No. 6

SEABIRD NUMBERS AND BREEDING SUCCESS IN BRITAIN AND IRELAND, 1991

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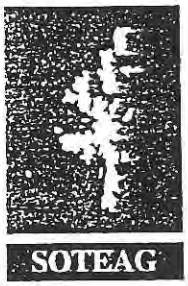

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Further information on patterns or trends shown in the report, or on particular regions or colonies, can also be obtained through the report compilers.

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1. SUMMARY

1.1 The results of monitoring of seabird numbers and breeding success in Britain and Ireland during 1991 are summarised in this report, within the context of 1986-91 results as a whole. Most of the relevant monitoring is carried out by (or under contract to) JNCC, RSPB and SOTEAG, with JNCC's Seabird Monitoring Programme in a coordinating role, collating information from these and other sources.

1.2 Monitoring efforts are particularly directed at the numbers and breeding success of cliff-breeding species and of terns. Breeding success of widespread, wholly marine species such as kittiwake, fulmar and shag may provide an effective means of monitoring changes in aspects of the wider marine environment (including food availability). The information collected is also of use in formulating conservation policies. Terns are of particular conservation importance in that breeding numbers are relatively small, and colonies are highly subject to disturbance, predation and other factors.

1.3 Breeding success of several species of seabird in Shetland improved dramatically in 1991, associated with increased availability of sandeels. This followed several years of very poor breeding success. The improvement was particularly striking for arctic terns (highest numbers of chicks fledged for at least seven years), kittiwakes and arctic skuas. A continued decline was seen in breeding numbers of cormorant, shag, arctic skua and kittiwake, but arctic tern, guillemot and razorbill numbers increased markedly compared to 1989-90.

1.4 Breeding success of arctic terns remained low in Orkney (lower than Shetland), and artcic skua success improved at a few colonies only, remaining moderate or poor overall. Cliff-breeding species (kittiwake, fulmar and guillemot) again had a successful season, with numbers of chicks fledged per pair among the highest in Britain. Guillemot and razorbill numbers were higher than than in 1988, although kittiwake numbers were lower.

1.5 Along the east coast of Scotland, kittiwake success was the lowest recorded in the period 1986-91, and similar to Shetland figures this year (about half as successful as Orkney birds). Kittiwakes in NE England were more successful, but overall productivity in NE mainland Britain fell significantly. Kittiwake numbers also fell at most colonies. Numbers of breding shags increased in all regions, but guillemot and razorbill showed more variable changes.

1.6 Tern population changes along the North Sea/eastern English Channel coast were variable, but common and little tern numbers again decreased overall, while Sandwich tern numbers showed little change. Breeding success of common, arctic and little terns, especially, was again low in many regions from N Scotland to SE England.

1.7 In SW Britain and around the Irish Sea, kittiwake productivity was again low (the lowest in Britain in 1991), although breeding numbers increased in several regions. Guillemot and razorbill numbers at Welsh colonies increased markedly, but cormorant numbers were low, apparently reflecting non-breeding.
Roseate tern numbers on Rockabill (Dublin) continue to increase, but at the expense of other colonies (especially in Anglesey). Sandwich and common tern numbers around the Irish Sea decreased overall, although regional changes were variable (and Sandwich tern bred in the Isle of Man for the first time). Tern breeding success was generally high at Welsh colonies (compared to North Sea coasts), but was low in NW England.

1.8 Common and arctic terns along the west coast of Scotland (Kintyre to Lochaber) again reared few chicks. Few clear trends or changes were evident from the limited information available for other species here, although most species on Handa (NW Sutherland) again had a productive season.

2. INTRODUCTION

This is third annual report on the results of seabird monitoring at coastal colonies throughout Britain and Ireland. Previous reports (Walsh *et al.* 1990, 1991) were produced by the former Nature Conservancy Council's Chief Scientist Directorate in cooperation with RSPB and SOTEAG, as part of NCC CSD's Seabird Monitoring Programme (SMP). Now with JNCC in a coordinating role, this programme is designed to encourage, and collate the results of, seabird monitoring by a range of individuals and organisations. By producing an annual report as soon as possible after each breeding season, one aim is to provide feedback and encouragement to the many observers involved. Another aim is to make available up-to-date information of potential interest to conservationists and seabird researchers in general.

1991 results relating to breeding success or population changes are summarised here, and comparative results for the period 1986-90 are also presented. The format in general is similar to that in previous year, but background information on data sources and conventions is repeated below. For summary details of seabird monitoring methods, see Appendix 1 of the 1990 report.

Information on red-throated divers is included for the first time this year, but full summaries for Manx shearwater and *Larus* gulls have had to be held over until next year's report.

Any offers of help for future seasons, or comments on this report, would be greatly appreciated.

Sources of information:

Information was collated from many sources (see section 4 - Acknowledgments), including:
- research or wardening staff of RSPB, SOTEAG and JNCC;
- wardening staff of the Nature Conservancy Council for Scotland (NCCS), English Nature (EN) and the Countryside Council for Wales (CCW);
- organisations including local wildlife trusts, universities, bird observatories, Institute of Terrestrial Ecology, Seabird Group, and others;
- many individual fieldworkers .

Seabird monitoring by JNCC focuses particularly on marine species such as fulmar, shag, kittiwake and auks, for which changes in breeding populations, success or other parameters may provide evidence of changes in the marine environment as a whole. The most detailed monitoring is undertaken at several geographically-dispersed 'key sites', largely through contracts placed with other organisations. These sites include the Isle of May (SE Scotland), Fair Isle (Shetland), Canna (NW Scotland) and Skomer (Wales). Long-term monitoring of numbers and breeding success is also undertaken on Orkney Mainland, and on St Kilda (NW Scotland), in cooperation with NCCS.

Monitoring of breeding success of cliff-breeding species is encouraged by JNCC at many other colonies, partly by contributing to fieldwork costs of volunteers through contracts with the Seabird Group. Collaboration with the Seabird Group also involves the Seabird Colony Register, a database of colony counts for Britain and Ireland, which is maintained as part of the SMP. Many observers and organisations (including SOTEAG and RSPB) contribute to the Register annually, and the counts can in most cases be used in assessing annual population changes in particular regions.
The majority of coastal colonies in Britain and Ireland were censused for the Register in 1985-87, providing a baseline for future largescale surveys of this

kind. Population changes since the previous full survey (the Seabird Group's Operation Seafarer in 1969-70) are summarised by Lloyd *et al.* 1991; population totals from the latter are summarised (with some updates) in table 2.1.

Through their network of reserves, RSPB monitor the numbers and breeding success of a range of species throughout Britain and Northern Ireland. For cliff-breeding species, populations and (in recent years) breeding success are monitored using the same methods as JNCC and SOTEAG. Monitoring of terns in Britain is largely coordinated by RSPB, with collation of data from many other organisations and individuals in addition to RSPB staff. The roseate tern is the subject of a special, international study by RSPB, aimed at conserving the species in the northeast Atlantic as a whole. In the northern isles (Shetland and Orkney), monitoring of arctic terns and skuas is undertaken at many colonies. Other monitoring or survey effort is directed at species including storm petrels.

In Shetland, Aberdeen University, under contract to SOTEAG, carries out extensive population-monitoring of cliff-breeding species and black guillemots. For some species (fulmar, guillemot and razorbill), annual counts are carried out in sample plots; for shag, kittiwake and black guillemot, counts are made of longer stretches of coastline at intervals of two years or more. Assessment of breeding success has been carried out at many colonies since the mid 1980s. This work is funded by the Sullom Voe Association Ltd, and forms part of a wider scheme of biological monitoring in Shetland.

Data for some Irish colonies are also collated by JNCC and RSPB (in part through the latter's wardening staff), helping to place patterns or trends for British colonies in a wider context. Contacts are maintained with organisations including with organisations including the Wildlife Service of the Office of Public Works, the Irish Wildbird Conservancy and the National Trust, and counts or productivity-monitoring at some colonies are funded by the Seabird Group.

Data-presentation and methods

Fuller details are given in the 1989 report, but some indications of the potential limitations of information presented in this report are given below.

Population changes: use of regional samples and annual indices

To allow a concise and standardised presentation of population data for each seabird species, individual colonies have, in most cases, not been considered in detail here. (Original counts are included in limited-circulation appendices only, held by JNCC, RSPB and SOTEAG.) Population changes of seabirds are known to vary markedly between different parts of the Britain and Ireland, and monitoring effort is uneven. For most species (the exceptions being several of the terns), it is thus not practicable to assess year-to-year changes for the population as a whole.

Instead, the coastline has been subdivided into 14 'regions', as defined in table 2.2 below. For most species, population data have been summarised region-by-region. Valid counts (see below) of whole colonies (or of sample plots within different colonies) have been summed for each year-to-year comparison. By using such regions, the aim is to draw attention to any common patterns shown by a number of regions, as well as to highlight any notable changes shown by colonies in particular regions.

Not all monitored colonies are counted annually, and population comparisons between years are thus often based on different combinations of colonies. Recent population trends (1986-91) have been estimated using a system of population indices, with 1986-87 average counts set as an arbitrary 100. Most colonies counted in 1991 were also counted in one or both of those years, when most of the

coverage for the Seabird Colony Register was achieved. (See 1989 report for fuller details of index calculations.)

Regional population changes are also tabulated for 1990-91. Note that changes between these years will not necessarily match changes shown by population indices, as not all colonies included in 1991 index values may have been counted in 1990. (The exceptions are Sandwich and little terns, for which a strict 'chain method' of calculating indices has been used, based only on colonies counted in consecutive years; a high proportion of colonies of these species is counted annually.) Some short-term fluctuations shown by the annual indices will reflect the use of different colonies in different years. With longer runs of data, however, such fluctuations should have relatively little influence on apparent trends.

Accuracy and representativeness of seabird counts

In comprehensive assessments of long-term changes in seabird numbers, for example between 1969-70 and 1985-87 (Lloyd *et al.* 1991), there is inevitably some loss of count accuracy at the expense of obtaining complete coverage. For this report, stricter criteria have been used to select counts for assessment of short-term changes. These criteria vary between species, and cover such factors as census unit ('pairs' or adult individuals) and the timing, frequency and apparent accuracy of counts (see species accounts and Appendix 1 for details). For most species, single, well-timed counts of apparently occupied nests are sufficient. The possibility of undetected variations in count accuracy, timing of season or completeness of counts should be borne in mind, however. For the most 'difficult' species, guillemot and razorbill, 5-10 counts of adults attending colonies in June each year are needed in order to minimise the effect of day-to-day variations in numbers. (Repeat counts of apparently occupied fulmar sites are also recommended.)

Where replication of counts, under a restricted range of counting conditions, is necessary, it is rarely possible to count the whole of a large colony. Counts of sample plots within a colony are usually needed. but these plots will not necessarily be representative of the colony as a whole. Random selection of plots is therefore recommended, although this is not always achieved. Even this does not allow for colony expansion.

As mentioned above, the seabird colonies regularly monitored may not be representative of British or Irish populations as a whole. Representativeness within particular regions is more likely to be achieved, but cannot be assumed (especially if few colonies or small population samples are monitored). In particular, if monitoring efforts are directed at individual colonies, the formation of new colonies elsewhere may be missed. Coverage of extensive stretches of coastline is a more satisfactory approach for species not requiring replicate counts. This approach is used, for example, in SOTEAG monitoring of shags, kittiwakes and black guillemots in Shetland.

Breeding success: use of 'low-input' methods

For general monitoring purposes, the number of chicks fledged per breeding (or nest-occupying) pair is the most useful parameter. This is less time-consuming to assess than, e.g., clutch-size, hatching success, or fledging success of hatched chicks, although will reflect all of these (to varying degrees). Productivity of species other than terns is usually assessed for sample plots (ideally ca. 50 'pairs' each) within colonies. For such species, and figures presented here have generally been averaged (rather than combined) between plots. Random selection of plots improves the likelihood of achieving representativeness within a colony. For terns whole-colony assessments of productivity are usually made. Note that for some species or regions, few colonies are monitored as yet, so that results may not be geographically representative.

In most cases, the 'low-input' methods used will overestimate the productivity of breeding pairs slightly. The methods used for fulmar, shag, kittiwake, guillemot and puffin were developed for the Seabird Monitoring Programme by Harris (1989), and can be applied to similar species. Field tests of these methods suggest that the degree of overestimation is generally up to 10 or 20%, depending on the frequency of monitoring visits during the season. This is considered acceptable, as major geographical or year-to-year changes will still be obvious. Where methods are known to have differed greatly between years this is noted for the relevant colony.

TABLE 2.1 Counts or estimates of total breeding populations of seabirds in Britain and Ireland in 1985-87 (mainly) (Seabird Colony Register). Units are 'pairs' for all species except auks (individual birds) - see Appendix 1 for precise units. See Lloyd *et al.* 1991 (from which counts, except arctic tern, are taken) for further details; figures have been revised slightly since 1989 report.

	Britain[a] coastal	Britain & Ireland[b] coastal	% change 1969-87[c] (B & I coastal)	B & I total[d]
Fulmar	537 000	571 000	+85%	571 000
Manx shearwater[e]	250 000+	c275 000	?	c275 000
Storm petrel	41+ colonies	72+ colonies	?	72+ cols.
Leach's petrel	7+ colonies	8+ colonies	?	8+ cols.
Gannet	158 700	187 900	+36%	187 900
Cormorant	6 050	10 400	+30%	11 700
Shag	36 400	47 300	+40%	47 300
Arctic skua	3 350	3 350	< +220%	3 350
Great skua	7 900	7 900	< +150%	7 900
Black-headed gull	77 300	84 200	+13%	233 000
Common gull	14 800	15 700	+21%	71 400
Lesser b.-b. gull	62 300	64 400	+28%	88 700
Herring gull	135 000	191 000	-43%	206 000
Great b.-b. gull	18 300	23 300	+3%	23 400
Kittiwake	492 000	544 000	+22%	544 000
Sandwich tern	14 050	18 400	+53%	18 600
Roseate tern	135	340	-80%	475
Common tern	11 850	14 700	-1%	16 000
Arctic tern[f]	47 000?	50 000?	-5%?	50 000?
Little tern	2 400	2 800	+40%	2 800
Guillemot	1 047 000i	1 203 000i	+118%	1 203 000i
Razorbill	147 000i	179 000i	probably +	182 000i
Black guillemot	37 500i	41 000i	probably +	41 000i
Puffin[g]	895 000i	930 000i	slightly +?	930 000i

Notes:

[a] Figures for Britain exclude Isle of Man and Channel Isds (included under B & I).

[b] Irish figures include some estimates (mainly for fulmar, shag and gulls) for coastal sections which had not been surveyed by 1988.

[c] Comparisons with results of 1969-70 'Operation Seafarer' survey (re-analysis of counts used by Cramp *et al.* 1974); differences in count methods prevent direct comparison for some species.

[d] British & Irish totals for some species include estimates of inland populations, to be revised once further information has been collated for the SCR.

[e] Manx shearwater figures very approximate (midpoints of population estimates).

[f] Arctic tern figures in Lloyd *et al.* (1991) use 1980 counts for Shetland and Orkney; figures quoted here are based on 1989 counts by RSPB which indicated 55% decline in Shetland and 40% decline in Orkney since 1980 (Walsh *et al.* 1990).

[g] Puffin figures very approximate (include high proportion of counts of pairs, multiplied by two to give individuals).

TABLE 2.2 Groupings of coastal counties or districts used in calculating population indices for defined regions. [Based on Figure 1 of Lloyd *et al.* (1991), except that Shetland and Orkney are each treated separately from 'NE Scotland' and the Inverness-to-Caithness coastline is treated separately ('N Scotland') from 'NW Scotland' here.]

County/District (clockwise from SW Scotland)	Defined region
Annandale & Eskdale, Nithsdale, Stewartry, Wigtown, Kyle & Carrick, Cunninghame, Inverclyde, Dunbarton, Argyll & Bute	SW Scotland
Lochaber, Skye & Lochalsh, Ross & Cromarty (west), Sutherland (northwest), Western Isles	NW Scotland
Shetland	Shetland
Orkney	Orkney
Caithness, Sutherland (east), Ross & Cromarty (east), Inverness	N Scotland
Nairn, Moray, Banff & Buchan, Gordon, City of Aberdeen, Kincardine & Deeside	NE Scotland
Angus, City of Dundee, NE Fife, Kirkcaldy, Dunfermline, City of Edinburgh, East Lothian, Berwickshire	SE Scotland
Northumberland, Tyne & Wear, Durham, Cleveland, N Yorkshire, Humberside, Lincolnshire	NE England
Norfolk, Suffolk, Essex	E England
Kent, E Sussex, W Sussex, Hampshire, Isle of Wight	SE England
Dorset, Devon, Cornwall, Isles of Scilly, Somerset, Avon, Gloucestershire, Channel Isds	SW Eng./C. Isds
Gwent, S Glamorgan, Mid Glamorgan, W Glamorgan, Dyfed, Gwynedd, Clwyd	Wales
Merseyside, Lancashire, Cumbria, Isle of Man	NW Eng./I. of Man
Londonderry, Antrim, Down	NE Ireland
Louth, Meath, Dublin, Wicklow, Wexford, Waterford	SE Ireland
Cork, Kerry, Limerick, Clare	SW Ireland
Galway, Mayo, Sligo, Donegal	NW Ireland

3.1 Red-throated diver *Gavia stellata*

Breeding numbers and success (figure & table 3.1.1)

Shetland holds over 50% of the British breeding population (Stroud *et al.* 1990). In four sample areas (parts of Unst, Bressay and, on Mainland, North Roe and Eshaness), numbers of successful breeding pairs are monitored annually (Okill 1991). Visits are made to suitable lochs during mid-to-late July, but no specific searches are made for evidence of failed breeding attempts. There has been no significant trend over the period 1980-91 (or 1986-91), and this index of breeding output has varied markedly from year to year (ranging from 34 successful pairs in 1980 to 66 in 1986) (figure 3.1.1). The total fell to only 43 successful pairs in 1988 (the lowest figure since 1980), with some improvement to 49, 56 and 49 in 1989-91 respectively. The latter figures are still below average compared to the period 1981-87. Brood-sizes near fledging are also recorded in the Shetland sample areas. Over the period 1980-91, the ratio of broods of one to broods of two has fluctuated markedly, but the proportion of broods of two is generally highest in years when the number of successful pairs is also high.

Breeding success in Orkney and Shetland during 1986-91 (chicks fledged per breeding pair) is summarised in table 3.1.2. The data are incomplete, but poor breeding success was noted in several parts of Shetland in 1988 and 1990. Some areas were notably more successful than others in particular years. In Orkney, productivity of red-throated divers has also been rather low in recent years (especially on Rousay during 1988-91, and Orkney as a whole in 1989). Few data have been collated for other Scottish regions, and breeding success is usually unclear from the details available. Instances of poor recent breeding success include Rhum (NW Scotland) in 1988 (13 pairs averaged only 0.23 chick/pair), Arran (SW Scotland) in 1987 and 1988, and the Uists (Western Isles) in 1989 (poor success due to predation of eggs by skuas and corvids).

Discussion

Reduced breeding output of red-throated divers in Shetland in recent years has been linked, at least in part, to reduced availability of sandeels (Ammodytidae) in inshore waters, especially during 1988-90. Okill (1991) considered the reduction in the relative proportion of broods of two chicks reared in recent years as evidence for such an influence. Furness (1989) noted that, during 1971-80, 97% of fish being carried by adults on Foula during the breeding season were sandeels. The sandeel proportion fell to 17% in 1988, coinciding with reduced breeding success, and was also low in 1990 (Furness 1990).

Factors such as disturbance by man (in some cases, illegal egg-collecting), predation, flooding of nests, and drying out of nesting-lochs also influence breeding output in Shetland and elsewhere. Even before the late 1980s, productivity of Shetland divers has generally been rather low. Gomersall (1986) reviewed productivity over the period 1918-1982, and calculated an average of 0.45 young/pair from a total sample of 1104 pairs, with no evidence of long-term trends. The precise causes of nesting failure are often unknown for particular pairs, and Gomersall suggested that, even where predation has occurred, it may not have been the primary cause of failure. Bundy (1978) provided evidence that adults which readily left lochs on the approach of human intruders were more likely to fail to rear young, especially when predation pressure (or disturbance) by gulls or great skuas was also high.

Red-throated divers in Orkney in the 1970s appear to have been more successful than Shetland birds, with 0.70 chicks/pair fledged from 104 breeding attempts during 1973-80 (Booth 1982). This is distinctly higher than 1988-91 figures for Orkney.

