sandeel in the diet (89% by biomass) was the highest since 2005.
- Guillemots had a successful breeding season (0.75 chicks leaving per pair) compared to recent years. Return rate of adults (92.0%) was normal following the low levels of the two previous winters. Adults fed their chicks mainly on sprats (67% by number) with sandeels (28%) the main alternative.
- Razorbill breeding success (0.61 chicks leaving per pair) was below the long-term average. Adult return rate (97.3%) was the highest ever recorded on the Isle of May. Chick diet was almost entirely 0 group sandeels.
- Atlantic puffins had a successful season with 0.72 chicks fledging per pair laying. The return rate for adults (84.7%) was normal following the poor showing over the two previous winters. Chicks were mainly fed 0 group sandeels (91% by number, 92% by biomass) that were substantially longer than during the last decade.

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# 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, 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.

However, since 2004 breeding success and adult return rate has been substantially lower for several species, including kittiwakes, despite the fishing ban still being in operation. The common guillemot has been 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. In recent years there

have also been 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* 2007).

Continued monitoring of the Isle of May seabirds is vital to assess their performance, and in particular to determine whether 2009 is the beginning of a recovery after the setback of the previous few years, or an outlier within 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.



## **2 Methods**

### **2.1 Breeding success**

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

#### **Northern fulmar**

The positions of apparently incubating birds in nine areas were marked on photographs on 4, 7 and 10 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 13, 16 and 27 July to determine those that had hatched eggs. A final check was made on 11 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 1 April until 11 August. Young (medium-sized or larger) that remained on 11 August were assumed to have fledged successfully. Success was estimated both by averaging across the plots and summing over plots.

#### **Black-legged kittiwake**

The positions of nests in 17 areas were marked on photographs and the presence or absence of an incubating bird, or the number of young present at each, was noted. Because of the long-term decline in kittiwake numbers on the Isle of May, the extent of the plots at Greengates and Cornerstone were increased in 2005 with new plots also put in place at South Horn and Hide Face and these were continued in 2009. Checks of nests were made on 3 and 10 June when regular checks of sample areas showed that most pairs had constructed nests. The first fledged young was seen on 24 July and a complete check of nests was made on 25 July. Further checks of nests with small chicks on 25 July were made on 28 July and 11 August. Chicks alive on 11 August were assumed to have fledged. Successes are given averaged across the plots and summed over the plots.

#### **Common guillemot and razorbill**

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

#### **Atlantic puffin**

Samples of 50 burrows where an egg was present were staked in each of four areas on 3-4 May (by when most pairs had laid). The staked burrows were re-checked on 25-28 June 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 most burrows are individually numbered). As in recent years, the area used for monitoring survival of adult black-legged kittiwakes included East Taret, Rona (North Horn Gully), Low Light Gully, Little Hole, Cornerstone and its nearby cliffs.

## **2.3 Food of chicks**

Food regurgitated by young European shags, young black-legged kittiwakes and adults of both species feeding young, and loads of fish dropped by adult Atlantic puffins caught in mist-nets were collected. Regurgitates and food loads were weighed, fish identified and, where possible, measured (total length, snout to tip of tail). Fish otoliths were extracted from regurgitates, identified and measured. The lengths of the fish from which they came were calculated using regressions derived from the otoliths of fish of known length where possible collected from birds on the island in 2009, otherwise from previously published relationships. Observations were made of fish brought to young common guillemots and razorbills during three 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. Fish sizes for razorbills were assessed against the bird's bill but were essentially orders of size as it was not possible to collect samples directly from this species.

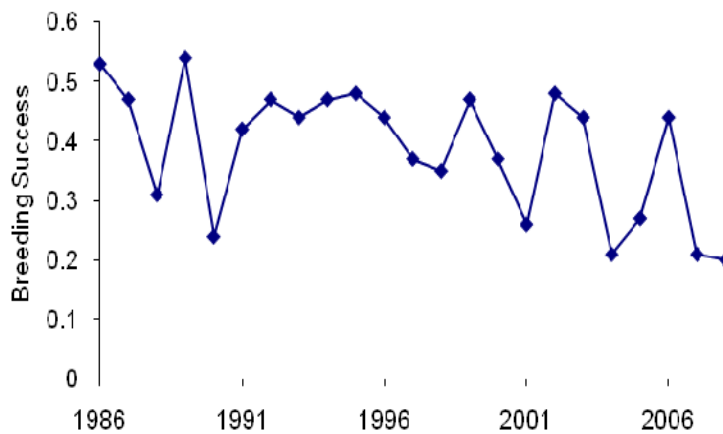
### 3 Results

#### 3.1 Breeding success

Appendix 1 gives species summaries in Tables 1- 4 and a comparison with recent years' results in Table 5. Long-term averages presented do not include the current year.

##### Northern fulmar

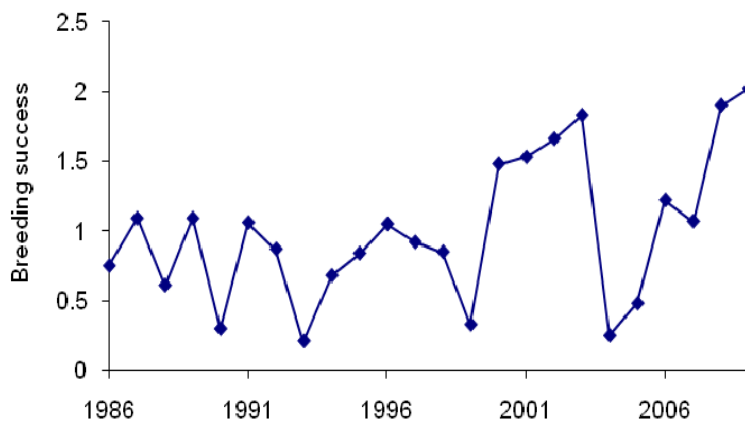
Breeding success at 0.44 chicks fledged per incubating pair (Figure 1) was a large increase on the previous two seasons. This compared to the long-term average of 0.39 (CI=0.34-0.43).



**Figure 1.** Breeding success (young reared per pair breeding) of Northern fulmar on the Isle of May 1986 – 2009

##### European shag

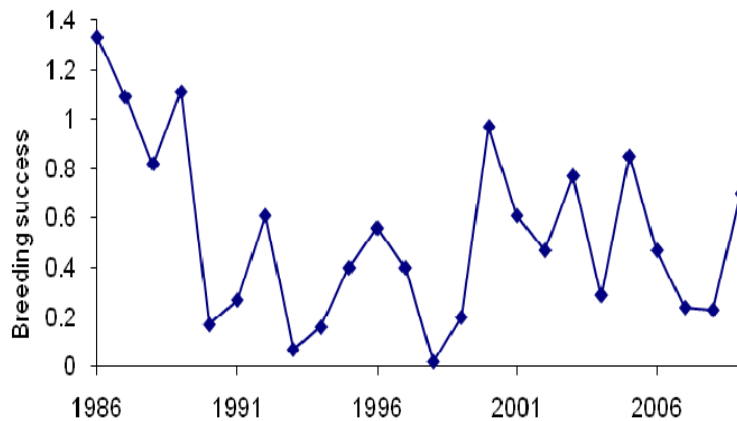
Of the 61 nests completed all pairs laid and raised a total of 123 chicks to fledging. Productivity at 2.02 chicks per nest built was the highest on record (Figure 2). The 1986-2008 average was 0.96 (CI=0.76-1.16).



**Figure 2.** Breeding success (young reared per pair breeding) of European shag on the Isle of May 1986 – 2009

### Black-legged kittiwake

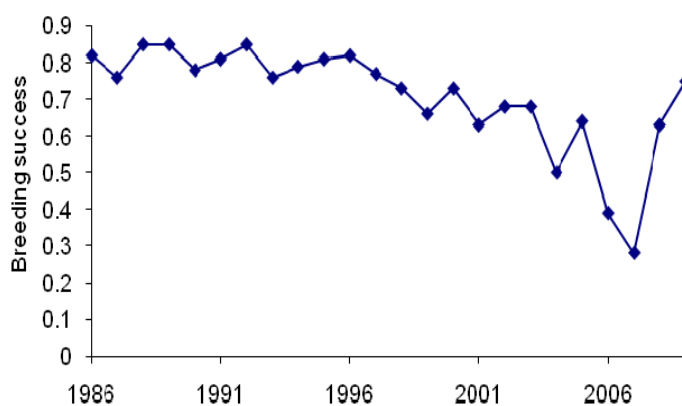
Mean breeding success was 0.64 ( $\pm$  se 0.11) chicks per completed nest, averaged across the plots, 0.70 after pooling areas (Figure 3). This value was well above the 95% Confidence Interval for the 1986-2008 average (0.53, CI=0.38-0.68) and the highest since 2005. Breeding success was very variable between plots which may have been down to high predation levels in some areas. Although predation by gulls, particularly herring gulls, has been suspected in past years it was very noticeable in 2008 and 2009 with actual observations on several occasions at different locations in particular North Lochside.



**Figure 3.** Breeding success (young reared per pair breeding) of black-legged kittiwake on the Isle of May 1986 – 2009

### Common guillemot

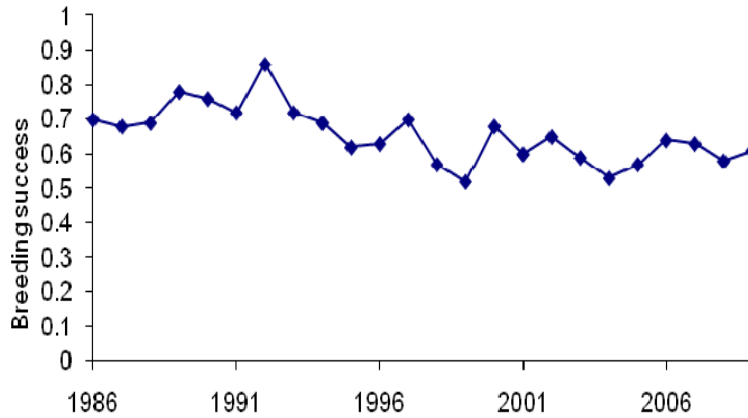
Breeding success (0.75 per pair laying for both the plot average and summed total) was a welcome improvement after the poor performance in recent years (Figure 4).