As noted by Gomersall (1986), most productivity estimates for this species will be overestimates (through early breeding failures being missed), and differences in methodology may account for some differences between areas or years. A detailed study of the effect of survey effort on productivity estimates for Shetland and Orkney pairs, would be useful.

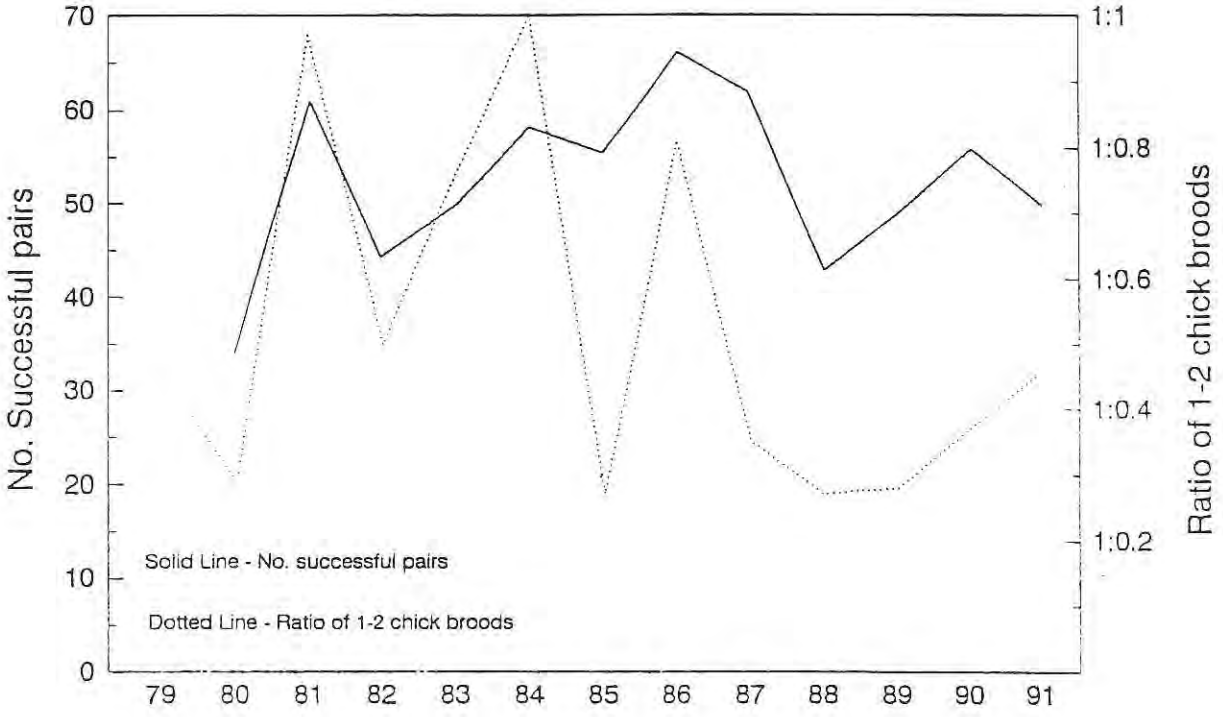

FIGURE 3.1.1 Annual variation in numbers of successful pairs and in brood-size at fledging of red-throated divers in Shetland study-areas (from Okill 1991).

TABLE 3.1.1 **Red-throated diver breeding success, 1986-91:** estimated number of chicks fledged per breeding pair at sampled sites. Note that the numbers of pairs do not necessarily indicate total populations in study areas.

	1986 prs[a]	fledged /pr	1987 prs[a]	fledged /pr	1988 prs[a]	fledged /pr	1989 prs[a]	fledged /pr	1990 prs[a]	fledged /pr	1991 prs[a]	fledged /pr
Hermaness	11	1.00	11	1.09	12	**0.42**	8	**0.88**	7	**0.71**	8	**0.88**
Petlar	-	-	-	**poor**	-	-	17	**0.41**	16	**0.06**	23	**0.43**
Yell	-	-	-	-	-	-	27	**0.85**	7	**0.14**	19	**1.21**
Foula	-	**0.6**	-	-	-	**0.3**	7	**0.43**	7	**0.28**	11	**0.63**
SHETLAND total	-	**good**	-	-	-	-	51	**0.64**	37	**0.16**	61	**0.77**
N Hoy	-	-	\		23	**0.52**	\		20	**0.45**	\	
	-	-	60	**0.7+**			48	**0.44**			91	**0.60**
other Hoy	-	-	/		-	**average**	/		35	**0.57**	/	
Rousay	-	-	-	-	9	**0.22**	12	**0.08**	13	**0.38**	11	**0.27**
Mainland	-	-	(12y reared)		(13y ringed)		13	**0.38**	9	**0.44**	17	**0.76**
ORKNEY total	-	**<1985**	-	-	31	**0.45**	73	**0.37**	77	**0.47**	119	**0.44**

3.2 Fulmar *Fulmarus glacialis*

Breeding numbers (table & figure 3.2.1)

Numbers in Shetland and Caithness, where sample counts of occupied sites are made at several colonies annually, have been roughly stable, or increasing slowly, over 1986-91 as a whole (no significant trends). Sample populations in Shetland increased by 5.3% in 1991, with significant increases at two and a significant decrease at one of the five colonies monitored. In Caithness, numbers fell by 3.4% (significant decreases at two of the four colonies). In Orkney, where adult fulmars (rather than apparently occupied sites) are counted, average June counts at five colonies 1991 were 15% higher than in the previous count, in 1988 (significant increase during 1986-91). Sampled populations in other regions are based mainly on single counts of occupied sites annually and tend to fluctuate more, in part because of day-to-day changes in fulmar attendance. Counts on Canna (NW Scotland) and at several colonies in SE Scotland were up at least 20% on 1990 figures, while the NE Scotland sample declined by a similar percentage. None of these regions has shown any significant recent trend, however. In contrast, significant increases are evident for sample populations in NE England (mainly the Farne Islands) and Wales during 1986-91.

Breeding success (table 3.2.2)

Overall productivity was moderately high and little changed from 1990 figures, with an average of ca. 0.41 chicks (±s.e. 0.02) fledged per site from 31 colonies. (If various colonies where less standardised methods were used are excluded, the average remains within the range 0.40-0.43.)

Colonies on North Sea coasts (including the northern isles) averaged 0.44±0.02 chicks/site, representing a slight but significant increase over 1990 (average increase 0.06±0.03 chicks/site, $t_{18} = 2.16$, $P<0.05$). Orkney colonies were again among the most successful (average 0.50±0.02 chicks/site at seven colonies, little change from 1990). Productivity at Shetland colonies averaged 0.44±0.03 chicks/site, an improvement over 1988-90 (average change ±0.08±0.04 from 1990) but still below 1986-87 averages (0.52-0.54). As in 1990, two east Caithness colonies produced few chicks (0.22/site each). Success improved at colonies in SE Scotland (compared to 1988 and 1990). On the west coast of Scotland, productivity fell on Canna and (most markedly) on Handa, but was similar to the national average. Outside of Scotland, fulmars on the Farne Islands (NE England) were again successful (0.57 chicks/site). Colonies in the Isle of Man and the Channel Islands were again among the least successful, however.

Discussion

Fulmar populations in virtually all regions evidently continue to increase, or at least to maintain their numbers, despite some apparent major year-to-year changes. As with the auks (see sections 3.21-3.24), variations in attendance behaviour of non-breeding fulmars can have a marked influence on counts, and this applies whether counts of apparently occupied sites or of individual birds are used. Some allowance for day-to-day changes can be made by using the average of several June counts. The possibility remains that the proportion of 'nest-sites' occupied by non-breeders may also vary from year to year.

The factors behind regional or annual variations in fulmar breeding success are not always clear. Reduced breeding success in Shetland since the mid 1980s (especially in 1988-90) does appear to have reflected availability of sandeels (Ammodytidae) there. Food availability may also be influencing productivity at other North Sea

colonies in some years, e.g. in the Firth of Forth in 1990. Factors such as weather or predation might also be important, and predation may account for some of the geographical variation seen in breeding success.

TABLE 3.2.1 **Population changes at monitored fulmar colonies, 1990-91** (apparently occupied sites in June). Superscript = number of colonies with 10+ AOS counted in 1990; counts with a reported inaccuracy of > ±5%, and regional samples <100 AOS in 1990, are excluded. Figures for regions in block capitals are based on the means of 4-10 counts per year at each colony.

	SHETLAND	N SCOT.	NE Scot.	SE Scot.	NE Engl.
1990	1 863	1 481	471	933	238
1991	1 962	1 430	379	1 158	260
% change	+5.3[5]	-3.4[4]	(-19.5)[2]	(+24.1)[3]	(+9.2)[1]

	Wales	NW Eng/I.o.Man	NW Scot.
1990	775	331	421
1991	732	337	520
% change	(-5.5)[2]	(+1.8)[3]	(+23.5)[1]

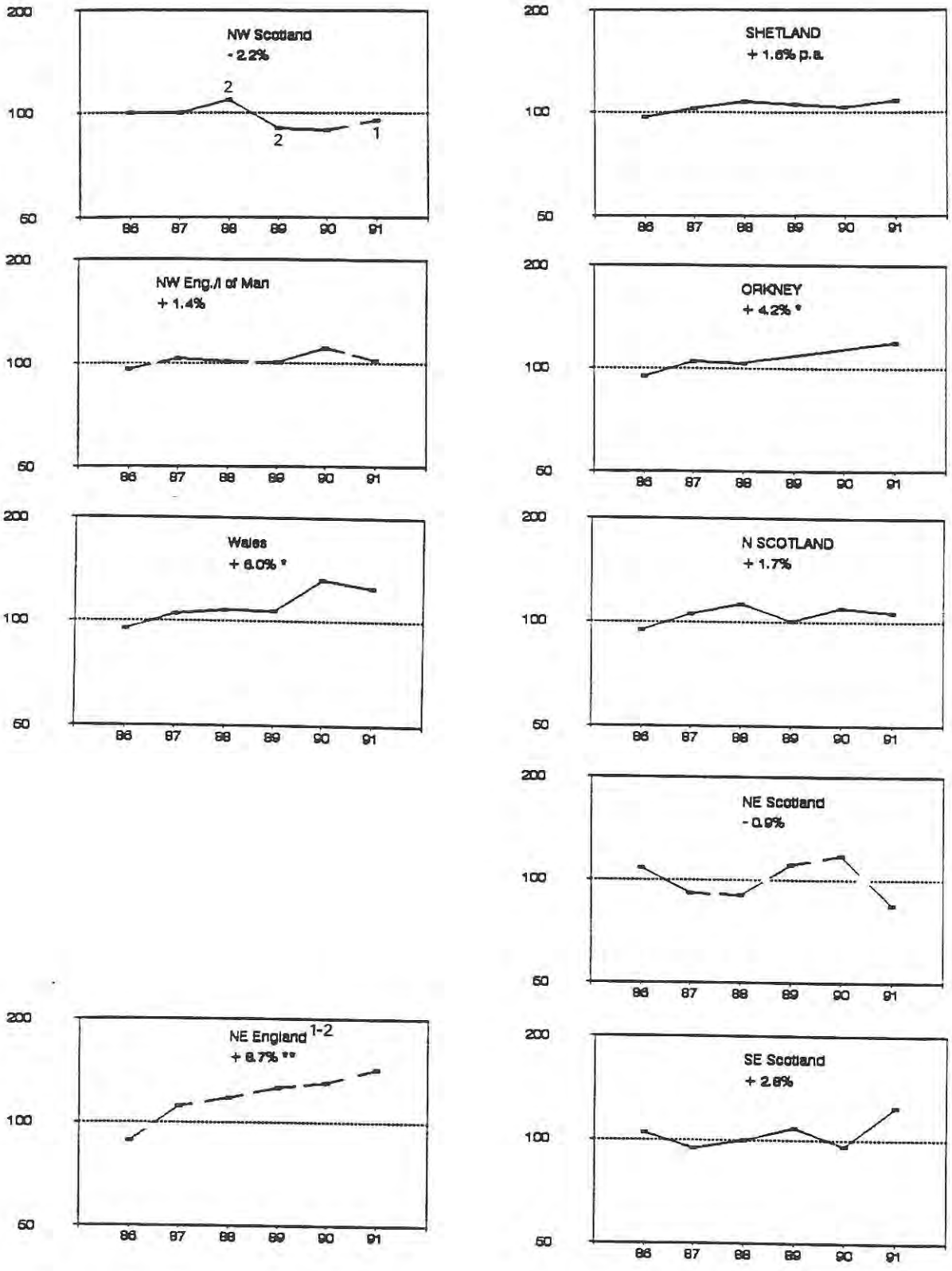

FIGURE 3.2.1 **Regional population indices for breeding fulmars, 1986-91 (apparently occupied sites in June).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05; ** P< 0.01). Region names in capitals indicate indices based on 4-10 counts per colony each year. Broken trend-lines indicate samples of 100-500 AOS. No. of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

TABLE 3.2.2 **Fulmar breeding success, 1986-91:** number of chicks fledged per apparently occupied site. Figures are based on 'regularly-occupied' sites (see Methods) or the average number of occupied sites in June (indicated by superscript A). Productivity is presented as mean ±standard error of figures from three or more plots (or midpoint ±half-range of two figures); * indicates coverage of all visible parts of colony. (See 1989 & 1990 reports for 1986-89 sample sizes.)

Colony	1986 Fledged/ site	1987 Fledged/ site	1988 Fledged/ site	1989 Fledged/ site	1990 Sites (plots)	1990 Fledged/ site	1991 Sites (plots)	1991 Fledged/ site	
Colonsay (Argyll & Bute)	-	0.45 ±0.07	0.35 ±0.08	0.51 ±0.06	64(2)	0.43 ±0.02	73(2)	**0.50 ±0.04**	a*
Canna (Lochaber)	0.34 ±0.14	0.61 ±0.15	0.31 ±0.18	0.30 ±0.13	44(2)	0.44 ±0.09	45(2)	**0.33 ±0.22**	b
St Kilda (W. Isles)	-	-	-	0.46	647(3)	0.41 ±0.13	-	-	
Uig, Lewis (W. Isles)	-	0.41 ±0.03	0.28 ±0.14	-	-	-	-	-	
Handa (Sutherland)	-	-	-	0.62 ±0.18	169(2)	0.62 ±0.10	167(2)	**0.41 ±0.06**	c
Faraid Head (Sutherland)	-	-	-	-	50(2)	0.34 ±0.06	-	**<0.54**	d
Hermaness[A] (Shetland)	-	-	-	0.33 ±0.05	276(2)	0.37 ±0.02	303(2)	**0.32 ±0.06**	e
Eshaness[A] (Shetland)	0.49 ±0.10	0.55 ±0.10	0.37 ±0.03	0.43 ±0.08	253(4)	0.30 ±0.09	236(4)	**0.47 ±0.03**	f
Noss[A] (Shetland)	0.53 ±0.04	0.50 ±0.14	0.30 ±0.03	0.33 ±0.02	450(3)	0.40 ±0.02	504(3)	**0.37 ±0.04**	g
Foula (Shetland)	good	good	poor	improved	-	-	-	-	
Westerwick[A] (Shetland)	-	-	-	-	81(1)	0.33	78(1)	**0.42**	f
Troswick Ness[A] (Shetland)	0.56 ±0.03	0.39 ±0.10	0.40 ±0.05	0.46 ±0.04	860(6)	0.44 ±0.03	876(6)	**0.44 ±0.05**	f
Sumburgh Head[A] (Shetland)	0.53 ±0.07	0.64 ±0.11	0.28 ±0.10	0.46	169(3)	0.39 ±0.04	200(3)	**0.54 ±0.07**	f
Fair Isle (Shetland)	0.51 ±0.05	0.60 ±0.03	0.43 ±0.03	0.52 ±0.04	423(5)	0.27 ±0.03	401(5)	**0.52 ±0.08**	h
N Ronaldsay (Orkney)	-	0.34	-	-	-	-	-	-	
N Hill, Papa Westray (Orkney)	-	-	-	0.41	94(*)	0.40	82(*)	**0.50**	i
Costa Head (Orkney)	-	-	-	0.50 ±0.05	217(3)	0.42 ±0.03	175(3)	**0.55 ±0.03**	j
Row Head (Orkney)	-	-	-	0.54	-	-	-	-	
Mull Head (Orkney)	-	-	-	0.32 ±0.09	177(5)	0.40 ±0.02	162(5)	**0.44 ±0.06**	j
Gultak (Orkney)	-	-	-	0.28 ±0.05	148(4)	0.47 ±0.06	140(4)	**0.49 ±0.06**	j
Hoy (Orkney)	-	-	-	0.48 ±0.04	113	0.64	100	**0.56**	k
Rousay, inland (Orkney)	-	-	-	0.52	46	0.52	48(3)	**0.50 ±0.09**	l
Rousay coastal (Orkney)	-	-	-	-	68	0.62	76(3)	**0.50 ±0.13**	l

St John's Hd (Caithness)	-	-	-	-	50(1)	0.50'	-	-	
Sandside Hd (Caithness)	-	-	-	-	50(2)	0.54'±0.22	-	<0.58	d
Iresgeo[A] (Caithness)	0.46 ±0.06	0.35 ±0.05	0.35 ±0.03	0.31	663(5)	0.23 ±0.04	659(5)	**0.22** ±0.03	m
An Dun[A] (Caithness)	0.41 ±0.04	0.34 ±0.05	0.35 ±0.03	0.26	568(5)	0.29 ±0.03	500(5)	**0.22** ±0.02	m
Isle of May (NE Fife) mean	0.53 ±0.10	0.47 ±0.11	0.31 ±0.09	0.60 ±0.10	-	-	-	-	
total		0.56		0.54	66	0.24	110	**0.42**	n
Tantallon (East Lothian)	-	0.51 ±0.13	0.37 ±0.10	0.52 ±0.18	93(3)	0.16	184(4)	**0.42'**±0.12	o
St Abb's Hd (Berwickshire)	-	-	-	-	c277	c0.15	315(*)	**0.30**	p
Farne Isds (Northumberland)	0.49	0.78 ±0.11	0.39 ±0.06	0.50	65(2)	0.53 ±0.15	132(3)	**0.57** ±0.09	q
Weybourne-Sheringham (Norfolk)	-	-	-	-	80(*)	0.37	-	-	
Guernsey (Channel Isds)	0.50'	0.17'	0.30'	0.19'	38	0.21'	22	**0.32**	r
Bardsey (Gwynedd)	-	0.60	-	-	-	-	-	-	
Calf of Man (Isle of Man)	-	-	0.44 ±0.22	-	-	-	-	-	
Traie Vane-Gob yn Ushtey (I/M)	0.31'	-	-	0.26+'	134(*)	0.23'	134(*)	**0.18'**	s
Around Peel Hill (Isle of Man)	-	0.19'	0.18'	-	67	0.27'	330(*)	**0.18'**	s
Glen Maye (Isle of Man)	0.33'	0.21'	0.7	0.25'	26(*)	0.27'	28(*)	**0.25'**	s
Bradda (Isle of Man)	-	-	-	-	-	-	44	**0.29**	s
Douglas (Isle of Man)	-	-	-	-	-	-	57	**0.40**	s

'= based on comparison of chick count in August with single count of AOS in June (thus productivity per regularly-occupied site may be underestimated slightly).

[A]1991 sources: a. J Clarke. b. Swann (1991). c. Furness & Aitken (1992). d. D M Stark. e. Swale (1991). f. SOTEAG. g. Armstrong & Gilbert (1991). h. Harvey & Orsman (1991). i. T Dodman (RSPB). j. P M Walsh. k. K Fairclough (RSPB). l. C Whyte. m. Evans (1991). n. Harris (1991). o. S R da Prato. p. Rideout et al. (1992). q. National Trust. r. M G Hill. s. A S Moore.

3.3 **Manx shearwater** ***Puffinus puffinus***

On Canna (NW Scotland) in 1991, only 25 (43%) of 58 study burrows were known to have been laid in. This is similar to the 1990 figure (42%), and higher than in 1989 (24%), but below the usual 60-70% occupancy rate recorded during 1976-88 (Swann 1991). Of the 25 burrows with eggs, 13 produced large chicks (0.52/egg). This is the same as in 1990, and close to the 1976-88 average (1976-88).

Observations at other colonies will be summarised in next year's report.

3.4. Leach's petrel *Oceanodroma leucorhoa*

Breeding numbers

On Gruney, Ramna Stacks (Shetland), nine occupied burrows were located on 21 August using tape-recording and an endoscope. Eight of the burrows held chicks (the other a deserted egg), and a population of ca. 20 breeding pairs was estimated. Breeding was last confirmed here in 1981, when <50 pairs were estimated (Fowler 1982). Elsewhere in Shetland, 15-20 suitable burrows were located at The Noup, Foula, in mid-August. No response to a Leach's petrel tape-recording was recorded, although it may have been too late in the season.