**Figure 4.** Breeding success (young reared per pair breeding) of common guillemot on the Isle of May 1986 – 2009

## Razorbill

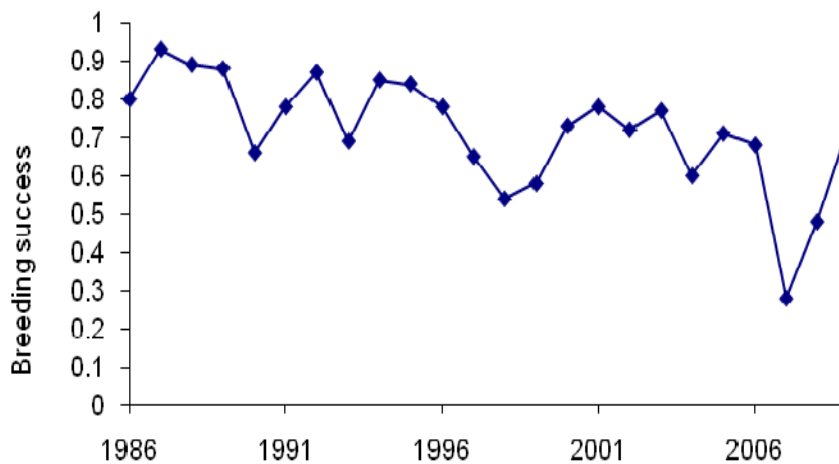
Mean breeding success (0.61 per pair laying for both the plot average and total pairs laying), was lower than the 1986-2008 mean (0.66, CI=0.63-0.69) (Figure 5).



**Figure 5.** Breeding success (young reared per pair breeding) of razorbill on the Isle of May 1986 – 2009

## Atlantic puffin

The mean breeding success based on chicks alive on 25-28 June was 0.72 chicks per egg laid, with very little variation between areas (Figure 6). This was a marked improvement over 2007 (0.29) and 2008 (0.48).



**Figure 6.** Breeding success (young reared per pair breeding) of Atlantic puffin on the Isle of May 1986 – 2009

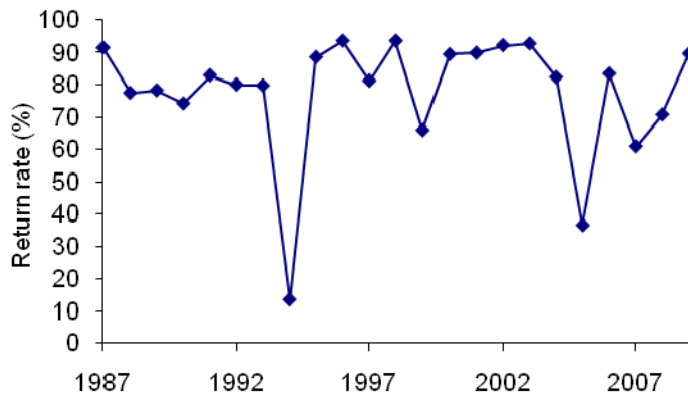
### 3.2 Adult survival 2008-2009

Not every adult alive is seen each year and thus return rates for 2009 presented here need to be treated as minimum estimates of survival of birds seen in 2008. The results are compared with those of previous years in Appendix 2. During 2009 an additional 51

European shags, 18 black-legged kittiwakes, 23 Atlantic puffins, 6 razorbills and 21 common guillemot were colour-ringed. The long-term averages presented in this section do not include the current year.

### European shag

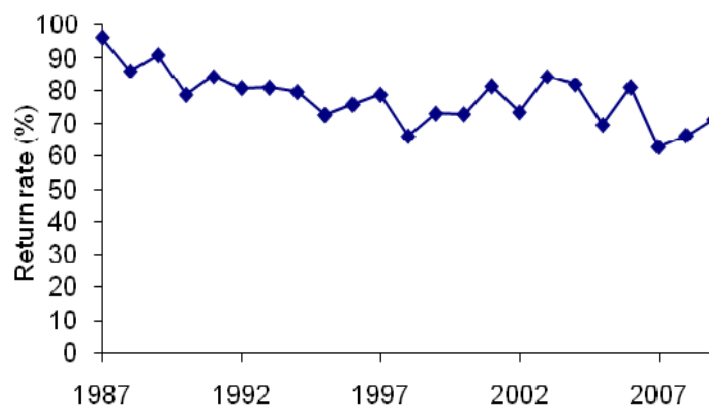
The return rate for 2009 (89.6%) was a large improvement on 2008 (70.6%) and well above the long-term average (77.6%, 95% CI = 69.4-86.8); and the highest value for six years (Figure 7).



**Figure 7.** Annual return rates of adult European shag on the Isle of May 1987 – 2009

### Black-legged kittiwake

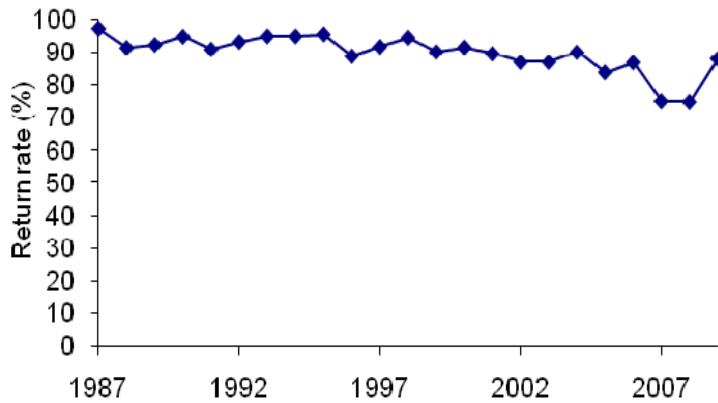
The return rate of black-legged kittiwakes (71.3%) was an improvement on 2008 (66.4%) but was still below the 1986-2008 average (78.0, 95% CI =74.7-81.4) (Figure 8).