A bird was mistnetted on Eilean Hoan (Sutherland) in late July, without the use of tapes, and several others were thought to have been present. However, there was no response to a tape played near suitable burrows; Leach's petrels have never been recorded breeding at this site. On Eilean Mor in the Flannan Isles (Western Isles), large numbers were recorded in late August. Over 100 were caught in a single 60-foot net without tape-lures over two nights, and some regurgitated food. Several hundred petrel burrows were found, and although Leach's petrels were heard calling in many of these, some were probably occupied by storm petrels. Several hundred, perhaps thousand, breeding pairs of each were estimated.

Discussion

Estimating breeding numbers and breeding success for the small petrels is notoriously difficult, and small colonies may go unnoticed or unconfirmed. The use of an endoscope has proved invaluable in locating occupied burrows and examining their contents on Gruney, Shetland, confirming that this colony (first discovered in 1980 by Fowler 1982) is still occupied. The expense of an endoscope rules out its widespread use, but other methods of locating this species are possible.

Incubating birds will respond to tapes (particularly of chatter-calls of the same sex: Taoka *et al.* 1989). Calling birds in burrows cannot be taken as proof of breeding, but responses from burrows during daylight are less likely to involve non-breeders (James & Robertson 1985). Numbers of apparently occupied burrows in random plots within suitable colonies could provide a basis for assessment of colony-size or major changes in burrow-occupancy between years. Such work would be useful at the larger colonies in particular (e.g. the Flannan Isles and St Kilda), where little or no reliable information is available on numbers and none on trends.

3.5 Storm petrel *Hydrobates pelagicus*

Breeding numbers

On Mousa, Shetland, monitoring continued at the same site as in 1990. In five nocturnal visits during July and August, 190 apparent territories were located in the study plot (a 250m length of wall), based on birds churring regularly from the same position. 52 chicks were located with an endoscope. This compares with 165 territories and 45 chicks found in 1990. At Noss, several birds were recorded flying about Cradle Holm at night, and breeding was considered likely in the boulder-fall there.

Three Orkney colonies were visited in 1991. On Rusk Holm, over 120 birds were

trapped in two visits in July-August, without the use of tape lures. Several occupied burrows were located and it seems likely that there is a sizable breeding population. (Birds were also churring from burrows in 1985-86.) On Eynhallow, four birds were heard calling from a stone cairn at the end of August, and one of nine birds caught nearby regurgitated food. Breeding is likely, but probably involves few birds; 15 churring birds were recorded in 1986. A visit to the Holm of Papa Westray in early September failed to locate signs of storm petrels (40+ churring birds had were estimated, and chicks were recorded, in 1986).

Forty birds were caught in a single 30 ft net on Eilean Hoan (Sutherland) in late July, and birds were also churring from burrows or crevices; this is thought to be a reasonably large colony. On Eilean Mor, Flannan Islands (Western Isles), over 100 birds were netted over two nights in late August in a 60-ft net, without using tape-lures. Several birds regurgitated food. Petrel chicks were calling from many of the several hundred likely burrows found, although some may have been Leach's petrel. As with the latter, a population of several hundred, possibly thousand, breeding pairs was estimated. Elsewhere in the Western Isles, storm petrels were present on Shillay in July, although no estimate of numbers was made; 225+ occupied burrows were recorded in 1990. In SW Scotland, storm petrels were again recorded on Sanda, Kintyre (where first confirmed in 1977), and breeding was confirmed on Lunga, Treshnish Isles (last proved breeding in 1937 apparently, but probable in 1969-70).

On Gugh (Isles of Scilly), at least 12 freshly-killed storm petrels were found on 2 July, cats being the most likely predator. No proof of breeding was obtained. A single egg was found on Annet (Isles of Scilly) in July, and, of 100 birds caught with a 30-ft net in one night (no tape-lure), 10 regurgitated food. A visit to Grassholm (Wales) in July located several birds churring from a small area of boulder scree. Breeding has never been proven here, but a small population seems likely (substantial populations are present on nearby Skokholm and Skomer). On the Calf of Man, 16 birds carrying food were netted in July/August, and birds were seen entering and leaving crevices at one site; 20-50 occupied sites were estimated. A single bird was caught on Coquet Island (Northumberland) in July, without the aid of a tape lure. Breeding has never been proven here, and there are currently no known colonies on North Sea coasts south of Orkney.

Discussion

The use of "Common Bird Census"-type techniques to assess storm petrel population changes is currently being tested by RSPB on Mousa, Shetland. Results are being evaluated, but look promising, and it would be useful if similar methods could be applied at other colonies. Further details are available from J. Sears at the RSPB.

Estimates of breeding numbers are desirable at colonies where only presence has previously been noted, and visits to other potential breeding colonies could prove fruitful (see Cramp *et al.* 1974 and Lloyd *et al.* 1991 for summaries of known colonies). As with Leach's petrel, the use of an endoscope was invaluable in inspecting burrow contents in Shetland; the presence of eggs or chicks is otherwise extremely difficult to confirm in most cases. However, using tapes to elicit responses from birds in burrows may give an indication of the number of occupied burrows (see James & Robertson 1985).

For both Leach's and storm petrel, breeding populations are very easy to overlook or underestimate. It seems sensible, therefore, to regard any sites where petrels are heard calling from burrows or crevices as probable breeding sites. Grassholm in Wales thus falls within this category. Confirmation of breeding (or, at least, of regular burrow-occupancy) should be sought where possible. Sites where petrels are netted without the aid of tape-lures may also involve breeders in many cases,

but are probably best treated as possible breeding locations only. Birds which regurgitate solid food when handled should perhaps be regarded as probable breeders, but the use of brood-patches in assessing breeding status may be more complicated (e.g., Furness & Baillie 1981)

3.6 Gannet *Morus bassanus*

Breeding numbers (figure 3.6.1)

Numbers at four of the smaller British colonies continued to increase in 1991. Totals were ca. 280 occupied nests on Foula (Shetland) (+27% since 1990), 687 on Fair Isle (Shetland) (+6.8%), 1252 at Bempton (Humberside) (+21%) and 94+ occupied sites at Troup Head (Banff & Buchan). Gannets first bred at the latter colony in 1988 (4+ nests), with 12 nests in 1989 and 38 in 1990. Numbers at all four colonies have increased significantly during 1986-91, although Fair Isle and Bempton numbers fell slightly in 1990.

Three of the larger British colonies were censused in July 1991 (Noss and Hermaness in Shetland, and Grassholm in Dyfed). At Hermaness, 10 057 nests were recorded. Based on re-analysis of previous counts, this represents a 7.6% increase since 1982 (equivalent to an average 0.8% per year) and a 1.6% increase since 1986 (Murray 1992). On Noss, colony sections visible from land totalled 5904 nests in 1991, a 20% increase since 1982 (equivalent to 2.0% per year). The 1984 count was similar to that in 1982, but the 1989 count of 7218 nests is now considered an overestimate (Murray & Wanless 1992). Preliminary analysis of counts from of aerial photographs taken of the Grassholm colony indicates little or no change since the 1984 count of 28,544 occupied sites (S Murray in prep.), although some increase is suggested by expansion of the colony limits.

Breeding success (table 3.6.1)

Average productivity was moderately high at five colonies (excluding Troup Head) in 1991, averaging 0.65 chicks fledged/nest ($\pm$0.04). This is similar to the 1990 average, although productivity fell at three out of four colonies. The least successful colonies were Fair Isle (0.52 chicks/nest) and, possibly, Troup Head (where 94+ occupied sites averaged $\underline{c}$0.55 chicks/site).

Discussion

Although gannet numbers appear to be increasing at most colonies counted in 1991, rates of growth are much slower at the larger colonies. Counts of the Hermaness and Noss gannetries in 1991, and analysis of counts from the period 1982-89, have confirmed the difficulty of comparing counts made by different observers or using different methods (Murray 1992; Murray & Wanless 1992). Counts of large colonies should, where possible, be broken down into readily identifiable subsections, and these should be documented photographically. Major discrepancies between counts can then be assessed in more detail, and it may be possible to pinpoint particular subsections where errors have been made. An analysis of annual counts for sample plots within the Noss colony concluded that the plots were too few and covered too little of the colony total (and extent) to be representative of whole-colony trends (Murray & Wanless 1992).

Breeding success continues to be relatively high at the majority of colonies. There is only limited evidence that Shetland birds were adversely influenced by poor sandeel availability during 1988-90; despite an improvement in the latter, productivity fell at two of the colonies in 1991. Geographical coverage of productivity at gannet colonies was improved in 1991, with the inclusion of an Ailsa Craig sample and four new study-plots at Bempton. Further colonies will be added if possible.

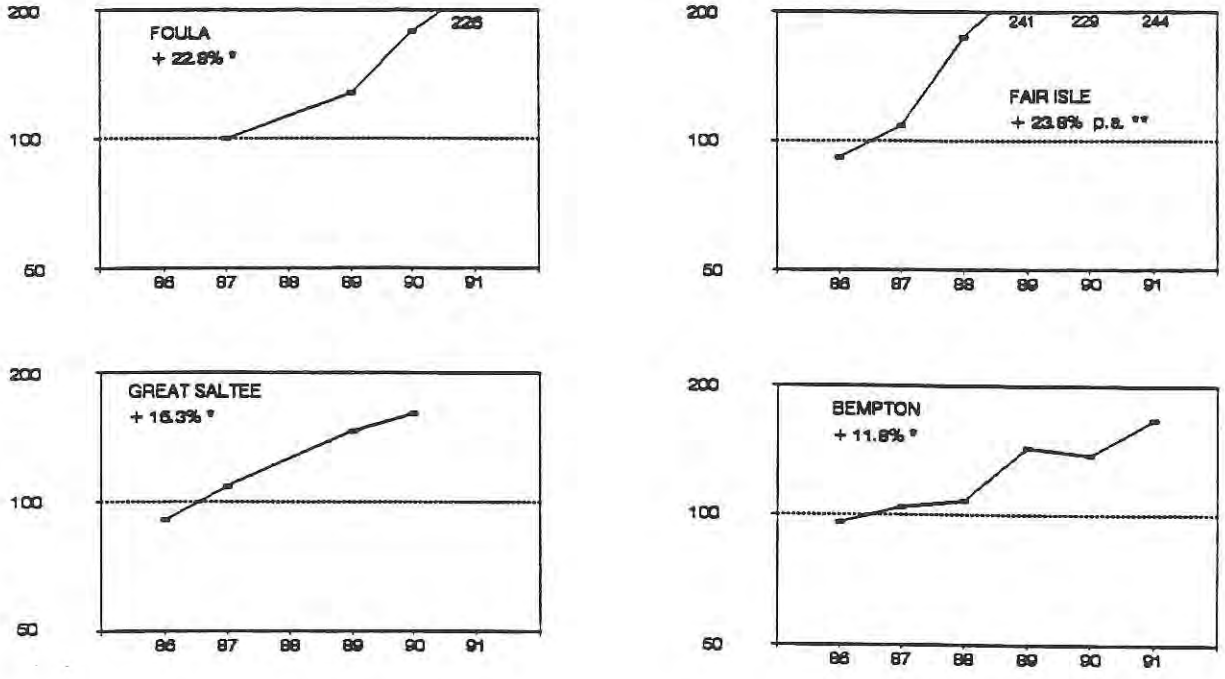

FIGURE 3.6.1 **Population indices for monitored gannet colonies, 1986-91 (occupied nests or sites in June - July).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05; ** P<0.01).

TABLE 3.6.1 **Gannet breeding success, 1986-91:** number of chicks fledged per occupied nest. Figures are presented as mean ±s.e. if based on more than one study plot. (See 1989 & 1990 reports for 1986-89 sample sizes.)

Colony	1986 Fledged/ nest	1987 Fledged/ nest	1988 Fledged/ nest	1989 Fledged/ nest	1990 Nests (plots)	1990 Fledged/ nest	1991 Nests (plots)	1991 Fledged/ nest	
Ailsa Craig (Kyle & Carrick)	-	-	-	-	-	-	62(1)	**0.66**	a*
Hermaness (Shetland)	-	-	-	0.78"	388(1)	0.63"	457(1)	**0.75**	b
Noss (Shetland)	0.73"±0.02	0.66"±0.04	0.72"±0.03	0.68"±0.04	301(4)	0.72"±0.05	355(4)	**0.63"±0.02**	c
Fair Isle (Shetland)	0.58	0.48	0.78	0.78	159	0.60	150	**0.52**	d
Troup Head (Banff & Buchan)	-	-	(1.00"	0.58"	38"	0.37	-	-	
Bempton (Humberside)	0.80+"	0.85"	0.81"	0.64	199(2)	0.77"±0.04	141(4)	**0.67 ±0.02**	e

*1991 sources: a. B Zonfrillo. b. Swale (1991). c. Armstrong & Gilbert (1991). d. Harvey & Armstrong (1991). e. RSPB.
" = based on comparison of chick count in mid August with peak nest count in June-July; other data are based on regular checks of mapped nests.

3.7 Cormorant *Phalacrocorax carbo*

Breeding numbers (table & figure 3.7.1)

The biggest change seen in 1991 was a 29% decrease at ten Welsh colonies since 1990 (including decreases at seven or eight individual colonies). Numbers also fell in three other regions, notably Shetland, where a 15% decrease follows a similar decrease in 1990). SE Scotland was the only region to show an increase (+19%), and is also the only region where numbers have increased significantly over 1986-91 as a whole. No other 1986-91 trends are significant, but most populations appear to have been stable or increasing (at least up to 1989 or 1990). Counts for SW England have not been compiled fully yet, but 1991 figures indicate a 47% increase at nine colonies since the early/mid 1980s (per R. M. Sellers).

Breeding success

Only limited information is available. At North Sutor (Ross & Cromarty in N Scotland), 37 nests produced an average of 2.54 fledged chicks/nest.
At Shetland colonies, average brood-size at ringing (3.0) was higher than in 1990 (2.6), although success from the egg stage is not known. In NE Ireland, one of the two Strangford Lough colonies was badly affected by strong winds and high tides, and productivity averaged only ca. 0.77 chicks from 90 nests. Fledging success on St Margaret's Island in SW Wales appeared to be good.

Discussion

Low breeding numbers at Welsh colonies in 1991 were associated with a late start to the breeding season at most colonies (R. M. Sellers pers. comm.). Many adults in SW Wales appeared not to have bred in 1991, so the population change may be only temporary (cf. shag for discussion of 'non-breeding years' in that species.) The marked decrease in Shetland for the second year in succession may be more serious however. As noted in the 1990 report, cormorants and shags sometimes show similar patterns of annual population change in particular regions. This year, monitored populations of both species increased substantially in SE Scotland, but similarities were not were not very obvious elsewhere.

TABLE 3.7.1 **Population changes at monitored cormorant colonies, 1990-91** (apparently occupied nests, mid May to June). Superscript = number of colonies counted in both years; counts with a reported inaccuracy of > ±5%, and regional samples <50 AONs, are excluded.

	Shetland	SE Scot.	NE Engl.	Wales	NE Irel.
1990	319	427	322	1006	227
1991	272	510	313	718	225
% change	-14.7^{7}	$+19.4^{4}$	-2.8^{2}	-28.6^{10}	-0.9^{4}

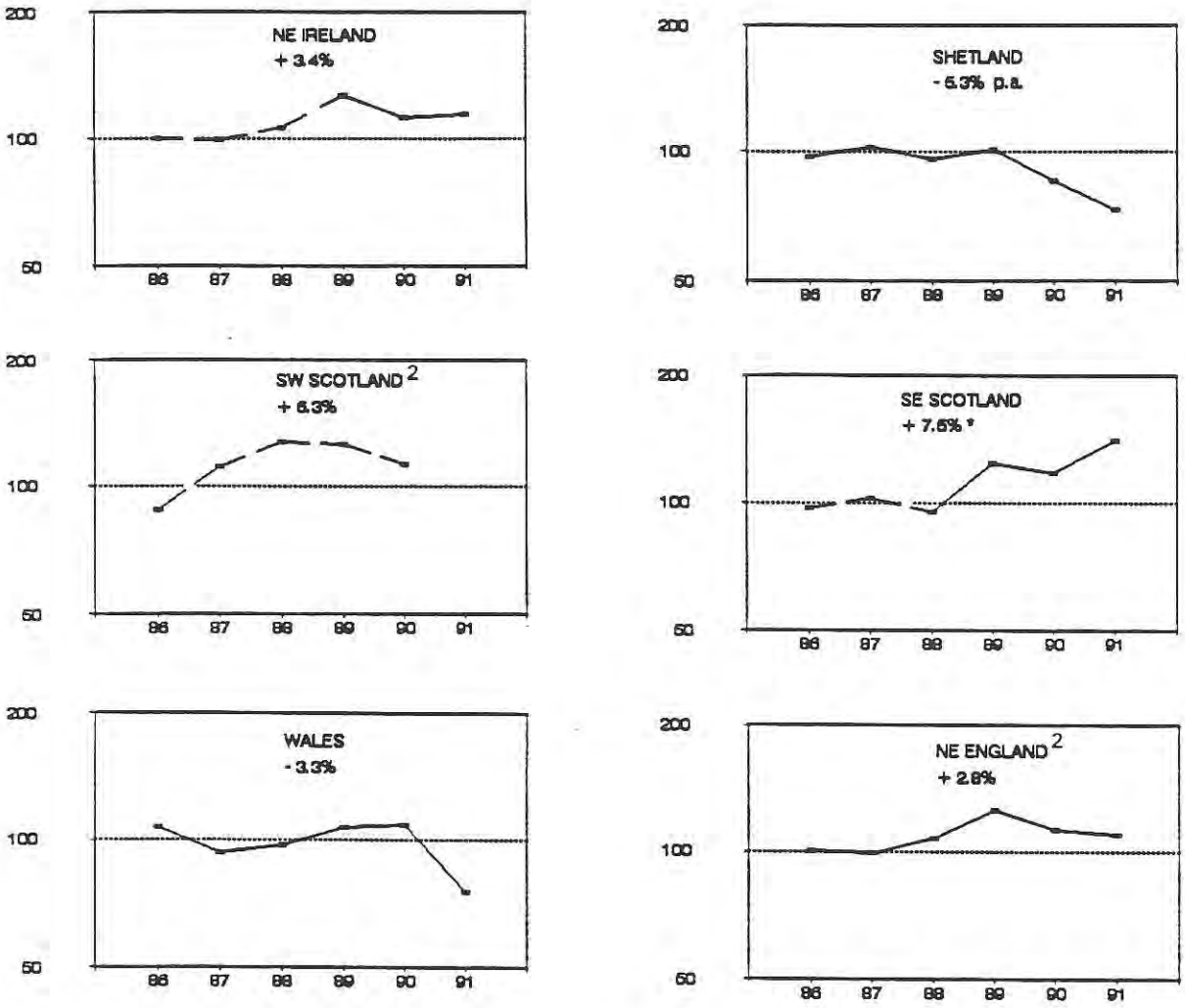

FIGURE 3.7.1 **Regional population indices for breeding cormorants, 1986-91 (apparently occupied nests in May/June).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05). Broken trend-lines are based on sample counts of 50-200 AONs. Number of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

3.8 Shag *Phalacrocorax aristotelis*

Breeding numbers (table & figure 3.8.1)

Shag numbers increased in 1991 at all monitored colonies on the North Sea coast from Caithness south to the Farne Islands (NE England). Sampled populations in the three regions increased by 9-19%, compared to decreases of 7-13% in 1990. Trends for these regions indicate stable or increasing numbers during 1986-91 as a whole (significant increase for NE England, mainly based on the Farnes). Further north, monitored populations in Shetland have declined significantly during 1986-91, although only a slight decrease (-3%) was noted in 1991 (14% decrease the previous year). Numbers decreased again on Canna (NW Scotland) for the fifth year running. In the small Welsh sample, little change was seen in 1991, but there has been a significant decline during 1986-91.

Breeding success (table 3.8.2)

Average success was moderately high (1.41 ±s.e. 0.12 chicks fledged/nest) at the 12 colonies sampled in 1991. This represents a significant increase over 1990 for colonies monitored in both years (average change +0.36 ±s.e. 0.15 chicks/nest, t_8 = 2.36, $P<0.05$). In particular, colonies in Shetland and SE Scotland were much more successful than the previous year, averaging 1.22±0.15 chicks/nest (compared to 0.61±0.12 in 1990). This improvement at North Sea colonies was not seen on the Farne Islands (NE England), where average productivity of only 0.8 chicks/nest was a further decline on 1990 figures. Success also fell again on Canna (NW Scotland). Four colonies in southwest Britain were the most successful this year (average 1.70±0.13), with Guernsey Shags having their most successful recent year.

Discussion

Reduced breeding success of shags in Shetland was evident in 1989 and 1990 at least, apparently associated with low availability of sandeels. Sandeel availability around Shetland improved in 1991, and with it breeding success of several seabird species. Poor success at two colonies in the Firth of Forth (SE Scotland) in 1990 (and on the Isle of May in 1988) may also have been associated with food availability. Average productivity of Shetland shags is still below-average for Britain as a whole, but few older data are available to indicate what the 'normal' geographical pattern is. It is clear, however, that breeding success of this species can fluctuate markedly from year to year, whatever the region.

Marked changes in productivity at particular shag colonies often match sudden changes in breeding numbers, which tend to suggest a common influence of food availability or feeding conditions. The phenomenon of 'non-breeding years' in shags is discussed with reference to the Isle of May colony by Aebischer & Wanless (1992). Such events are also believed to have occurred on Canna and in Shetland in some recent years.

TABLE 3.8.1 **Population changes at monitored shag colonies, 1990-91** (apparently occupied nests in late May/June). Superscript = number of colonies with 10+ AONs counted in 1990; counts with a reported inaccuracy of > ±5%, and regional samples <50 AONs, are excluded.

	Shetland	N Scot.	SE Scot.	NE Engl.	Wales	NW Scot.
1990	869	281	2 694	1 572	64	1 046
1991	839	335	3 196	1 716	63	918
% change	-3.4^{6}	$+19.2^{3}$	$+18.6^{7}$	$(+9.1)^{1}$	$(-1.6)^{2}$	$(-12.2)^{1}$

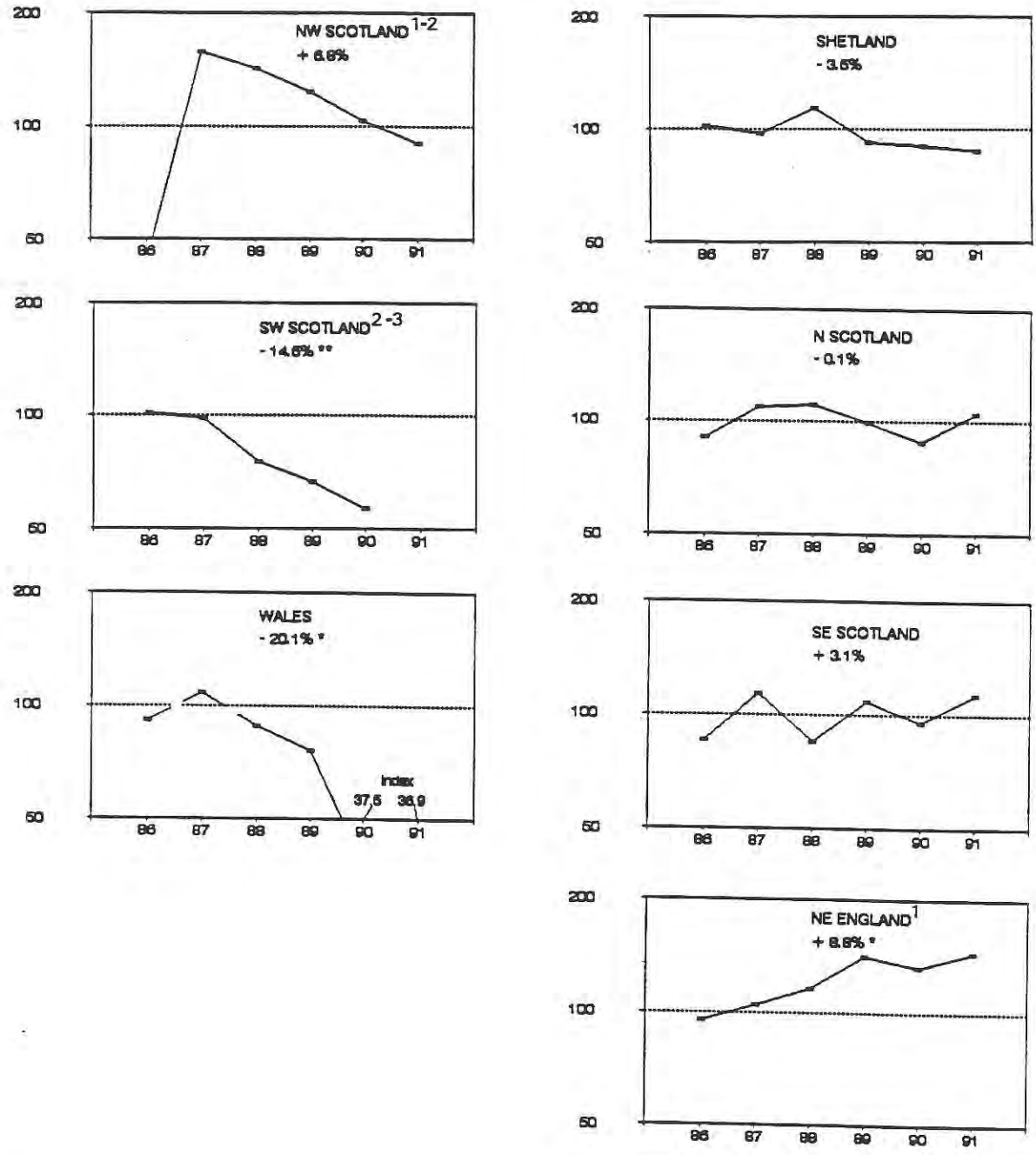

FIGURE 3.8.1 **Regional population indices for breeding shags, 1986-91 (apparently occupied nests in late May/June).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * = P<0.05; ** P<0.01). Broken trend-lines are based on samples of 50-200 AONs. No. of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

TABLE 3.8.2 **Shag breeding success, 1986-91:** number of chicks fledged per nest where eggs or apparent incubation recorded. Productivity is presented as mean ±standard error of figures from three or more plots (or midpoint ±half-range of two figures). (See 1989 & 1990 reports for 1986-89 sample sizes.)

Colony		1986 Fledged/ nest	1987 Fledged/ nest	1988 Fledged/ nest	1989 Fledged/ nest	1990 Nests (plots)	1990 Fledged/ nest	1991 Nests (plots)	1991 Fledged/ nest	
Colonsay (Argyll & Bute)	mean	-	1.64 ±0.16	1.90 ±0.10	1.25 ±0.28	20(3)	1.56 ±0.36	21(2)	**1.98** ±0.10	a*
	total	-	1.87	1.86	1.37	20	1.50	-	-	
Canna (Lochaber)		1.17	2.02	2.04	1.46	42	1.43	33	**1.15**	b
Hermaness		-	-	-	0.28 ±0.06	68(3)	0.43 ±0.17	83(3)	**1.13** ±0.15	c
Foula (Shetland)		good	-	good	good	-	good	-	-	d
Sumburgh Head (Shetland)	mean	good	good	1.40 ±0.13	1.17 ±0.14	101(4)	0.61 ±0.13	38(3)	**0.97** ±0.08	e
	total			1.38	1.31	101	0.65	-	-	
Fair Isle (Shetland)	mean	-	-	-	1.41 ±0.09	-	-	-	-	
	total	1.51	1.20	1.30	1.42	62	0.97	95	**1.18**	f
Isle of May (NE Fife)	mean	0.75	1.09 ±0.14	0.61 ±0.09	1.09 ±0.09	154(14)	0.30 ±0.05	187(14)	**1.06** ±0.11	g
	total	-	1.12	-	1.11	-	-	-	-	
St Abb's Head (Berwickshire)		-	-	-	-	88	0.76		**1.80**	h
Farne Isds (Northumberland)	mean	-	1.56 ±0.13	1.22 ±0.18	1.66 ±0.22	303(11)	1.16 ±0.12	266(10)	**0.83** ±0.13	i
	total	-	1.58	-	1.62	-	-			
Berry Head (Devon)		-	-	-	-	-	-	7(*)	**1.42**	j
Guernsey (Channel Isds)	mean	-	0.85 ±0.24	0.77 ±0.28	0.59 ±0.20	-	-	-	-	
	total	-	0.90	-	0.85	42	1.05	125	**1.54**	k
Bardsey (Gwynedd)		-	1.76	-	-	-	-	17(*)	**1.82**	l
Calf of Man (Isle of Man)		-	-	25% normal	-	-	-	52(2)	**2.01** ±0.13	m

*1991 sources: a. J Clarke. b. Swann (1991). c. Swale (1991). d. Furness (1991). e. SOTEAG. f. Harvey & Orsman (1991). g. Harris (1991). h. Rideout et al. (1992). i. National Trust. j. M Smallbones. k. M G Hill. l. S Walker. m. M V McCanch.

3.9 Arctic skua *Stercorarius parasiticus*

Breeding numbers (table 3.9.1)

Numbers at monitored colonies on Shetland decreased again in 1991, by 4.8% (similar to the 1989-90 decrease). On Fair Isle, the total fell from 105 apparently occupied territories (AOTs) in 1990 to 99 in 1991, but a large increase was noted on Foula (+25.9%), a reversal of recent trends. Numbers on Orkney (especially Papa Westray) may have shown a similar decrease to those on Shetland in 1991, but but counts may not be directly comparable between years (E. R. Meek). On Handa (Sutherland), breeding numbers have remained reasonably constant at about 30 AOTs since 1986, while on Lewis (Western Isles) numbers increased at the main colony during 1988-91 (+6.5 % 1990-91).

Breeding success (table 3.9.2, figure 3.9.1)

A dramatic increase in breeding success was evident throughout Shetland in 1991. All monitored colonies, including Foula and Fair Isle, produced at least 0.5 chicks/territory, the highest values recorded in any year 1988-91.

In Orkney, breeding success was higher than in 1990 at four out of six colonies. There was considerable variation between colonies, and total failure was recorded at a small colony on Hoy. Average productivity (0.60 chicks/nest) was slightly below the average for Shetland (0.68 excluding Fair Isle and Foula) in 1991. Limited information from Lewis suggests a good breeding season for the main colony there. As in 1989 and 1990, the most successful colony was on Handa, where breeding success has remained relatively constant at 1.2-1.3 chicks/territory since 1989.

Discussion

All monitored colonies in Shetland and most of those in Orkney showed an improvement in breeding success in 1991, most dramatic in Shetland. Productivity was the highest since at least the mid 1980s in Shetland, but still lower than available pre-1987 productivity figures (e.g. 0.94-1.21 at various colonies: Furness 1987). On Foula, territory attendance by adults was noticeably higher than in 1990, and most pairs that laid eggs raised chicks to fledging (Furness 1991). All indications point to a large increase in the number of sandeels available to seabirds on Shetland this year, allowing arctic skuas many more opportunities to steal food.

Arctic Skuas usually breed for the first time when four or five years old (Furness 1987). Thus birds reared in 1986 or 1987 would have been attempting to breed in 1991. Since the indications are that both 1986 and 1987 were years of low breeding success in Shetland, there were probably few birds available to join the breeding population in 1991. Despite the high breeding success throughout Shetland this year, it seems likely that the breeding population will continue to decrease over the next few years, unless substantial immigration occurs. Arctic skuas arrived very late on Foula this year, but in much higher numbers than in 1990. This may have involved immigration, or the return of birds that had not held territories in in the last two years (Furness 1991).

Although breeding success in Orkney this year was better than in 1989 and 1990, predation of large chicks by great skuas remains a problem at some colonies, especially in mixed colonies on Hoy. On Westray, many pairs failed at the egg stage; the problem here was thought to be sheep and/or gulls. The fact that arctic terns in Orkney were much less successful than in Shetland in 1991 (section 3.19)

may suggest that a shortage of food in inshore waters was also a factor behind arctic skua breeding failure in Orkney.

Population trends of arctic skuas in Orkney are less clear than in Shetland, but there may have been a decrease in 1991. Based on the low productivity in recent years, it does seem likely that some decline will be seen during the next few years. A complete census of great and arctic skuas in Orkney and Shetland in 1992, coordinated by RSPB, will shed further light on trends since the early or mid 1980s.

In NW Scotland, population trends and breeding success on Handa suggest a healthy population there. More systematic monitoring on Lewis would help assess whether this is also true of the Western Isles.

TABLE 3.9.1 Population changes at monitored arctic skua colonies in Shetland, 1990-91 (apparently occupied territories in late May/June). Superscript = number of colonies counted in both years.

	Foula	Fair Isle	other Shetland	total Shetland
1990	112	105	287	504
1991	141	99	270	480
% change	+25.9	-5.7	-5.9[1 1]	-4.8[1 3]

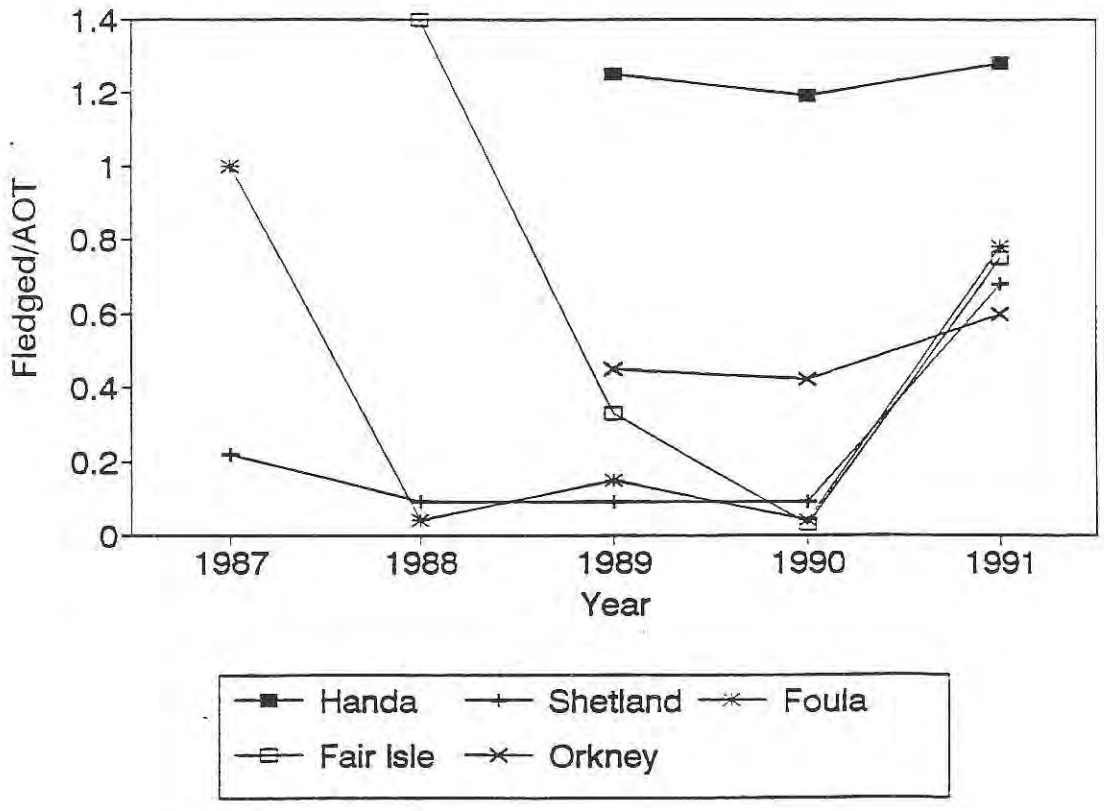

FIGURE 3.9.2 **Breeding success of arctic skuas (chicks fledged per territory)**

TABLE 3.9.2 **Arctic skua breeding success, 1986-91:** number of chicks fledged per apparently occupied territory (AOT). (See 1989 report for 1986-88 sample sizes.)

Colony	1986 Fledged/ AOT	1987 Fledged/ AOT	1988 Fledged/ AOT	1989 Fledged/ AOT	1990 AOTs	1990 Fledged/ AOT	1991 AOTs	1991 Fledged/ AOT	
Handa (Sutherland)	≤1.0	-	good	1.25	21*	1.19	28*	**1.28**	a**
Unst, 2 colonies (Shetland)	-	-	0.12	0.06	46	0.24	50	**0.60**	b
Fetlar, 1-2 colonies (Shetland)	-	0.14	0.00	0.03	21	0.00	19	**0.84**	b
Hascosay (Shetland)	-	-	0.00	-	-	-	-	-	
Yell, 2 colonies (Shetland)	-	-	0.04	0.19	46	0.37	34	**0.88**	b
Papa Stour (Shetland)	poor	poor	0.00	0.00	90	0.00	88	**0.51**	b
Noss (Shetland)	0.68	0.30	0.33	0.20	15	0.00	15	**0.67**	b
Mousa (Shetland)	-	-	0.00	-	19	0.00	16	**0.75**	b
Mainland, 4-7 colonies (Shetland)	-	-	0.15	0.07	50	0.00	48	**0.52**	b
SHETLAND total (excl. Foula/Fair I.)	(0.68)	0.21	0.08	0.07	287	0.12	-	-	
SHETLAND x±s.e.[1] (excl. Foula/FI)	-	0.22±0.08[2]	0.09±0.04[17]	0.09±0.03[11]	287	0.09±0.05[12]	270	**0.68** ±0.05[11]	b
Foula (Shetland)	-	<1.0	0.04	0.15	112	0.04	141	>**0.78**	c
Fair Isle (Shetland)	-	-	1.40	0.33	105	0.03	99	**0.75**	d
North Hill, Papa Westray (Orkney)	-	-	-	0.48	144	0.11	125	**0.73**	a
Westray (Orkney)	-	-	-	-	35*	0.40	30*	0.43	a
Rousay (Orkney)	-	-	-	0.28	119	0.69	122	**0.76**	a
Eday (Orkney)	-	-	-	-	22*	0.23	-	-	a
Stronsay (Orkney)	-	-	-	-	26*	0.38	-	-	a
Flotta (Orkney)	-	-	-	-	21*	0.95	23*	**0.83**	a
Lushan Basin, Mainland (Orkney)	-	-	-	0.59	38	0.53	21*	**0.86**	a
Hoy (Orkney)	-	-	-	-	21*	0.09	21*	**0.00**	a
ORKNEY total	-	-	-	0.42	426	0.44	342	-	a
ORKNEY x±s.e.[1]	-	-	-	0.45±0.09[3]	426	0.42±0.11[8]	342	**0.60** ±0.14	a

*Occupied nests in intensively-monitored colonies.
**1991 sources: a. RSPB b. RSPB/NCCS. c. Furness 1991 d. Harvey & Orsaan 1991.

3.10 Great skua *Stercorarius skua*

Breeding numbers

On Foula, the largest colony, 2300 AOTs were counted, virtually the same as in 1990. Elsewhere in Shetland, numbers increased slightly on Fair Isle (+5.3%) and at Lumbister, Yell (+7.3%). A study plot on Hoy (Orkney) held 38 AOTs in 1991, compared to 40 in 1990. The Handa (Sutherland) population continued to increase, from 81 AOTs in 1990 to 92 in 1991 (+13.6%). On Lewis (Western Isles) the main colony showed a slight decrease, from 38 AOTs in 1990 to 36 AOTs in 1991, while on Hirta, St. Kilda, 52 nests (55-56 territories) was little change from 1990.

Breeding success (table 3.10.1, figure 3.10.1)

Great skuas on Shetland enjoyed a much-improved breeding season this year, with numbers fledged/territory about twice as high as in 1990 at Hermaness, Fetlar and Noss (though still only 0.47/territory at the latter). Productivity was good on Yell (0.93), but four colonies on Mainland fledged only eight young from 44 pairs (0.18). On Foula, productivity was up 50% from 0.4 in 1990 to 0.6 in 1991, while on Fair Isle productivity remained at 0.7 fledged/territory. The average productivity for Hoy (the stronghold of great skuas in Orkney) was 0.8 fledged/AOT, higher than the Shetland average. At one colony in NW Hoy, productivity fell from from 0.83 in 1990 to 0.5 in 1991 (although part of this may have reflected different survey methods). As in 1989 and 1990, the most successful colony monitored was Handa (Sutherland) where 89 pairs fledged an average of 1.28 young each.

Discussion

Increased breeding success in Shetland this year most likely reflected the increased availability of sandeels, which also benefitted other species. Sandeels are normally important in the diet of chicks of both skua species in Shetland (Furness 1987). Great skuas appeared to be able to shift to alternative food sources to a greater degree than arctic skuas during recent years, and breeding success did not decrease to the same degree. In 1991, there was still considerable variation between Shetland bonxie colonies, suggesting that local factors were important. Monitored colonies on Mainland and Noss produced only 0.25 chicks/territory overall, while colonies on the north isles (Yell, Unst and Fetlar), Fair Isle and Foula were more successful. On Foula breeding was late and many pairs holding territory did not lay. Adult attendance was higher than in 1990, but some cannibalism of chicks was recorded. Kleptoparasitism was much more frequent on Foula than in other recent years, though predation on seabirds was less than in 1990 (Furness 1991).