**Figure 8.** Annual return rates of adult black-legged kittiwake on the Isle of May 1987 – 2009

## Common guillemot

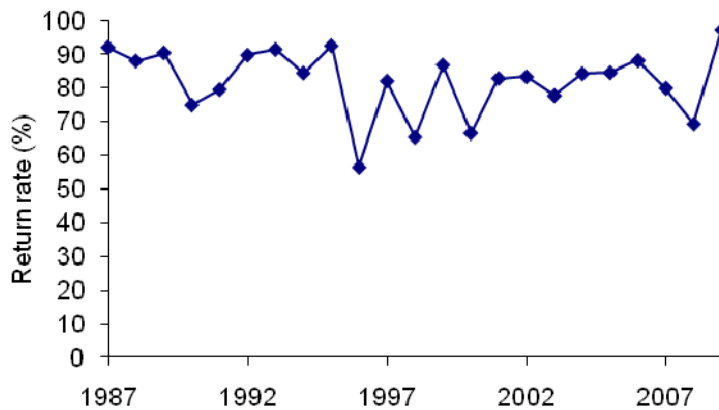
The return rate for common guillemot was 92.0% (266/289) (Figure 9), a marked contrast to the very low values recorded in 2008 (75.0%) and 2007 (75.2%) but within the 95% Confidence Interval for the 1986-2006 average (91.4, 95% CI = 89.9-92.9).



**Figure 9.** Annual return rates of adult common guillemot on the Isle of May 1987 – 2009

## Razorbill

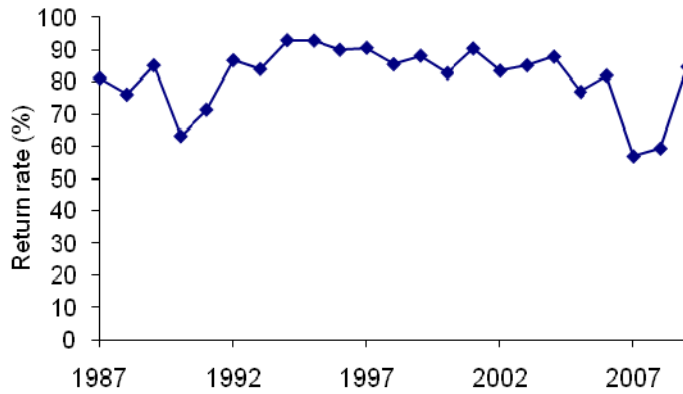
The return rate of razorbills (36/37 or 97.3%) was the highest since records began (Figure 10).



**Figure 10.** Annual return rates of adult razorbill on the Isle of May 1987 – 2009

## Atlantic puffin

In 2009, the return rate of Atlantic puffins was 84.7%, a high figure given that conditions were far from ideal for seeing colour-rings after the growth of the vegetation resulting from the die-off of most of the rabbits during the 2007/8 winter. This rate was a dramatic improvement over the 56.9% and 59.4% in 2007 and 2008, respectively, and close to the average of 84.0% for the previous 20 years (Figure 11).



**Figure 11.** Annual return rates of adult Atlantic puffin on the Isle of May 1987 – 2009

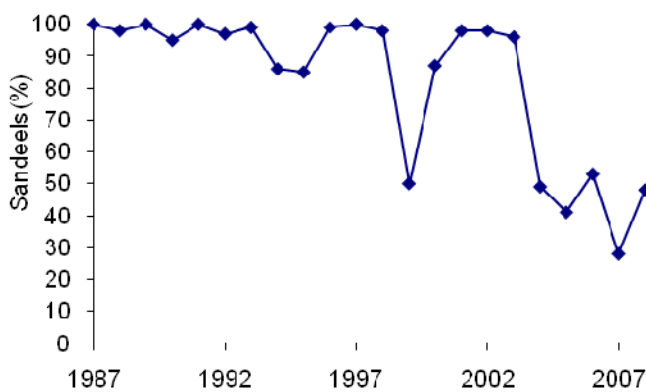


### 3.3 Food of young

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

#### European shag

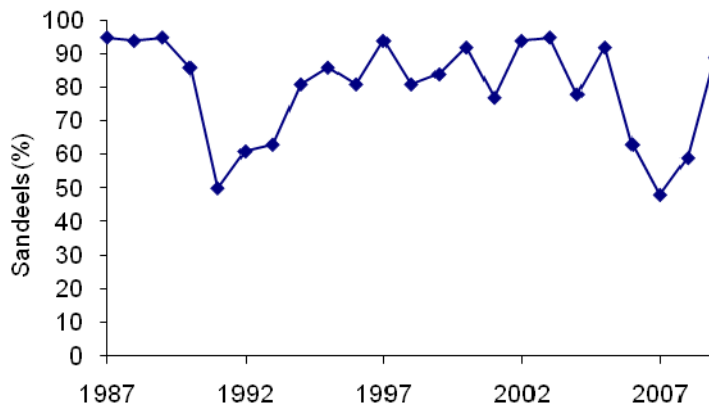
The most frequent prey (by occurrence in a regurgitate) in the 33 regurgitations was sandeel *Ammodytes marinus* which occurred in 54.5% of samples, followed by Gadidae (including whiting *Merlangius merlangus* and rockling) in 27.3%, wrasse in 27.3%, Clupeidae 27.3%, Gobiidae 21.2% and butterflyfish *Pholis gunnellus* in 15.2% (Table 7). Sandeels constituted 51.6% of the biomass, a slight increase on 48% in 2008. The remains of other items found were crustacea (3), mollusc (3), Cottidae (probably sea scorpion *Taurulus bubalis*, 2) and small flatfish (2). For the second consecutive year no pipefish were found. In the years 2004 to 2006 and 2008 an unusually high proportion of 0 group sandeels occurred in the diet during chick-rearing but in 2007 all sandeels were older (1+). In 2009, 0 group again dominated comprising 91% of sandeel otoliths in the obtained regurgitates.