On Hoy (Orkney), three study plots on different parts of the island showed considerable variation in breeding success. Extensive cannibalism occurred at the NW Hoy colony, contributing to poor success. In the more productive colonies, nests were more widely spaced, ground-cover was better and there was no "club" of non-breeding birds; few instances of cannibalism were recorded.

Breeding numbers on Foula (the largest colony in the world) were similar to those recorded in 1990, although the non-breeding population decreased again (Furness 1991). Limited information for other Shetland colonies also indicated little change from 1990. The small Stourdale colony on Hoy has increased from 26 territories in 1986 to 38 in 1991 (41 in 1989). The Hoy population as a whole may also be increasing (e.g. a $\underline{c}$60% increase on the North Hoy reserve between 1984 and 1990), although this is less certain. A full census of skuas in the northern isles, being organised by RSPB, will allow more detailed assessment of changes since the last full surveys, in 1982 (Orkney) and 1985-86 (Shetland).

TABLE 3.10.1 **Great skua breeding success, 1987-91:** number of chicks fledged per apparently occupied territory (AOT).

	1987	1988	1989	1990		1991		
	Y/AOT	Y/AOT	Y/AOT	AOTs	Y/AOT	AOTs	Y/AOT	
Handa (Sutherland)	-	-	1.16	80	1.19	89*	**1.28**	a
Hermaness (Shetland)	-	<0.50	1.03	39	0.69	44	**1.14**	b
Fetlar, 1-2 colonies (Shetland)	-	-	0.13	30	0.20	51	**0.73**	b
Mainland, 4 colonies (Shetland)	-	-	-	-	-	44	**0.18**	b
Yell (Shetland)	-	-	-	-	-	16	**0.93**	b
Noss (Shetland)	-	≤0.70	0.15	36	0.22	15	**0.47**	b
SHETLAND $\bar{x}$±s.e. (excl. FI/Foula)	-	≤0.60	0.44 ±0.30	105	0.37 ±0.16	170	**0.69** ±0.17	
Fair Isle (Shetland)	-	-	0.79	73	0.70	79	**0.70**	c
Foula (Shetland)	0.7	<0.01	0.24	-	≤0.4	-	**0.60**	d
NW Hoy (Orkney)	-	-	0.96	30	0.83	30*	**0.50**	a
S Hoy (Orkney)	-	-	poor	-	-	30*	**0.83**	a
E Hoy (Orkney)	-	-	-	-	-	24*	**1.08**	a
HOY (Orkney) ±s.e.	-	-	-	-	-	84*	**0.80** ±0.17	a

*occupied nests, not territories.
**1991 sources: a. RSPB. b. RSPB/NCCS. c. Harvey & Orsman 1991. d. Furness (1991).

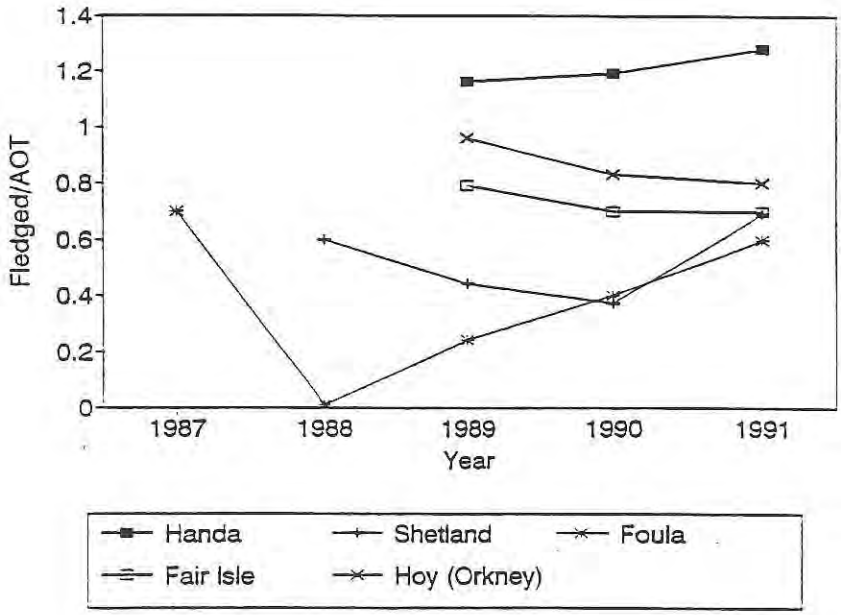

FIGURE 3.10.1 **Breeding success of great skuas (chicks fledged per territory)**

3.11-3.15 Black-headed gull *Larus ridibundus* / common gull *L. canus* / lesser black-backed gull *L. fuscus* / herring gull *L. argentatus* / great black-backed gull *L.marinus*

Results for 1991 will be summarised fully in next year's report.

Most notably this year, breeding success of lesser black-backed gulls on Skomer (south Wales) improved markedly - 16,000 pairs averaged ca. 0.45 chicks fledged per pair. This followed almost total breeding failure in 1989 and 1990 (0.02-0.04 chicks/pair in the latter year).

3.16 Kittiwake *Rissa tridactyla*

Breeding numbers (table & figure 3.16.1)

Numbers of occupied nests decreased (by up to 14%) in all North Sea regional population samples from Shetland south to Humberside in 1991. This included decreases in 20 out of 25 individual colonies. Numbers also fell by 5-15% in sample plots at six Orkney colonies between 1988 and 1991. The Shetland population has declined significantly during 1986-91, although the 4% decrease in 1991 was less than in 1990. Population indices for North Sea regions other than Shetland indicate roughly stable or increasing numbers over 1986-91 as a whole (despite year-to-year decreases such as 1990-91), and none of the trends is significant.

Population samples are generally smaller elsewhere, but 1986-91 trends do seem more variable than on North Sea coasts. Regional totals in the west of Scotland and NW Ireland showed decreases in 1991 (based on very few colonies). In contrast, increases were seen for all southern or southwestern regions of Britain (from the Irish Sea around to Suffolk) in 1991. Numbers have declined significantly in SE Ireland over the period 1986-90, with only a slight increase in 1991.

Breeding success (table & figure 3.16.2)

Average breeding success at 55 colonies around Britain and Ireland was 0.63 $\pm$s.e. 0.05 chicks fledged/nest, a rather low figure (although biased towards regions with more sampled colonies). This represents a slight increase over 1990 figures (average change +0.07$\pm$0.05 chicks/nest, $t_{45} = 1.30$, not significant).

The most notable feature of 1991 results was an increase in productivity at all monitored Shetland colonies, to an average of 0.56$\pm$0.12 chicks/nest. This is similar to 1987 levels, and a significant increase over 1990 (average +0.44$\pm$0.10 chicks/nest, $t^7 = 4.26$, $P<0.01$). The improvement might have been greater but for predation by great skuas or corvids at some colonies. As in 1990, Orkney was one of the most successful Scottish regions (average 1.00$\pm$0.08 chicks/nest).

Productivity was much lower than in Orkney along the Scottish coast from Caithness south to Borders, averaging only 0.54$\pm$0.07 chicks/nest (a significant average decrease from 1990: -0.23$\pm$0.08, $t_8 = 2.63$, $P<0.05$). Productivity fell by a similar amount in NE England, and there was thus a significant decrease for North Sea coasts from Caithness south to Humberside (-0.22$\pm$0.06, $t_{12} = 3.41$, $P<0.01$). Colonies in NE England were, nevertheless, much more successful (0.96$\pm$0.11 chicks/nest) than in eastern Scotland.

Away from northeast Britain, colonies in SE England and the west of Scotland were the most successful on average. Productivity at colonies in SW Britain/SE Ireland was poor for at least the third year in succession, averaging only 0.39$\pm$0.08 chicks/nest at 18 colonies (the lowest "regional" figure in 1991). Colonies in SW England (0.20$\pm$0.11 chicks/nest) and Wales (0.36$\pm$0.14) were particularly unsuccessful. Some of these colonies failed totally, although a few were quite successful. Nevertheless, productivity improved slightly at these "southwestern" colonies compared to 1990 (average change +0.17$\pm$0.10 chicks/nest, not significant).

Discussion

There is evidence from several regions (notably Shetland and, in SW England, the Isle of Scilly) of substantial movement of breeding kittiwakes between small colonies (and subcolonies) over periods of a few years. In some cases, this may be be associated with breeding failure at particular colonies, although detailed

evidence has not been compiled yet. This has obvious implications for population monitoring of kittiwakes. Thus Shetland populations are monitored on the basis of stretches of coastline, rather than defined "colonies". Kittiwake monitoring based on counts of sample plots is particularly susceptible to changes in colony extent or relative density; counts of whole colonies will at least take account of intra-colony movements of birds.

For the first time since 1986, breeding success of Shetland kittiwakes has not been the lowest in Britain and Ireland. The marked improvement in Shetland coincided with increased availability of sandeels in Shetland waters in 1991 (e.g. Wright & Bailey 1991). Productivity at Shetland colonies was, nevertheless, low overall, but predation contributed to this; chick survival was high at colonies where there was little predation. Orkney colonies were again successful, but success was low at North Sea "mainland colonies". This was associated with low breeding numbers, and, on the Isle of May at least, mostly involved failure at the egg or small chick stage. The proportion of nests laid in may also have been lower than in previous years on the Isle of May, and from the pattern of breeding there it appeared that kittiwakes were short of food early in the season (Harris 1991). Poor weather may also have contributed to breeding failure at the North Sea colonies.

Colonies in the Irish/Celtic Sea, Bristol Channel and southwest approaches were the least successful in 1991, although total failures were not as frequent as was the case in Shetland during 1988-91. The possible role of food availability at these southwestern colonies is far from clear, but seems likely to be important. Large population changes at some of these colonies from year-to-year, and instances of subcolonies where few eggs are laid in nests, may indicate variation in the proportion of adults which breed. This might also be a consequence of changes in food availability or feeding conditions. Predation is also involved at some southwestern colonies, however.

The proportion of broods left unattended during the two weeks before first fledging generally varied from 0% to 20% at North Sea and other colonies in 1991. As usual, broods of one or younger broods were more likely to be attended than larger or older broods. Attendance was very variable between colonies (and possibly from day to day), and the available data show no clear relationship with breeding success. This also seems to be the case from a preliminary analysis of 1989-91 data as a whole. It may be that attendance is low when food availability or feeding conditions are poor, but that the fate of unattended chicks is very dependent on predation rates or weather conditions at the same time. Analysis is also hindered by the paucity of older data for successful colonies. Only for the Isle of May (SE Scotland) is there hard evidence for a recent (1986-onwards) decrease in brood-attendance (Wanless & Harris 1989).

TABLE 3.16.1 **Population changes at monitored kittiwake colonies, 1990-91** (apparently occupied nests in June). Superscript = number of colonies with 10+ AONs counted in 1990; counts with a reported inaccuracy of > ±5%, and regional samples <100 pairs, are excluded.

	Shetland	Orkney	N. Scot.	NE Scot.	SE Scot.
1990	3 671	256	5 193	915	27 547
1991	3 517	253	4 575	789	24 345
change	-4.2^{11}	$(-1.2)^{1}$	-11.9^{5}	$(-13.8)^{1}$	-11.6^{6}

	SE Engl.	NE Engl.	E Engl.	SW Engl.	Wales
1990	2 445	7 625	115	305	4 830
1991	2 545	6 922	157	380	5 221
% change	$+4.1^{3}$	-9.2^{2}	$(+36.5)^{1}$	$(+24.6)^{3}$	$+8.1^{8}$

	SW Scot.	NW Scot.	NE Irel.	SE Irel.	NW Irel.
1990	441	844	540	2 061	552
1991	363	770	624	2 126	456
% change	$(-17.7)^{1}$	$(-8.8)^{1}$	$(+15.6)^{1}$	$+3.2^{8}$	$(-17.4)^{1}$

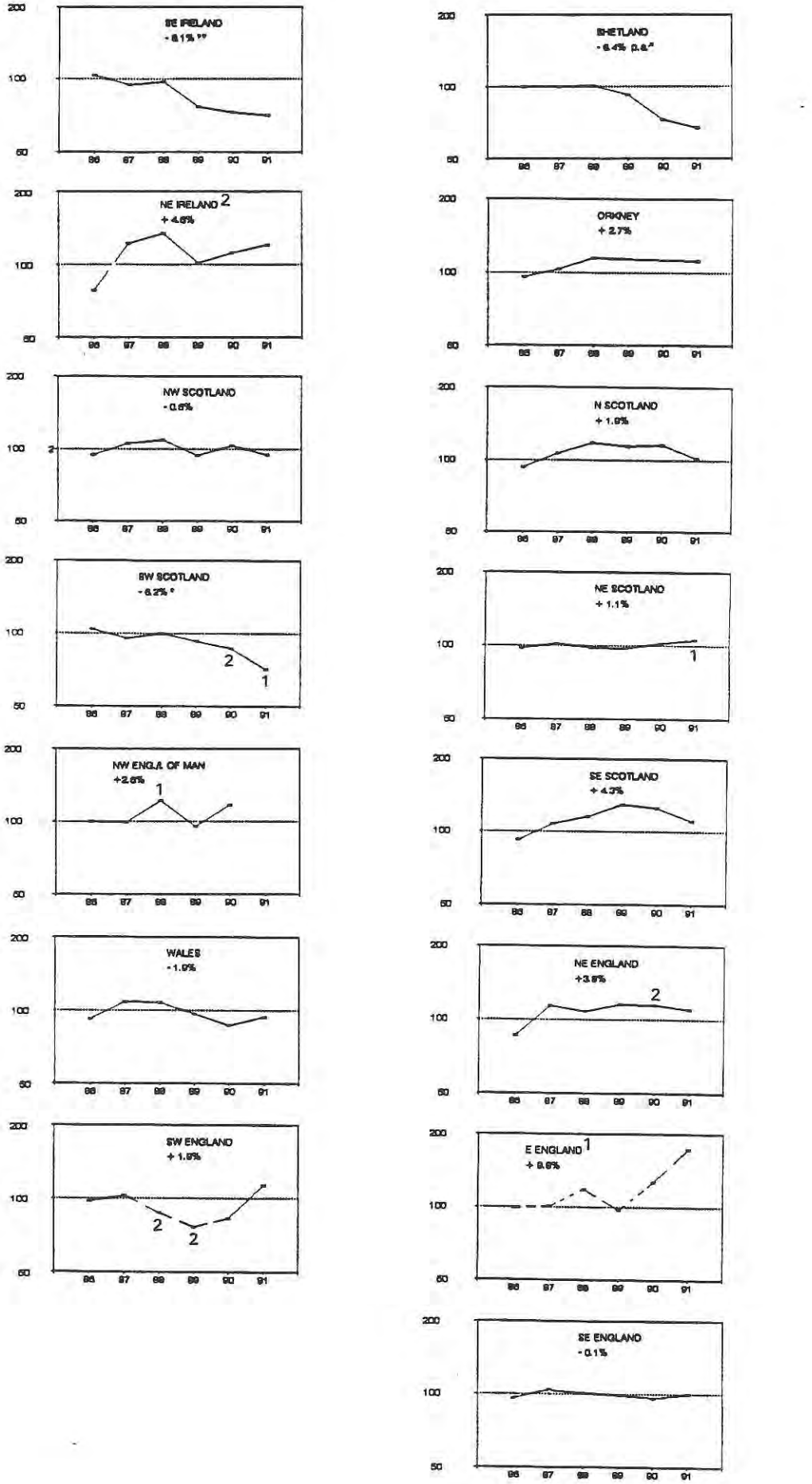

FIGURE 3.16.1 **Regional population indices for breeding kittiwakes, 1986-91 (apparently occupied nests in June).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05). Broken trend-lines are based on samples of 100-500 AONs. Number of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

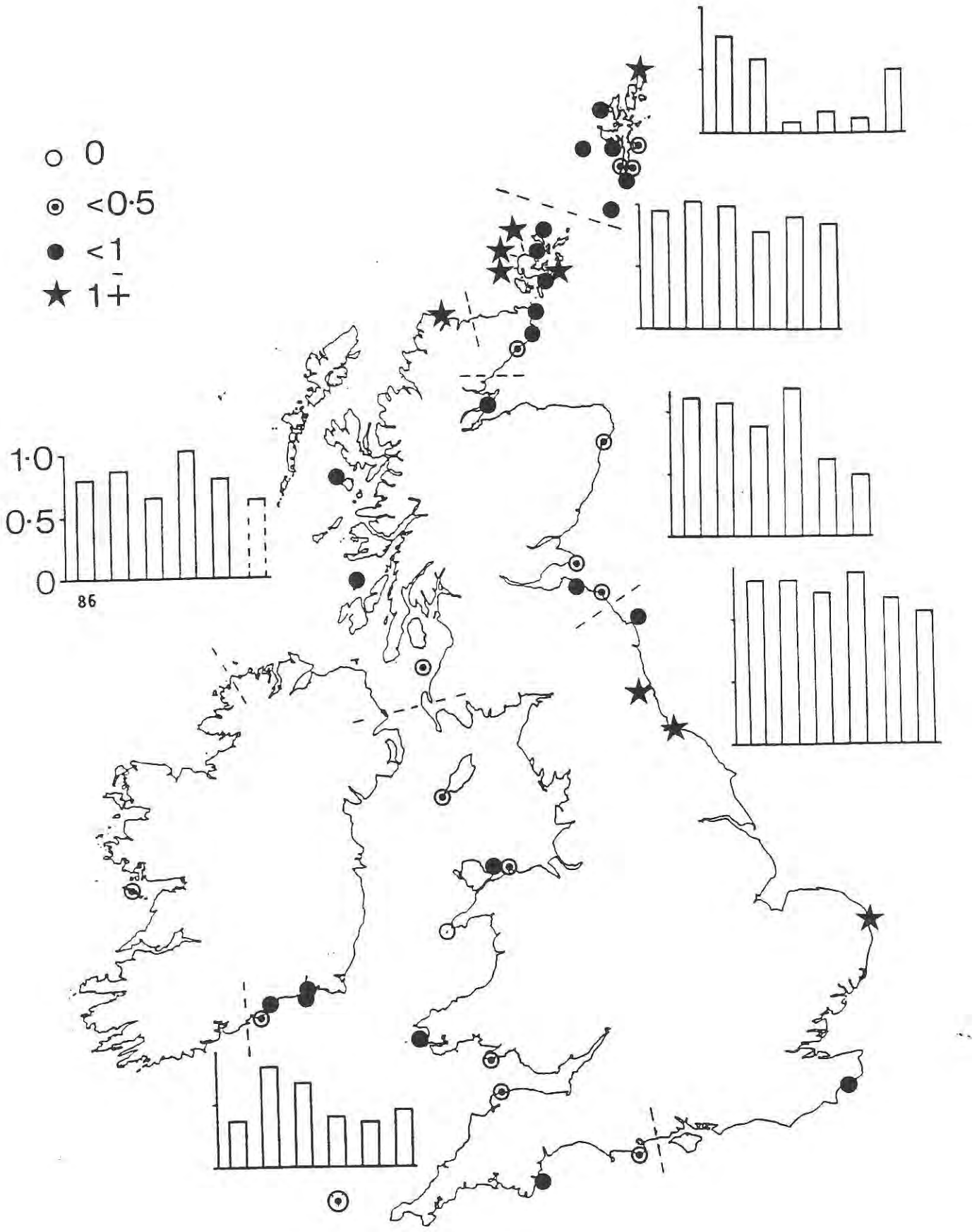

FIGURE 3.16.2 **Breeding productivity (chicks fledged per well-built nest) at kittiwake colonies, 1986-91.** Colony symbols indicate 1991 figures for individual colonies. Histograms indicate annual variation in average productivity for six subdivisions of the coastline (based on colonies studied in 1991, including estimates for 'missing' years to allow direct comparisons between years and regions).

TABLE 3.15.2 **Kittiwake breeding success, 1986-91:** number of chicks fledged per occupied, well-built nest ('apparently occupied nest' or AON). Productivity is presented as mean ±standard error of figures from three or more plots (or midpoint ±half-range of two figures); * indicates coverage of all visible parts of colony. (See 1989 & 1990 reports for 1986-89 sample sizes.)

Colony	1986 Fledged/ nest	1987 Fledged/ nest	1988 Fledged/ nest	1989 Fledged/ nest	1990 Nests (plots)	1990 Fledged/ nest	1991 Nests (plots)	1991 Fledged/ nest	
Rathlin Island (Antrim)	-	-	0.21 ±0.02	1.04 ±0.05	-	-	-	-	
Ailsa Craig (Kyle & Carrick)	poor	˜0.33 ±0.08	˜0.03	˜0.08 ±0.08	139(3)	˜0.12 ±0.12	118(2)	**0.22** ±0.03	a
Islay (Argyll & Bute)	-	-	1.13 ±0.05	1.31 ±0.14	99(2)	0.98 ±0.05	-	-	
Colonsay (Argyll & Bute)	-	1.08 ±0.07	0.57 ±0.18	0.86 ±0.43	441(3)	0.86 ±0.17	363(3)	**0.67** ±0.02	b
Canna (Lochaber)	0.28 ±0.28	0.50	0.19 ±0.16	0.75 ±0.22	322(2)	0.97 ±0.24	314(2)	**0.64** ±0.34	c
St Kilda (W. Isles)	0.52 ±0.11	0.76 ±0.13	0.65 ±0.09	0.60 ±0.03	778(10)	0.29 ±0.04	121(2)	**0.84** ±0.03	d
Eilean Mor, Flannans (W Isles)	-	-	-	-	489(7)	‹0.39 ±0.05	-	-	-
Eilean Mhuire, Shiants (W Isles)	-	-	-	-	290(5)	‹0.68 ±0.13	-	-	
Stac Shuardail, Lewis (W. Isles)	-	-	-	1.33	162(5)	0.92 ±0.13	-	-	
Tiumpan Hd, Lewis (W Isles)	-	-	-	-	44(1)	1.04	-	-	
Cellar Head, Lewis (W. Isles)	-	-	-	1.31	61(1)	0.56	-	-	
Spainneavaig, Lewis (W Isles)	-	-	-	-	110(4)	0.88 ±0.09	-	-	
Handa (Sutherland)	1.09 ±0.13	-	0.69 ±0.09	1.53 ±0.06	301(5)	1.35 ±0.06	363(5)	**1.54** ±0.06	e
Faraid Head (Sutherland)	-	-	-	-	43(1)	1.88	50(1)	**1.38**	f
Hermaness (Shetland)	-	-	-	0.45 ±0.09	179(2)	0.47	170(2)	**1.06** ±0.05	g
Fetlar (Shetland)	-	0.16 ±0.08	0	0	33(*)	0	-	-	
Eshaness (Shetland)	0.64	0.65 ±0.05	0.45 ±0.05	0.62 ±0.09	334(2)	0.50 ±0.07	328(2)	**0.72** ±0.04	h
Westerwick (Shetland)	‹0.47	0.03 ±0.02	0	0	61(*)	0	54(*)	**0.68**	h
Foula (Shetland)	‹0.88	poor	0	‹0.31	-	‹0.50	-	**‹0.75**	i
Kettla Ness (Shetland)	‹0.64	0.57	0	0	143(*)	0	126(*)	**0.05**	h
Noss (Shetland)	0.58 ±0.23	0.27 ±0.09	0	0	187(4)	0	231(4)	**0.17** ±0.07	j
Troswick Ness (Shetland)	1.05 ±0.01	0.43 ±0.03	0	0.003	140(2)	0	119(2)	**0.32** ±0.11	h
Sumburgh Head (Shetland)	0.54 ±0.09	0.61 ±0.05	0.01	0.06 ±0.02	193(4)	0	196(4)	**0.63** ±0.19	h
Fair Isle (Shetland)	1.06 ±0.06	1.01 ±0.03	0.08 ±0.01	0.37 ±0.10	1363(10)	0	1253(10)	**0.89** ±0.06	k

Fowl Craig, P. Westray (Orkney)	-	-	-	0.62 ±0.24	265	0.61	233	**0.76**	l
Rousay (Orkney)	-	-	-	0.92 ±0.13	373(4)	0.92 ±0.04	338(4)	**0.80** ±0.21	m
Costa Head (Orkney)	ˆ1.00 ±0.10	ˆ1.45 ±0.07	ˆ1.38 ±0.06	0.92 ±0.08	-	-	220(3)	**1.10** ±0.09	n
Marwick Head (Orkney)	1.05 ±0.28 ˆ0.99 ±0.07	1.25 ±0.20 ˆ1.40 ±0.04	1.00 ±0.23 ˆ1.17 ±0.05	1.02 ±0.02	255(4)	1.00 ±0.12	250(4)	**1.21** ±0.11	n
Row Head (Orkney)	ˆ0.96 ±0.05	ˆ1.24 ±0.06	ˆ1.21 ±0.04	0.95 ±0.04	323(4)	1.03 ±0.02	283(4)	**1.28** ±0.03	n
Mull Head (Orkney)	ˆ1.08 ±0.06	ˆ1.11 ±0.03	ˆ1.02 ±0.06	0.67 ±0.02	238(2)	1.04 ±0.01	237(3)	**1.03** ±0.04	n
Gultak (Orkney)	ˆ0.93 ±0.11	ˆ1.00 ±0.01	ˆ1.13 ±0.06	0.50 ±0.04	120(2)	0.69 ±0.12	114(2)	**0.83** ±0.21	n
Sandside Head (Caithness)	-	-	-	-	50(1)	0.62	-	-	f
Skirza Head (Caithness)	- ˆ1.28	- ˆ1.19	- ˆ1.15	0.62 ˆ0.82	228(1) 228(1)	0.88 ˆ0.98	181(1) 181(1)	**0.58** ˆ**0.59**	o
Iresgeo (Caithness)	- ˆ1.24 ±0.16	- ˆ1.25 ±0.05	- ˆ1.27 ±0.01	0.93 ±0.04 ˆ1.03 ±	276(3) 276(3)	1.03 ±0.16 ˆ1.09 ±0.13	254(3) 254(3)	**0.64** ±0.07 ˆ**0.64** ±0.07	o
An Dun (Caithness)	- ˆ1.48 ±0.06	- ˆ1.35 ±0.07	- ˆ1.28 ±0.17	1.12 ±0.10 ˆ1.22 ±	317(2) 317(2)	1.19 ±0.02 ˆ1.24 ±0.04	288(2) 288(2)	**0.42** ±0.03 ˆ**0.43** ±0.04	o
N Sutor (Ross & Cromarty)	-	-	-	-	98	ˆ0.84	114	ˆ**0.89**	p
Covesea (Moray)	-	-	0.62	0.92	251(*)	0.74	-	-	
Bullers of Buchan (Banff & Buchan)	-	-	-	1.35 ±0.08	359(5)	0.77 ±0.08	268(3)	**0.60** ±0.02	q
Sands of Forvie (Gordon)	-	-	-	0.82 ±0.19	138(2)	0.46 ±0.13	131(2)	**0.33** ±0.04	r
Fowlsheugh (Kincardine & Deeside)	1.13	1.29 ±0.05	1.00 ±0.05	1.29 ±0.08	706(8)	0.61 ±0.04	-	-	
Isle of May (NE Fife)	1.33 ±0.04	1.09 ±0.06	0.82 ±0.08	1.11 ±0.07	1149(15)	0.16 ±0.04	1172(15)	**0.27** ±0.05	s
Dunbar (E Lothian)	-	1.39	1.05	1.58	435(*)	0.94	415(*)	**0.70**	t
St Abb's Head (Berwickshire)	-	ˆ1.02	ˆ1.06	ˆ1.24	1182	0.61 ±0.13	1118(3)	**0.41** ±0.15	u
Farne Islands (Northumberland)	-	1.13 ±0.08	1.17 ±0.08	1.37 ±0.09	604(11)	1.00	633(11)	**0.60** ±0.08	v
North Shields (Tyne & Wear)	1.40	1.34	1.16	-	-	-	-	-	
Gateshead (Tyne & Wear)	-	-	-	1.32	249(*)	1.16	232(*)	**1.03**	w
Marsden Rock (Tyne & Wear)	-	-	0.96 ±0.06	-	-	-	-	-	
Saltburn (Cleveland)	1.19 ±0.02	1.03 ±0.06	0.93 ±0.05	1.00 ±0.10	234(4)	1.01 ±0.10	191(3)	**1.05**	x
Bempton (Humberside)	1.13 ±0.23	1.55 ±0.04	0.53 ±0.05	1.21 ±0.24	294(6)	1.52 ±0.05	326(6)	**1.18** ±0.07	y

Lowestoft (Suffolk)	1.34	1.56	1.43	(0.40)*	115(*)	1.16	157(*)	1.25	z
South Foreland (Kent)	-	-	-	-	-	-	102(3)	0.88 ±0.29	aa
Blacker's Hole (Dorset)	-	-	-	-	-	-	84(*)	0.21	bb
Berry Head (Devon)	0.96 ±0.17	0.99 ±0.19	0.86 ±0.19	0.22 ±0.22	107(2)	0.70 ±0.41	140(2)	0.75 ±0.09	cc
Trewavas Head (Cornwall)	-	0.04	-	-	-	-	-	-	
Gugh (Isles of Scilly)	-	-	-	-	-	-	110(*)	0.05	dd
Samson (Isle of Scilly)	-	-	-	-	-	-	90(*)	<0.01	dd
Annet (Isles of Scilly)	-	-	-	-	-	-	35(*)	0	dd
St Martin's (Isles of Scilly)	-	-	-	-	-	-	46(*)	<0.06	dd
Gorregan/Men a' Vaur (Scilly)	-	-	-	-	-	-	few	0	dd
Lundy (Devon)	0.22	0.22	0.79	(1.10	-	-	-	-	
Woody Bay (Devon)	-	-	-	-	82(*)	0	150(*)	0.17	ee
Devil's Truck (W Glamorgan)	-	-	-	-	-	-	130(*)	*0.16	ff
Elegug Stacks (Dyfed)	-	-	-	-	-	-	284(5)	0.12 ±0.08	gg
Skomer (Dyfed)	0.45 ±0.09	0.97 ±0.08	0.76 ±0.04	0.61 ±0.01	1209(3)	0.53 ±0.02	262(3)	0.87 ±0.07	hh
Bardsey (Gwynedd)	poor	1.01	0.85	0.48 ±0.23	94(1)	0.14	81(4)	0	ii
Great Ormes Head (Gwynedd)	-	-	-	0.20	167	0.50	195	0.33	jj
Lochtyn (Gwynedd)	-	-	-	-	-	very poor	-	-	
Puffin Island (Gwynedd)	-	-	-	-	-	-	146(3)	*0.70 ±0.04	kk
Calf of Man (Isle of Man)	0.15	0.20 ±0.11	0.04 ±0.01	0.44 ±0.23	89(2)	0.24 ±0.05	143(2)	0.42 ±0.28	ll
Around Peel Hill (I. o Man)	-	-	-	-	-	very poor	-	mod - poor	mm
St Bee's Head (Cumbria)	0.13	1.03	0.29	0.32	57(1)	0.16	118(3)	1.15 ±0.08	nn
Rockabill (Dublin)	-	-	-	*0.85	49(*)	*0.51	-	-	
Wicklow Head (Wicklow)	-	-	-	*1.36	-	-	-	-	
Great Saltee (Wexford)	-	-	-	*0.42	1132(9)	*0.36 ±0.05	-	-	
Dunmore East (Waterford)	0.53 ±0.53 *0.72	0.90 ±0.05 *0.91	0.79 ±0.06 *0.80	0.52 *0.56	192(1) 849(*)	0.33 *0.35	175(1) 862(*)	0.46 *0.53	oo
Portally (Waterford)	*0.10	*1.26	*1.06	*0.18	88(*)	*0.27	87(*)	*0.53	oo
Helvick Head (Waterford)	-	-	-	*0.31	484	*0.38	782	*0.57	oo

Ram Head (Waterford)	-	-	-	0.61 ±0.09	565	ˆ0.60		519	ˆ0.40	oo
Big Doon (Cork)	-	-	-	ˆ0.33	-	-		-	-	
Old Head of Kinsale (Cork)	-	-	-	ˆ0.59	-	-		-	-	
Cliffs of Moher (Clare)	-	-	-	-	147(3)	(0.44 ±0.10		-	-	
Inishmore (Galway)	-	-	-	0.18 ±0.07	568(*)	0.25		485(*)	0.30	pp

ˆ= productivity based on comparison of no. of large chicks present in mid July with peak or single late May-mid June count of AONs in each plot.
(= productivity based on late June/early July counts of both AONs and chicks.
**1991 sources: a. B Zonfrillo. b. J Clarke. c. Swann (1991). d. J Vaughan (NCCS). e. Furness & Aitken (1992). f. D M Stark.
g. Swale (1991). h. SOTEAG. i. Furness (1991). j. Armstrong & Gilbert (1991). k. Harvey & Orsman (1991). l. T Dodman (RSPB). m. C Whyte (RSPB). n. P M Walsh. o. Evans (1991). p. R L Swann. q. B Topp. r. D J G Gill. s. Harris (1991). t. S R da Prato.
u. Rideout et al (1992). v. National Trust. w. B Little. x. K Perry. y. D O'Hara (RSPB). z. B J Brown. aa. M Stephenson. bb. T Hayson/R Plowman. cc. K E Partridge. dd. Robinson (1991). ee. C Manning. ff. D Paynter (CCW)/D Thomas. gg. R L Haycock (CCW). hh. Poole & Sutcliffe (1991). ii. S Walker. jj. T Gravett. kk. R W Arnold. ll. M V McCanch. mm. A S Moore. nn. M Preece. oo. D McGrath. pp. A Whilde.

3.17 Sandwich tern *Sterna sandvicensis*

J. Sears

Breeding numbers (tables 3.17.1-2, figure 3.17.1)

With the inclusion of data from NW Ireland, the number of colonies counted annually since 1986 now stands at 29. These counts, which represent over 90% of the British and Irish population, have been used to calculate regional and national indices of population change. The 29 colonies held a total of 13911 pairs in 1991, a slight decrease of 1.5% since 1990. Numbers were markedly higher in 1987-88, but there has been no significant trend over 1986-91 as a whole.

There have been some large changes at individual colonies. Strangford Lough (NE Ireland) lost 692 pairs in 1991. This was partly compensated for by an increase of 113 pairs at Green Island, Carlingford Lough, but overall the NE Ireland population decreased by 24%. Numbers in Wexford changed little from 1990, but have increased significantly during 1986-91. Elsewhere there have been several apparent re-distributions. In NE England, the Farne Islands lost 720 pairs while Coquet Island gained 533, a net loss of 4.6%. The NW England population appeared little changed from 1990, although the Foulney colony decreased by 388 pairs and the Hodbarrow colony increased by 400 pairs. A colony of 26 pairs in the Isle of Man was the first known breeding record there. The overall trend for NW England plus the Isle of Man has been significantly upward during 1986-91.

In eastern England the population has remained relatively stable, Blakeney Point remaining the largest colony (3000 pairs). 320 pairs initially attempted to breed on Scolt Head but moved to Blakeney Point after failing early.

Breeding success (table 3.17.3)

1991 was the worst year on record for Sandwich tern breeding success, with an average productivity at 16 colonies of only 0.45 fledged per pair. This is well below the average annual productivity for 1969-90 of 0.79 young/pair (Sears & Walsh, in prep.).

The lowest productivity was recorded in NW England, where no young fledged from Hodbarrow (520 pairs), mainly due to fox predation, and only 50 young fledged at Foulney (332 pairs). At one of the largest colonies, Sands of Forvie in NE Scotland, foxes took 226 well-feathered young over 8 days and the 1115 pairs raised only 335 young. Productivity was also very low (0.27 fledged/pair) at Blakeney Point, for unknown reasons. Productivity was not assessed at the second largest colony in Britain and Ireland, the Farne Islands, but the third largest, Coquet Island, was relatively successful (0.8 fledged/pair).

Discussion

After suffering a 15% decline between 1988 and 1989 followed by a slight increase in 1990 (+2.6% including updates for Foulness/Maplin and NW Ireland), there was relatively little change in the national population index in 1991. However, this masked large changes in numbers at individual colonies and there were several apparent colony shifts. The Sandwich tern's habit of moving between colonies makes it very important to continue monitoring as many sites as possible, including ones which appear to have been deserted. For example, after eleven years of either one or no pairs breeding at Minsmere, Suffolk, five pairs were recorded in 1990, increasing to twenty pairs in 1991. It is possible that the Minsmere colony will buil up again, although it has a long way to go to reach its 1974 peak of 750 pairs.

Table 3.17.1 **Numbers of Sandwich terns breeding pairs at regularly-counted colonies in Britain and Ireland.** In addition to these, 26 pairs bred at an Isle of Man site in 1991 (none in 1986-90).

Colony	1986	1987	1988	1989	1990	1991
Loch of Strathbeg	493	130	404	239	121	283
Sands of Forvie	597	1082	664	744	1126	1115
Inchmickery	416	656	383	272	418	473
Coquet Island	1049	1586	1616	1164	1203	1736
Farne Islands	3456	2870	3408	3445	2846	2126
Scolt Head	2550	3089	2775	1052	0	0
Blakeney Point	1000	475	1000	1500	3000	3000
Minsmere	1	0	0	0	5	20
Havergate	145	200	63	50	60	84
Foulness/Maplin	98	243	350	300	280*	280
Dungeness	350	3	125	220	240	250
Rye Harbour	42	155	0	3	25	2
Pagham Harbour	0	0	0	0	26	2
Chichester Harbour	12	27	0	15	22	5
Langstone Harbour	0	3	2	0	0	0
North West Solent	176	220	305	198	150	151
Pitts Deep-Hurst	45	50	70	?	25	0
Brownsea Island	103	25	72	90	64	75
Anglesey	450	700	1080	830	517	601
South Walney	45	180	0	0	0	0
Foulney	400	550	700	770	720	332
Hodbarrow	0	0	0	50	120	520
Swan Island	63	74	117	138	130	135
Green Island	61	286	78	36	59	172
Strangford Lough	1418	2127	2228	962	1382	879
Lady's Island Lake	524	708	412	1317	1395	1469
Lough Swilly	95	102	73	76	109	99
Mulroy Bay	112	98	225	240	79	76
Total	13701	15639	16150	13763+	14122	13885

* Revised record for Foulness/Maplin in 1990.

TABLE 3.17.2 Population changes at monitored Sandwich tern colonies, 1990-91 (breeding pairs). Superscript = number of colonies.

	NE Scot.	SE Scot.	NE Engl.	E Engl.	SE Engl.
1990	1 247	418	4 049	3 345	488
1991	1 398	473	3 862	3 384	410
% change	+12.1[2]	(+13.1)[1]	-4.6[2]	+1.2[4]	-16.0[6]

	Wales	NW Engl./ I. of Man	NE Irel.	SE Irel.	NW Irel.	TOTAL
1990	517	840	1 571	1 395	188	14 112
1991	601	878	1 186	1 469	175	13 911
% change	+16.3[2]	+4.5[3]	-24.5[3]	(+5.3)[1]	-6.9[2]	-1.6[26]*

*3 of 29 regularly-counted colonies held no breeding pairs in both years.