**Figure 12.** Percentage of sandeels (by weight) in the diet of young European shag on the Isle of May, 1987-2009

## Black-legged kittiwake

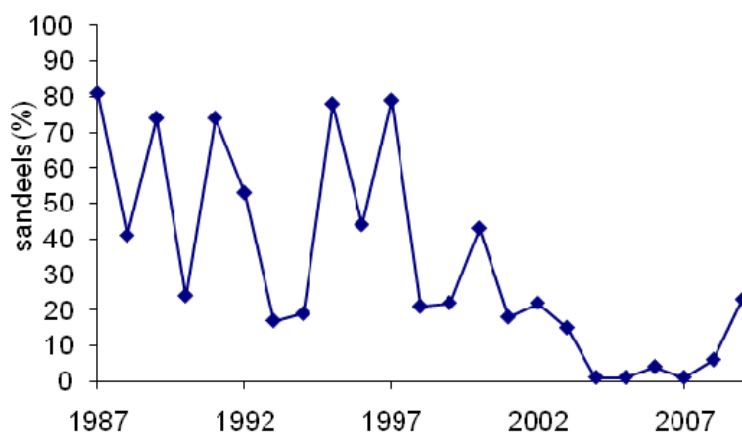
Of the 80 food samples, 96.3% contained sandeels (Figure 13). Of 2,041 otoliths examined, 92.6% were from 0 group sandeels and 0.3% from 1+ group sandeels, with average length of 7 cm, an increase of 2cm from 2008. In terms of biomass, 0 group and older sandeels contributed 87.2% and 0.2% by mass of the diet, respectively. This sandeel biomass proportion is an increase on the 59% found in 2008 and the highest for four years. Clupeids (mainly sprat *Sprattus sprattus*) contributed only 6.3% of the biomass but occurred in 35% of regurgitations. The remains of other items found were Gadidae (in 9 regurgitates, 6 of which contained rockling) and mollusc (4). The number of samples containing rockling is a drop on the preceding two seasons and no pipefish were found in any samples despite the dramatic appearance during 2006 and 2007.



**Figure 13.** Percentage of sandeels (by weight) in the diet of young black-legged kittiwakes on the Isle of May, 1987-2009

## Common guillemot

About 67% of the 1211 food items delivered to chicks were clupeids. All those that could be identified to species were sprat. Most were assigned to the medium (10 cm) or small (8.5 cm) size categories (Table 8). About 28% of the fish were sandeels (Figure 14); this is the first year since 2002 that sandeels have been such a major component of the diet of young guillemots. Although most were 1 group or older, some were small enough to be 0 group. Clupeids made up 67% and 74% of the diet by number and weight, respectively and sandeels were the next commonest prey making up 23% of the total mass. Identification of Gadidae in the field is extremely difficult but saithe *Pollarchius virens* and whiting *Merlangius merlangus* were specifically identified among the 64 gadoids seen. The average weight of a prey item (estimated from body-length and mass-length relationships) was 6.0g.



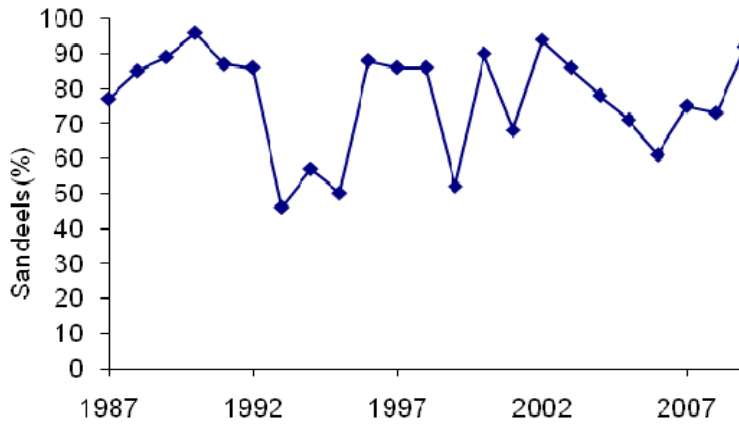
**Figure 14.** Percentage of sandeels (by weight) in the diet of young common guillemot on the Isle of May, 1987-2009

## Razorbill

Sandeels made up the bulk of the fish brought in by razorbills, being the only or main species recorded in 133 (95.7%) of the 139 feeds where the fish were clearly visible (Table 9). In 101 (75.9%) of the 133 loads containing sandeels all the fish appeared to be small 0 group with the remainder containing older fish. The small clupeids present in 6 (4.3%) of loads were unidentifiable. One load of small sandeels also contained a single small saithe.