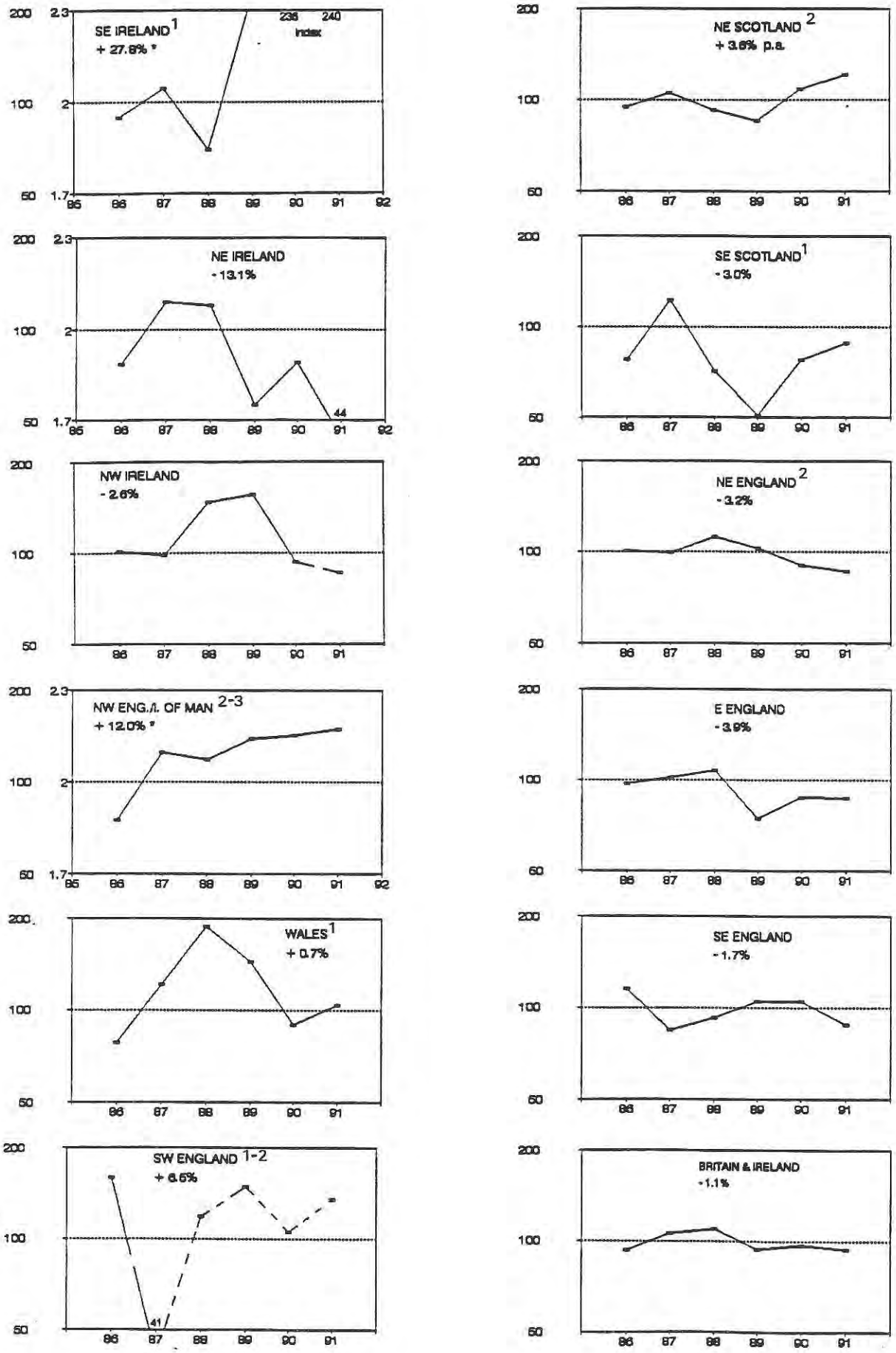

FIGURE 3.17.1 **Population indices for breeding Sandwich terns, 1986-91 (pairs or apparently occupied nests).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05). Broken trend-line indicates sample count of <200 pairs (dashed line = 20-100 pairs). Number of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

TABLE 3.17.3 **Sandwich tern breeding success, 1986-91:** estimated number of chicks fledged per breeding pair at sampled colonies. Note that the same colonies have not necessarily been monitored in each region each year, and that numbers of pairs given here are sample sizes (and do not necessarily indicate population changes between years).

Region	1986 prs[a]	fledged /pr	1987 prs[a]	fledged /pr	1988 prs[a]	fledged /pr	1989 prs[a]	fledged /pr	1990 prs[a]	fledged/pair range[a]	fledged/pair total	1991 prs[a]	fledged/pair range	fledged/pair total
Orkney	-	-	-	-	16[1]	**0.63+**	-	-	-	-	-	-	-	-
N Scotland	-	-	-	-	-	-	-	-	35[1]	-	**0.00**	-	-	-
NE Scotland	1090[2]	**0.44**	1212[2]	**0.89**	1068[2]	**<0.51**	983[2]	**<0.89**	1247[2]	0.05-0.80	**0.73**	1398[2]	0.30-0.35	**0.31**
NE England	1049[1]	**0.95**	1586[1]	**0.79**	1616[1]	**0.87**	1164[1]	**0.69**	1203[1]	-	**0.84**	1736[1]	-	**0.80**
E England	2659[2]	**0.87**	3289[2]	**1.02**	2775[1]	**0.43**	1352[2]	**0.19**	3340[3]	0.28-1.0	**0.99**	3384[4]	0.27-0.71	**0.31**
SE England	350[1]	**1.00**	158[2]	**0.33**	127[2]	**0.79**	220[1]	**0.85**	312[4]	0.0-0.9	**0.69**	259[4]	0.0-1.0	**0.96**
SW England	-	-	25[1]	**1.40**	-	-	-	-	64[1]	-	**0.47**	75[1]	-	**0.80**
Wales	451[1]	**<0.80**	-	-	-	-	-	-	517[1]	-	**0.56**	600[1]	-	0.55
NW England	400[1]	**0.10**	550[1]	**0.73**	700[1]	**1.00**	820[2]	**0.85**	840[2]	0.0-1.0	**0.44**	852[2]	0.0-0.15	**0.06**
SE Ireland	-	-	-	-	-	-	-	-	1395[1]	-	**0.75**	1469[1]	-	**0.56**
TOTAL	6035[9]	**0.64**	6823[10]	**0.93**	6304[7]	**0.63**	4539[8]	**0.62**	8953[16]	0.0-1.0	**0.79**	9773[16]	0.0-1.0	**0.45**

[a]Number of colonies monitored. [a]Range is quoted for colonies of 10+ pairs only.

3.18 Roseate tern *Sterna dougalli*

A. del Nevo

Breeding numbers (table 3.18.1)

The British and Irish population in 1991 is estimated at ca. 470 pairs. This represents a small decline on 1990, but the rapid decline in numbers which occurred in the 1970s and 1980s does seem to have halted. The continued growth of the Rockabill colony to 366 pairs in 1991 has been at the expense of other colonies (e.g. Anglesey). Several ringed birds which had previously bred on Anglesey were recorded breeding on Rockabill during 1991. The colony in Larne Lough continued to decline, and held its lowest number of roseate terns for 20 years. Gradual sinking of the island used in Carlingford Lough has resulted in the total loss of roseates at this site. Roseate terns in north Wales fared little better, with only one pair between the two most regular Anglesey colonies although at least three pairs bred at another Anglesey site. The downward trend continued on the Farne Islands and Coquet Island, and for the second successive year no birds bred at Inchmickery (although 15 pairs bred at another Firth of Forth site).

Breeding success (table 3.18.1)

Comprehensive coverage of Rockabill resulted in 568 pulli being ringed, indicating productivity of ca. 1.5 chicks per pair. The water level at Lady's Island Lake was high enough to prevent ground predators from reaching the colony there and the 56 pairs fledged an average of 0.80 chicks each. In Northern Ireland each of the four four pairs in Larne Lough fledged one chick. The only young birds produced in North Wales were at one of the Anglesey sites, where three pairs produced at least one chick each. In NE England, Coquet Island produced a minimum of 14 young from 20 pairs and at least 2 young fledged from the 3 pairs on the Farne Islands. The only confirmed Scottish breeders, 15 pairs on an islet in the Forth, fledged about one chick per pair.

Discussion

1991 was a disappointing year at roseate tern colonies outside of Ireland. Rockabill continues to dominate the NW European distribution of roseate terns and in recent years has been the only colony throughout the European range consistently rearing above one fledged chick per pair.

In Brittany, France, the Société pour l'Étude et la Protection de la Nature en Bretagne (SEPNB) continues to warden and monitor the roseate tern colonies (with financial aid from RSPB and EC). A total of 82 pairs was recorded, with 80 of these at one colony. However, 54 incubating/brooding adults were killed by a ferret *Mustela furo* and it is estimated that only 40 chicks fledged.

Continued work by the RSPB and the University of the Azores has estimated the Azores breeding population at 1,250 pairs during 1991. The mean breeding success for the archipelago was 0.98 chicks per pair, remarkedly good considering the relatively low clutch size (mean = 1.1) compared to the mean clutch size in the UK and Ireland (1.7) in 1991 (RSPB, IWC unpublished data).

TABLE 3.18.1 Roseate tern numbers (pairs) at major colonies (those holding 20+ pairs in at least one year) during 1986-91, and breeding success (chicks fledged/pair) in 1991.

Colony	1986	1987	1988	1989	1990	1991	y/pr
Inchmickery (E Lothian)	18	20	21	5	0	0	-
Coquet Isd (Northumberland)	20	17	21	25	23	20	0.7
Farne Isds (Northumberland)	9	14	21	12	4	3	0.7
Anglesey (2 cols.) (Gwynedd)	200	61	45	89	42	1	-
Larne Lough (Antrim)	21	25	23	37	19	4	1.0
Carlingford Lough (Down)	34	40	7	25	3	0	-
Rockabill (Dublin)	177	250	332	194	321	366	1.5
Lady's Isd Lake (Wexford)	0	8	0	76	60	56	0.8
TOTAL*	490	450	480	470	490	470	1.34

*Totals include other regularly-counted, small colonies (incl. SE Scotland & a third Anglesey colony in 1991).

3.19 Common tern *Sterna hirundo*

Breeding numbers (table & figure 3.19.1)
As usual, coverage for this species is incomplete, and so indices of population change need to be treated with caution (given the propensity of terns for moving between colonies in different years). Breeding numbers at monitored Scottish colonies appeared to decline by ca. 10% between in 1991. However, this varied markedly between colonies and regions, and no significant trends were noted for 1986-91 as a whole. Total numbers at the four largest east-coast colonies were virtually unchanged since 1989 (823 pairs compared to 821 in 1991).

Within England, trends in the east and south-east regions have been re-assessed since the 1990 report as more records are collated. Although the 1989-90 decline for SE England is now estimated at only 0.7%, numbers fell by 23% in 1991. Numbers in E England increased by 8% in 1991 (after a 16.6% decrease in 1990), but the 1986-91 trend for this region is still of a significant decline. Breeding numbers at monitored English colonies fell by 16.3% overall in 1991, largely reflecting declines in the NE and SE regions. This contributed to a continued, significant decline of the English and Welsh population sample over 1986-91 as a whole.

Breeding numbers at Shotton Steelworks (Wales) in 1991 were about half those in 1990, accounting for most of the 1991 decrease in Wales. Little change was seen in NE Ireland. In SE Ireland the Rockabill colony continues to grow (70% increase to 178 pairs in 1991), and the region as a whole shows a significant upward trend over the period 1986-91.

Breeding success (table 3.19.2)
Productivity in Scotland in 1991 was again low (ca. 0.4 chicks/pair), similar to that in 1990 (but higher than in 1989). Success was highly variable between colonies, with, as usual, predation by foxes and gulls a major problem at many sites. On the west coast, predation by otters *Lutra lutra* and mink *Mustela vison* was a continued problem. In parts of SW Scotland (notably in the Sound of Jura, where few if any chicks fledged from ca. 150 clutches), clutch-sizes were small and adults appeared to be deserting and moving between colonies; food shortage was suggested as a possible explanation.

In England, breeding success in 1991 (0.5 chicks/pair) was slightly higher than in 1990, but lower than in the period 1986-1989. Flooding, predation and disturbance were the main problems, but success was high at sites where artificial rafts were available (e.g. Breydon Water in Norfolk). Productivity at Welsh colonies was much improved in 1991, over 370 young fledging from 400 pairs. The main colonies in SE Ireland were also successful (especially Rockabill).

Discussion

Incomplete coverage means that firm conclusions on trends of this species are difficult, but breeding numbers at monitored colonies in Britain decreased in 1991. Productivity in Scotland and England was again rather low, reflecting a combination of factors, but a dramatic improvement was seen in Wales.

It is notable that the most successful colonies tended to be in man-made locations. These include industrial yards such as Nigg Oil Terminal (Ross & Cromarty) and Shotton Steelworks (Clwyd), and the nesting-rafts provided at Breydon Water (Norfolk), where numbers increased again to 140 nesting pairs in 1991. Such sites are less affected by mammalian predation and flooding, and are rapidly colonised by Common Terns. (This also applies to artificial rafts at inland sites, e.g. gravel pits, not covered in this report.) The provision of more artificial

sites may help maintain Common Tern numbers if other sites become unsuitable. Increased monitoring is to be encouraged in 1992 to make regional trends for this species clearer.

TABLE 3.19.1 **Population changes at monitored coastal common tern colonies,** 1990-91 (breeding pairs). Superscript = number of colonies counted in both years. Regional samples <100 pairs are excluded (but are included in totals).

	SW Scot.	NW Scot.	N Scot.	NE Scot.	SE Scot.	SCOTLAND
1990	1267	286	426	476	413	2868
1991	1020	352	495	384	343	2594
% change	-19.5^{16+}	$+23.0^{12}$	$+16.2^{6}$	-19.3^{4}	-16.9^{4}	-9.6^{42+}

	NE Engl.	E Engl.	SE Engl.	SW Engl.	WALES	NW Engl.
1990	1041	418	860	183	464	161
1991	812	452	662	135	290	167
% change	-22.0^{5}	$+8.1^{6}$	-23.0^{9}	-26.2^{2}	-37.5^{4}	$+3.7^{3}$

	ENGLAND	ENG./WALES	NE Irel.	SE Irel.
1990	2663	3127	1218	289
1991	2228	2518	962	428
% change	-16.3^{25}	-19.5^{29}	$-21.0^{>5}$	$+48.1^{2}$

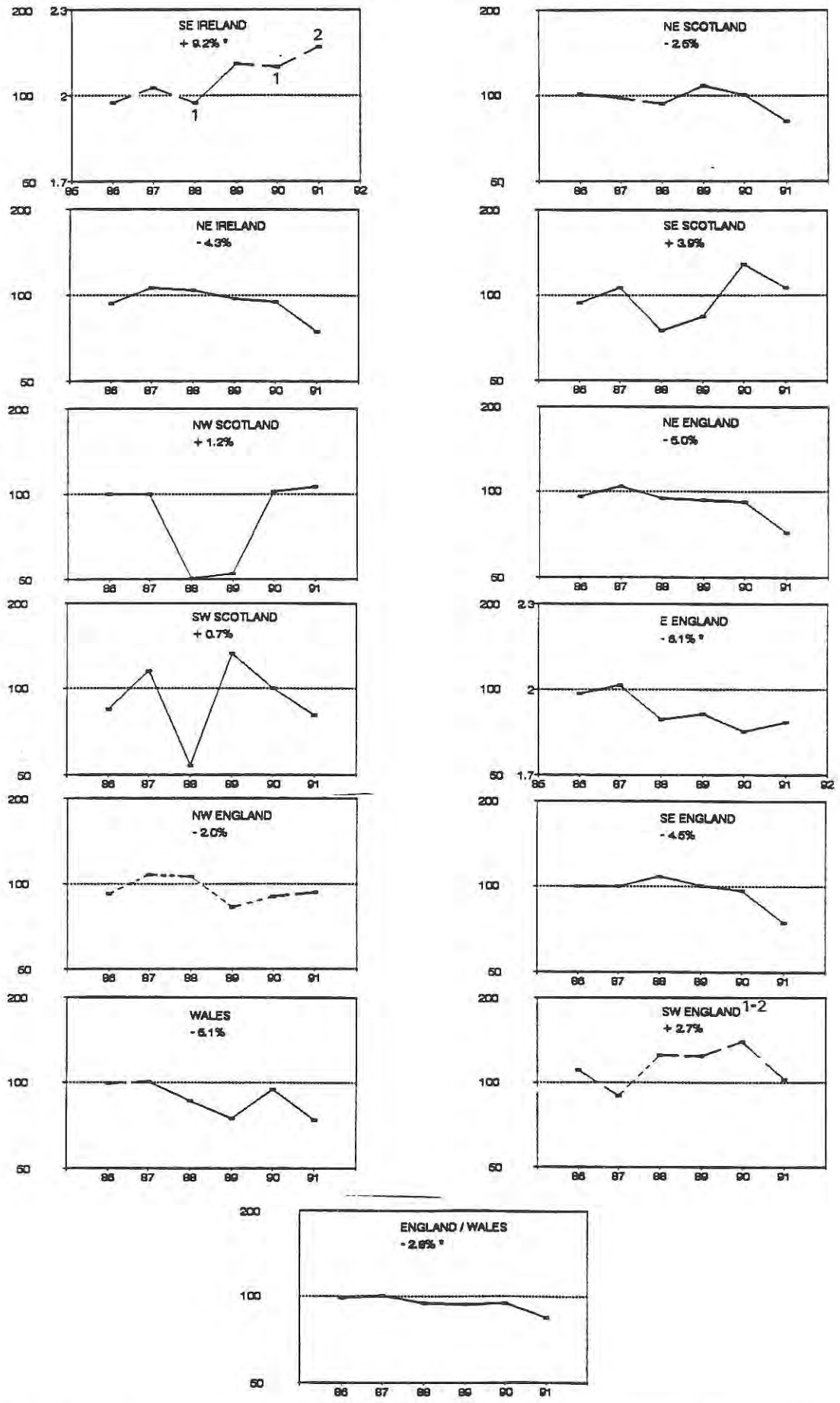

FIGURE 3.19.1 **Regional population indices for breeding common terns, 1986-91 (pairs or apparently occupied nests).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05). Broken trend-lines are based on sample counts of 100-200 pairs (dashed line = 50-100). Number of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

TABLE 3.19.2 **Common tern breeding success at coastal colonies, 1986-91:** estimated number of chicks fledged per breeding pair at sampled colonies.

Region	1986 prs[a]	fledged /pr	1987 prs[a]	fledged /pr	1988 prs[a]	fledged /pr	1989 prs[a]	fledged /pr	1990 prs[a]	fledged/pair range[b]	fledged/pair total	1991 prs[a]	fledged/pair range	fledged/pair total
SW Scotland	-	-	-	-	653[9]	**0.43**	c1174[14]	c**0.94**	1230[9]	0.0-0.87	**0.46**	984[7+]	0.0-0.60	**0.36**
NW Scotland	-	-	-	-	c125[7]	<**0.28**	130[7]	**0.20**	280[8]	0.0-1.26	**0.21**	226[10]	0.0-1.2	**0.18**
Shetland	-	-	-	-	78[2]	**0.03**	25[1]	**0.04**	-[2+]	-	<**0.05**	10[1]	-	**0.20**
N Scotland	-	-	-	-	-	-	220[3]	**0.14+**	466[6]	0.0-c0.9	c**0.7**	715[9]	0.0-1.17	**0.53**
NE Scotland	97[1]	c**0.46**	241[2]	c**1.13**	155[1]	**0.56**	c309[2]	<**0.12**	305[2]	-	**0.0**	198[2]	0.0-0.72	**0.09**
SE Scotland	22[1]	c**1.04**	141[2]	**1.09**	c50[1]	c**0.90**	60+[1]	c**1.10**	c190[1]	-	**0.03**	c219[2]	0.42-0.5	c**0.05**
SCOTLAND	119[2]	**0.57**	386[5]	**1.11+**	1061[20]	**0.43**	1913[28]	**0.13**	>2319[29+]	0.0-1.26	<**0.4**	2352[31+]	0.0-1.2	**0.38**
NE England	15[1]	**0.67+**	14[1]	**0.86+**	-	-	613[1]	c**0.65**	131[4]	0.0-1.09	**0.85**	607[2]	0.0-0.71	**0.67**
E England	361[4]	**0.69**	381[4]	**0.59**	320[3]	**0.30**	359[3]	**0.38**	782[7]	0.0-1.67	**0.69**	456[6]	0.0-1.14	**0.37**
SE England	440[4]	c**0.62**	362[3]	**1.16**	364[2]	**1.04**	280[2]	**0.99**	655[7]	0.0-0.50	**0.09**	327[5]	0.0-0.91	**0.63**
SW England	-	-	86[2]	**1.08+**	120[2]	**0.67+**	-[1]	-	186[2]	0.38-0.40	**0.39**	285[3]	0.33-0.71	**0.48**
NW England	-	-	-	-	68[4]	**0.0**	61[3]	**0.36**	161[3]	0.0-0.02	**0.01**	166[2]	-	**0.0**
ENGLAND	820[11]	**0.65**	843[11]	**0.89**	872[12]	**0.64**	1391[10]	**0.64**	1915[23]	0.0-1.67	**0.49**	1841[19]	0.0-1.14	**0.50**
WALES	-	-	c175[2]	c**0.50**	-	-	-	-	404[3]	-	**0.0**	400[4]	0.05-c2.0	c**0.93**
SE Ireland	-	-	-	-	-	-	-	-	-	-	-	428[2]	c0.7-2.3	c**1.4**

[a]Number of colonies monitored. [b]Range is quoted for colonies of 10+ pairs only.

3.20 Arctic tern *Sterna paradisaea*

Breeding numbers (tables 3.20.1-2, figure 3.20.1)

Breeding numbers at 93 sample colonies in Shetland in 1991 showed a dramatic increase compared to 1990 (+261%), whereas in Orkney numbers at 63 sample colonies fell by 31%. Although it would unwise to treat these figures as comprehensive, they probably reflect general trends in population changes. Elsewhere in Scotland, numbers at 15 east-coast colonies showed little change, holding 1575 pairs in 1990 and 1478 pairs in 1991 (-6%). However, there were distinct regional differences, with a 45% decrease in NE Scotland but increases further north and south. On the west coast, numbers in a SW Scotland study-area fell by 19%, but there was a marked increase further north.