## Atlantic puffin

Sandeels made up 91% by number (Figure 15) and 92% by biomass in the diet of young Atlantic puffins. All but nine of 1236 sandeels examined were 0 group, mostly between 5 and 9 cm long (Table 10). Most of the remainder of the diet was made up of saithe (3% by number, 2% by mass) and rockling (2% by number, 0.4% by mass). The mean load size of 10.6g was the highest recorded for over 20 years, although just below the 11.1g in 1987.



**Figure 15.** Percentage of sandeels (by weight) in the diet of young Atlantic puffin on the Isle of May, 1987-2009

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## 5 Further reading

The following is a list of papers on Isle of May seabirds published or in press since publication of the 2008 report.

Blackall, T.D., Wilson, L.J., Bull, J., Theobald, M.R., Bacon, P.J., Hamer, K.C., Wanless, S. & Sutton, M.A. 2008. Temporal variation in atmospheric ammonia concentrations above seabird colonies. *Atmospheric Environment*, 42 (29). 6942-6950.

Frederiksen, M., Daunt, F., Harris, M.P. & Wanless, S. 2008. The demographic impact of extreme events: stochastic weather drives survival and population dynamics in a long-lived seabird. *Journal of Animal Ecology*, 77 (5). 1020-1029.

Harris, M.P., Newell, M., Leitch, A., Bruce, B. and Hunt, J. 2009, Dramatic decline in numbers of Atlantic Puffins in the Firth of Forth. *Scottish Birds* 29 (2) 132-134.

Sakamoto, K.Q., Sato, K., Ishizuka, M., Watanuki, Y., Takahashi, A., Daunt, F. & Wanless, S. 2009. Can ethograms be automatically generated using body acceleration data from free ranging birds? *PLoS One*, 4 (4).

Sato, K., Daunt, F., Watanuki, Y., Takahashi, A. & Wanless, S. 2008. A new method to quantify prey acquisition in diving seabirds using wing stroke frequency. *Journal of Experimental Biology*, 211 (1). 58-65.

Thaxter, C.B., Daunt, F., Hamer, K.C., Watanuki, Y., Harris, M.P., Gremillet, D., Peters, G. & Wanless, S. 2009. Sex-specific food provisioning in a monomorphic seabird, the common guillemot *Uria aalge*: nest defence, foraging efficiency or foraging effort? *Journal of Avian Biology*, 40 (1). 75-84.

Wanless, S., Frederiksen, M., Walton, J. & Harris, M.P. 2009. Long-term changes in breeding phenology at two seabird colonies in the western North Sea. *Ibis*, 151 (2). 274-285.

## 6 Appendices

### Appendix 1: Breeding success

**Table 1.** Breeding success of northern fulmars on the Isle of May in 2009

<i>Area</i>	<i>Incubating birds</i>	<i>Young fledged</i>
Cleaver	6	5
Pilgrim's Haven	2	1
Cornerstone	2	0
Loch (S)	65	33
Greengates	26	8
Horse Hole	13	3
Tarbet	20	7
Low Light	6	4
Colm's Hole	7	4
Rona	0	0
<b>Total</b>	<b>147</b>	<b>65</b>
<b>Overall mean</b>		<b>0.44 fledged/ pair</b>

Notes:

Incubating birds were those sitting tight on three checks or where an egg was seen. Chicks present on 11 August were assumed to have fledged.

**Table 2.** Breeding success of European shags on the Isle of May in 2009

	<i>Total incubated</i>	<i>Other nests</i>	<i>Young fledged</i>			<i>Total</i>	<i>Fledging success per completed nest</i>
			<i>1</i>	<i>2</i>	<i>3</i>		
Maidens	4	1	0	13	11	2.75	
South Horn	1	0	0	0	0	0.00	
Pilgrim's Haven	5	0	0	12	8	1.60	
Mill Door (N)	6	0	2	31	11	1.83	
Mill Door (S)	7	0	0	41	11	1.57	
Horse Hole	9	0	1	34	19	2.11	
North Horn	15	2	4	37	31	2.07	
Tarbet	8	1	0	35	21	2.63	
Low Light	5	1	1	12	9	1.80	
Colm's Hole	1	0	0	10	2	2.00	
<b>Mean ± se</b>						<b>1.84±0.24</b>	
<b>Total</b>	<b>61</b>	<b>5</b>	<b>8</b>	<b>20</b>	<b>25</b>	<b>123</b>	<b>2.02</b>

Notes:

No nests were built in the plots at South Ness, Lady's Bed Stack, Chatterstones, North of Pilgrim's Haven, South Face, or Bishop's Cove in 2009.

**Table 3.** Breeding success of black-legged kittiwakes on the Isle of May in 2009

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			
Cleaver	13	6	3	22	4	2	0	8	0.62
South Horn	47	3	9	24	21	2	0	25	0.53
Pilgrim's Haven	19	1	4	8	7	4	0	15	0.79
South Face	13	0	5	3	6	4	0	14	1.08
Colony 4	34	0	16	10	13	11	0	35	10.3
Hide Face	26	6	2	13	7	6	0	19	0.73
Cornerstone	91	2	11	31	38	22	0	82	1.81
Lock (S)	0	0	0	0	0	0	0	0	0.00
Loch (N)	35	4	4	30	4	1	0	6	0.17
Greengates	49	0	6	23	9	17	0	43	0.88
Bishop's Cove	32	0	9	15	12	5	0	22	0.69
Horse Hole	2	0	1	2	0	0	0	0	0.00
Iron Bridge	24	0	10	11	10	3	0	16	0.67
Rona	39	0	4	14	19	6	0	31	0.79
Tarbet	39	0	11	23	9	7	0	23	0.59
Low Light	14	0	1	12	0	2	0	4	0.29
Colm's Hole	14	0	0	12	2	0	0	2	0.14
<b>Mean ± se</b>									<b>0.64± 0.11</b>
<b>Total</b>	<b>491</b>	<b>22</b>	<b>96</b>	<b>238</b>	<b>161</b>	<b>92</b>	<b>0</b>	<b>345</b>	<b>0.70</b>

**Table 4.** Breeding success of auks on the Isle of May in 2009

Species	Area	Pairs laying	Young "fledged"	Young leaving / pair
Guillemot	Dense	259	198	0.76
	Hide / White Ledge	85	64	0.75
	Colony 4	218	147	0.67
	South	38	27	0.71
	Cornerstone	224	186	0.83
	<b>Mean ± se</b>			
	<b>Total</b>	<b>259</b>	<b>198</b>	<b>0.76</b>
Razorbill	Hide / White Ledge	29	18	0.62
	Colony 4	58	28	0.48
	South	21	13	0.62
	Cornerstone	72	51	0.71
	<b>Mean ± se</b>			
	<b>Total</b>	<b>180</b>	<b>110</b>	<b>0.61</b>
Puffin	Lady's Bed	39	27	0.69
	Kirkhaven	54	38	0.70
	Burrian	42	31	0.74
	Rona	41	30	0.73
	<b>Mean ± se</b>			
	<b>Total</b>	<b>176</b>	<b>126</b>	<b>0.72</b>

**Table 5.** Breeding success (mean number of young reared per breeding pair) of seabirds on the Isle of May, 1996-2009

<i>Species</i>	<i>1996</i>	<i>1997</i>	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>
Northern fulmar	0.44 (135)	0.37 (136)	0.35 (120)	0.47 (115)	0.37 (143)	0.26 (134)	0.48 (131)
European shag	1.05 (105)	0.92 (109)	0.85 (125)	0.33 (58)	1.48 (127)	1.53 (135)	1.66 (130)
Black-legged kittiwake	0.56 (825)	0.40 (822)	0.02 (683)	0.20 (616)	0.97 (545)	0.61 (459)	0.47 (477)
Common guillemot	0.82 (786)	0.77 (842)	0.73 (852)	0.66 (870)	0.73 (942)	0.63 (975)	0.68 (955)
Razorbill	0.63 (140)	0.71 (132)	0.57 (134)	0.52 (142)	0.68 (149)	0.60 (167)	0.65 (167)
Atlantic puffin	0.78 (173)	0.65 (166)	0.54 (179)	0.58 (181)	0.73 (132)	0.78 (185)	0.72 (174)
	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<b><i>2009</i></b>
Northern fulmar	0.44 (109)	0.21 (97)	0.27 (135)	0.44 (139)	0.21 (141)	0.20 (121)	<b>0.44 (147)</b>
European shag	1.83 (156)	0.25 (103)	0.48 (42)	1.22 (81)	1.07 (57)	1.90 (60)	<b>2.02 (61)</b>
Black-legged kittiwake	0.77 (423)	0.29 (476)	0.85 (675)	0.47 (613)	0.24 (609)	0.23 (485)	<b>0.70 (491)</b>
Common guillemot	0.68 (1014)	0.50 (984)	0.63 (945)	0.41 (932)	0.28 (850)	0.63 (807)	<b>0.75 (824)</b>
Razorbill	0.59 (177)	0.54 (190)	0.55 (200)	0.62 (190)	0.63 (188)	0.58 (170)	<b>0.61 (180)</b>
Atlantic puffin	0.77 (195)	0.60 (196)	0.71 (184)	0.68 (166)	0.29 (158)	0.48 (179)	<b>0.72 (176)</b>

Notes:

The number of pairs followed is given in brackets. Details of the monitoring methods for these species can be found in this and previous reports to JNCC.



## Appendix 2: Annual return rates

**Table 6.** Annual return rates of adult seabirds on the Isle of May, 1992-2009

<i>Species</i>	<i>No. seen in 2008</i>	<i>No. seen in 2009</i>	<i>Return rate (%)</i>						
			<i>2008-09</i>	<i>2007-08</i>	<i>2006-07</i>	<i>2005-06</i>	<i>2004-05</i>	<i>2003-04</i>	<i>2002-03</i>
Kittiwake	101	71	<b>71.3</b>	66.4	62.9	80.9	69.7	81.8	84.2
Guillemot	289	266	<b>92.0</b>	75.0	75.2	86.9	83.9	90.1	87.0
Razorbill	37	36	<b>97.3</b>	69.4	80.0	88.2	84.6	84.3	77.8
Puffin	137	116	<b>84.7</b>	59.4	56.9	81.8	77.0	87.9	85.2
Shag	135	121	<b>89.6</b>	70.6	60.8	83.3	36.4	82.2	92.7
	<i>2001-02</i>	<i>2000-01</i>	<i>1999-00</i>	<i>1998-99</i>	<i>1997-98</i>	<i>1996-97</i>	<i>1995-96</i>	<i>1994-95</i>	<i>1993-94</i>
Kittiwake	73.5	81.2	72.9	73.1	66.2	78.7	75.8	72.7	79.5
Guillemot	87.0	89.6	91.6	90.2	94.6	91.8	88.9	95.6	95.0
Razorbill	83.8	82.9	66.7	86.9	65.5	82.1	56.6	92.6	84.5
Puffin	83.5	90.5	82.8	88.2	85.5	90.7	90.1	93.0	93.1
Shag	92.2	89.8	89.4	65.8	93.6	91.1	93.6	88.5	13.4

### Notes:

Only birds which had definitely bred in 2008 or earlier are included.

Directly comparable figures for earlier seasons are given. These have not been corrected for missing birds seen in later years, and for some species may severely under-estimate actual survival rates.

These figures should not be used for population dynamics calculations without consultation with S Wanless.

## Appendix 3: Chick diet

**Table 7.** Food of young black-legged kittiwakes and European shags on the Isle of May during chick-rearing in 2009

	<i>Black-legged kittiwake</i>	<i>European shag</i>
No. of regurgitations	80	33
Range of dates	16 June-23 July	03 June-01 July
Total weight (g)	1112	968
% regurgitations with sandeels	96.3	54.5
with Gadidae	11.3	27.3
with Clupeidae	35.0	27.3
with flatfish	0	6.1
with butterfish	0	15.2
with Cottidae	0	6.1
with pipefish	0	0
% (by weight) of sandeels in sample	89.1	51.6
% (by number) of sandeels in sample	76.2	39.1
Lengths of most sandeels (cm)	7	7
Other remains identified	Mollusc (4).	Gobiidae (7), crustacea (3), mollusc (3).

Notes:

Samples were collected from chicks or adults during the chick-rearing period.

Counts and lengths of fish were based on otoliths retrieved from the regurgitations.

**Table 8.** Food of young common guillemots on the Isle of May in 2009

	<i>No. of sandeels</i>				<i>No. of Clupeidae</i>				<i>No. of Gadidae</i>		
	<i>minute</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>minute</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>small</i>	<i>medium</i>	<i>large</i>
Length (cm)	7	11	13	15.5	7	8.5	10	13	6	8	10
<b>All-day watches</b>											
22 June	3	86	36	13	1	47	141	12	10	2	2
24 June	3	31	7	5		24	25		1		1
26 June		25	6	1		28	18		1	1	
<b>Other records</b>											
2 June - 6 July	13	61	38	5	12	59	427	20	28	10	8
<b>Total</b>	<b>19</b>	<b>203</b>	<b>87</b>	<b>24</b>	<b>13</b>	<b>158</b>	<b>611</b>	<b>32</b>	<b>40</b>	<b>13</b>	<b>11</b>

Notes:

Lengths were based on visual estimates against the bird's bill checked by measurements of dropped fish.

**Table 9.** Food of young razorbills on the Isle of May in 2009

	<i>Sandeels</i>			<i>Single Clupeidae</i>			<i>Several Clupeidae</i>		
	<i>small</i>	<i>medium</i>	<i>large</i>	<i>small</i>	<i>medium</i>	<i>large</i>	<i>Small</i>	<i>medium</i>	<i>large</i>
<b>All-day watches</b>									
22 June	33	6	6	0	0	1	0	0	0
24 June	33	5	0	2	0	0	0	0	0
26 June	23	8	4	0	1	0	0	0	0
<b>Other records</b>									
13 June –									
11 July	12	2	1	0	0	1	1	0	0
<b>Total</b>	<b>101</b>	<b>21</b>	<b>11</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>

## Notes:

One load of medium sandeels also had some small sandeels

One load of large sandeels also had one small sandeel

One load of small sandeels also contained a small saithe

**Table 10.** Food of young Atlantic puffins on the Isle of May, 25 May to 13 July 2009

	<i>Sample size</i>	<i>Mean</i>	<i>s.e</i>
a) Load weight (g)	114	10.6	0.5
b) Fish/load	116	11.0	0.4
c) Numbers and lengths of fish (mm)			
Sandeels <i>Ammodytes sp.</i>	1236	70.6	0.4
Unidentified Clupeid ( <i>Clupeidae</i> )	24	43.8	1.5
Sprat <i>Sprattus sprattus</i>	5	112.2	3.4
Saithe <i>Pollachius virens</i>	40	41.3	1.7
Rockling <i>sp.</i> ( <i>Gadidae</i> )	28	33.8	0.6
Whiting ( <i>Merlangius merlangus</i> )	1	67	
Cod <i>Gadus morhua</i>	12	39.9	1.3
Unidentified <i>Gadidae</i>	3	34.7	1.4

Note: There was also two small squid included in the fish/load figure.

**Table 11.** Percentage of sandeels (by weight) in the diet of young seabirds on the Isle of May, 1990-2009

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Shag	95	100	97	99	86	85	99	100	98
Kittiwake	86	50	61	63	81	86	81	94	81
Guillemot	24	74	53	17	19	78	44	79	21
Puffin	96	87	86	46	57	50	88	86	86

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Shag	<50	87	95	98	96	49	41	53	28	48	52
Kittiwake	84	92	76	94	91	79	92	63	48	59	89
Guillemot	22	43	18	22	15	2	1	4	1	6	23
Puffin	52	90	68	94	86	78	71	61	75	72	92

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 all years except 2004, but it is extremely difficult to assess proportions in terms of biomass