A 39% decline in NE England was mainly due to a loss of 1380 pairs on the Farne Islands. Numbers at two Welsh colonies increased by 32% in 1991, contributing to a significant increase over the period 1986-91 as a whole. In NE Ireland numbers at the main colonies fell from 273 pairs in 1990 to ca. 70 in 1991, and there has been a significant decline during 1986-91.

Breeding success (table 3.20.3)

In Shetland, the breeding success of 1090 pairs was monitored in 19 colonies selected at random, and an average of 0.67 chicks fledged per pair (the second-highest regional figure in 1991). Large numbers of fledged young were seen at other colonies throughout Shetland, in striking contrast to 1990 and other recent years. Clutch sizes and hatching success were also high, and relatively few dead chicks were found.

In Orkney, 5390 pairs at 14 monitored colonies fledged only about 750 young (0.14 fledged/pair), continuing a run of poor years recently. Large colonies on Pentland Skerries (1500 birds), Flotta (800), Walls (400) and Westray (480) all failed completely at the egg or small-chick stage. Although no direct evidence is available, predation by gulls and/or skuas was thought largely responsible, and hedgehogs *Erinaceus europaeus* were again recorded taking eggs on North Ronaldsay. Weather conditions at hatching time were much more favourable than last year, so it is unlikely that large-scale failures were due to bad weather. The most successful monitored colony was North Hill, Papa Westray, but even here only 600 chicks fledged from a total of 2840 pairs (0.21 fledged/pair).

Success was also poor in SW and NW Scotland, where predation by mink and otter continues to be a problem (along with possible food-shortage in some areas - see under common tern). Elsewhere, at eight colonies in N Scotland productivity ranged 0 - 0.65 chicks fledged/pair, the most successful colonies being in the industrial yards at Ardersier and Nigg. Failures at other colonies were largely due to gull predation and flooding. In NE Scotland, 335 pairs at three colonies fledged only 30 chicks (0.08 fl/pr), all at one colony (St Fergus gas terminal). Predation by gulls and foxes was the main problem, and stoats *Mustela erminea* may have reduced success at St Fergus.

In NE England, breeding success at two colonies varied from 0.4 to 0.68 chicks fledged/pair, predation by kestrels *Falco tinnunculus* reducing success at the former colony (Long Nanny). Two of the three monitored colonies in NW England failed completely, due to predation by large gulls and flooding, and only 10 young fledged from 25 pairs at the third colony.

At the four monitored Welsh colonies, 1108 pairs fledged at least 776 young, but success was very variable between colonies. At the largest colony, 700 pairs

raised over 700 young, but at another colony (where predation by peregrines *Falco peregrinus* occurred) only 3 young fledged from 200 pairs. Bad weather in NE Ireland resulted in late nesting and poor breeding success, although no detailed figures are available.

Discussion

The dramatic increase in breeding numbers in Shetland was unexpected, and the origins of these birds is uncertain. They may have been immigrants from elsewhere, or Shetland-bred birds that had not attempted to breed in the last few years during the period of food-shortage. It is possible that at least some of the increase in numbers on Shetland involved birds that had bred in Orkney in 1990 moving to Shetland, since numbers decreased at Orkney study-colonies in 1991. Movements may also be occurring between regions holding smaller populations, possibly accounting for some of the marked fluctuations seen during 1986-91.

Sandeels were abundant in Shetland waters in 1991 (Wright and Bailey 1991) and arctic terns enjoyed their highest breeding success for at least eight years. However, poor breeding success continued in Orkney, and it seems possible that food shortage may be at the root of the problem here, reducing adult nest-attendance and allowing heavy predation of eggs and chicks. Breeding success continues to be low in most other regions. Within Scotland, colonies at three industrial yards on the east coast were among the most successful. These sites are less affected by predation and flooding, and may well become increasingly important breeding sites in future years (see also common tern).

TABLE 3.20.1 Numbers of arctic terns (individuals) recorded at sample colonies in Shetland and Orkney which were surveyed in both 1990 and 1991 (n = no. colonies).

SHETLAND	n	1990	1991	% change
Fetlar	38	222	1479	+701
N Mainland	5	53	72	+36
Papa Stour	23	70	1210	+1629
W Mainland	5	97	84	-13
Delting	5	220	143	-35
S. Mainland	5	59	280	+375
Noss	1	150	200	+33
Mousa	6	212	860	+306
Unst	2	59	110	+86
Yell	3	54	120	+122
Total	93	1346	4858	+261

ORKNEY	n	1990	1991	% change
Papa Westray	5	8940	5918	-34
Westray	9	2256	2055	-9
North Ronaldsay	24	1995	837	-58
Mainland	6	194	462	+138
Walls & Flotta	6	3407	1442	-58
South Ronaldsay	3	1024	1673	+63
Rousay, Egilsay & Wyre	10	1272	760	-40
Total	63	19088	13147	-31

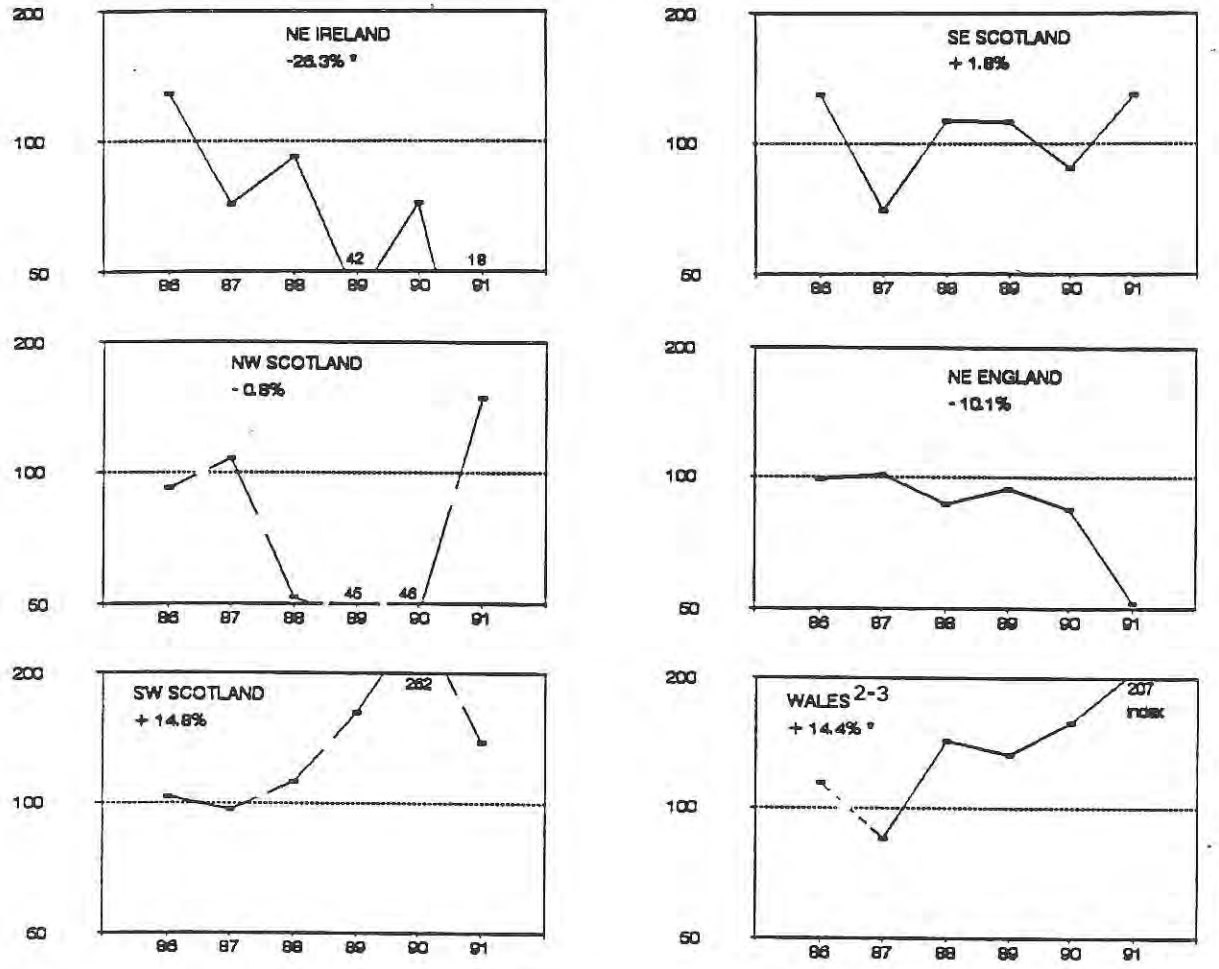

FIGURE 3.20.1 **Regional population indices for breeding arctic terns, 1986-91 (pairs or apparently occupied nests).** Average annual rates of change are calculated by regression of log of index against year (significant trends:

TABLE 3.20.2 **Population changes at monitored arctic tern colonies, 1990-91** (breeding pairs). Superscript = number of colonies counted in both years. Regional samples <100 pairs are excluded.

	SW Scot.	NW Scot.	Shetland*	Orkney*	N Scot
1990	252	49	1346i	19 088i	364
1991	204	238	4858i	13 147i	563
% change	-19^{8+}	$+486^{7}$	$+361^{93}$	-31^{63}	$+55^{8}$

	NE Scot.	SE Scot.	NE Engl.	Wales	NE Irel.
1990	890	321	3 777	684	273
1991	485	472	2 310	900	67+
% change	-45^{4}	$+47^{3}$	-39^{4}	$+32^{2}$	$-c70^{4}$

*Counts of individual adults, Shetland and Orkney (cf. table 3.20.1)

TABLE 3.20.3 **Arctic tern breeding success, 1986-91:** estimated number of chicks fledged per breeding pair at sampled colonies.

Region	1986 prs[a]	fledged /pr	1987 prs[a]	fledged /pr	1988 prs[a]	fledged /pr	1989 prs[a]	fledged /pr	1990 prs[a]	fledged/pair range	fledged/pair total	1991 prs[a]	fledged/pair range	fledged/pair total
SW Scotland	16[1]	**0.81**	-	-	c181[9]	**<0.37**	199[12]	**0.54**	305[6]	0.0-0.63	**0.36**	c253[8]	0.0-0.38	**0.17**
NW Scotland	-	-	-	-	c27[1]	**<0.92**	c16[2]	**c0.87**	46[2]	-	**0.07**	147[5]	0.11-0.26	**0.20**
Shetland	-	**<0.01**	-	**<0.01**	-	**<0.01**	-	**<0.02**	-	-	**<0.01**	1090[19]	0.0-1.10	**0.67**
Orkney[b]	-	-	-	-	-	-	17000i[8]	**<0.20**	386[27]	-	**0.33**	5390[14]	0.0-0.21	**0.14**
N Scotland	-	-	-	-	-	-	c88[3]	**0.57+**	358[6]	0.0-0.03	**<0.01**	443[8]	0.0-0.65	**0.35**
NE Scotland	-	-	49[1]	**c1.00**	80[2]	**0.55+**	c304[8]	**c0.41**	890[4]	0.0-0.17	**0.09**	335[3]	0.0-0.12	**0.09**
SE Scotland	202[2]	**c0.33**	185[2]	**c0.38**	c281[2]	**c0.28**	c273[2]	**c0.11**	291[2]	0.01	**0.01**	c436[2]	0.17	**0.18**
NE England	-	-	-	-	-	-	-	-	549[3]	0.65-1.5	**0.76**	462[2]	0.40-0.68	**0.42**
Wales	130[1]	**0.85**	260[1]	**c1.00**	-	-	-	-	738[3]	0.0-0.65	**0.42**	1108[4]	0.01-1.0+	**0.70+**
NW England	-	-	-	-	49[3]	**0.20**	35[1]	**0.09**	54[1]	-	**0.13**	41[3]	0.0-0.40	**0.24**

[a]Number of colonies monitored. [b]Range is quoted for colonies of 10+ pairs only.
[b]Orkney: individual adults counted in 1989 & 1991; productivity assumes number of adults = 1.5 x no. of pairs.

3.21 Little tern *Sterna albifrons*

J Sears

Breeding numbers (table & figure 3.21.1)

The slow but steady decline in the English and Welsh population since 1987 continued in 1991. Numbers in 50 colonies counted in both 1990 and 1991 dropped by 4%. The small Scottish population has shown no obvious trend over 1986-91, although numbers at 14 monitored colonies increased by 21% in 1991.

Regional patterns of population change were generally similar to 1990. Numbers were stable in East Anglia, the region with the highest number of little terns, but declined in the other main regions, SE and NE England. (Numbers in the latter region have declined significantly during 1986-91.) For the third year running, Great Yarmouth (Norfolk) was the largest colony in Britain or Ireland, after increasing by a further 38% (to 277 pairs) since 1990. In contrast, numbers at the second largest colony, in Langstone Harbour (Hants.), fell by 29% to 103 pairs.

Breeding success (table 3.21.2)

Very low breeding success was recorded at most of the 61 colonies monitored in Britain, with overall productivity only 0.19 young fledged/pair. Such low productivity has been recorded in only one other year (1978) since 1969. In Scotland only 8 young were fledged by 111 pairs at 10 colonies (0.07 young/pair), following predation by foxes and gulls and disturbance. For the first time since 1969, half the monitored colonies in Britain failed to fledge any young. Many of the colonies along the south and east coasts of England failed due to bad weather and high tides in mid June. At Gibraltar Point (Lincs.), several dead chicks were found to be severely emaciated and were considered to have starved because strong winds prevented the adults finding enough food. Predation was a common cause of failure throughout Britain. None of the 103 pairs at Langstone were successful, largely due to foxes, and only 12 young fledged from Great Yarmouth, where predation by three pairs of kestrels and a fox was recorded.

Discussion

The decline in both population and breeding success has continued in 1991. For the third year running overall productivity at British colonies has been below 0.5 young/pair. There is concern that the number of breeding pairs will decline further as a result. The continuing problem of predation at large colonies needs to be addressed. In 1992, artificial feeding of kestrels at Great Yarmouth will be attempted to see if predation rates can be reduced. Several failed breeders from Great Yarmouth appeared to move to Walberswick (Suffolk) and other movements were apparent along the east coast after so many colonies failed. This highlights the need to protect alternative sites once large colonies have become unsuitable.

TABLE 3.21.1 Population changes at monitored little tern colonies, 1990-91 (breeding pairs). Superscript = number of colonies counted in both years. Regional samples (50 pairs are excluded (but are included in totals).

	SCOTLAND	NE Engl.	E Engl.	SE Engl.	SW. Engl.
1990	100	223	835	345	37
1991	121	198	838	290	55
% change	-21.0^{14}	-11.2^{10}	$+0.4^{23}$	-15.9^{13}	$(+48.6)^{1}$

	Wales	NW Engl.	ENG./WALES	BRITAIN
1990	51	54	1545	1645
1991	54	48	1483	1604
% change	$(+5.9)^{1}$	$(-11.1)^{5}$	-4.0^{53}	-2.5^{64}

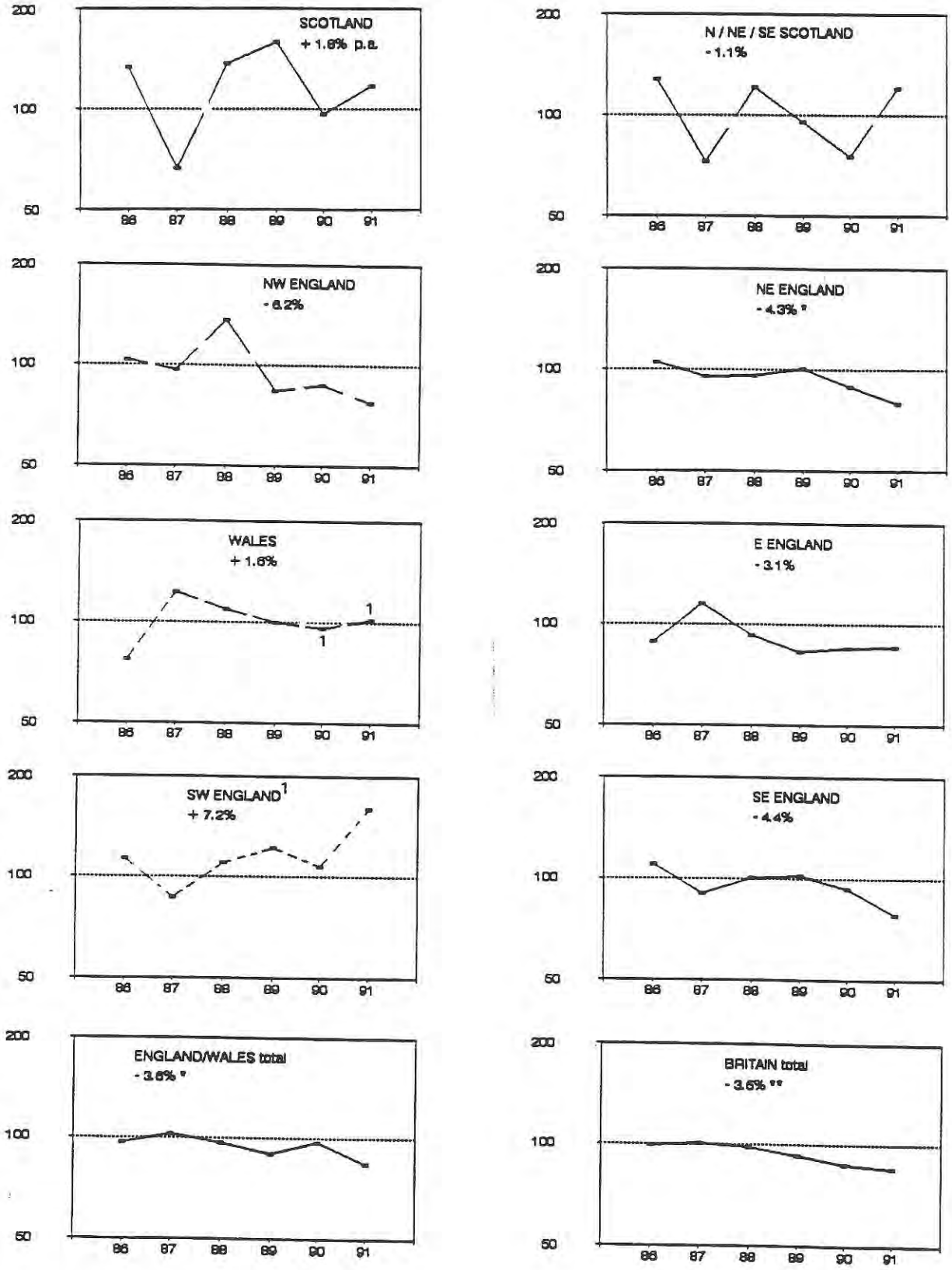

FIGURE 3.21.1 **Population indices for breeding little terns, 1986-91 (pairs or apparently occupied nests).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05; ** P<0.01). Broken trend-lines are based on sample counts of 50-100 prs (dashed line = 30-50).

TABLE 3.21.2 **Little tern breeding success, 1986-91:** estimated number of chicks fledged per breeding pair at sampled colonies. [a]Number of colonies monitored.

Region	1986 prs[a]	fledged /pr	1987 prs[a]	fledged /pr	1988 prs[a]	fledged /pr	1989 prs[a]	fledged /pr	1990 prs[a]	fledged/pair range	fledged/pair total	1991 prs[a]	fledged/pair range	fledged/pair total
SW Scotland	6[2]	**1.00**	4[1]	**0.50**	3[1]	**0.00**	-	-	12[1]	-	**0.00**	5[1]	-	**0.00**
NW Scotland	-	-	-	-	-	-	-	-	35[1]	-	**<0.43**	-	-	-
N Scotland	1[1]	**2.00**	-	-	6[1]	**<1.50**	28[2]	**0.21**	24[2]	0.0-0.6+	**<0.30**	19[3]	0.0-0.40	**0.10**
NE Scotland	16[1]	**0.44+**	36[2]	**0.05**	60[3]	**0.48+**	43[2]	**0.21**	33[2]	0.0-0.13	**0.12**	24[2]	0.0-0.09	**0.08**
SE Scotland	26[1]	**0.00**	21[2]	**0.62**	35[2]	**1.20**	12[1]	**0.33**	30[4]	0.75-1.64	**1.00**	45[4]	0.0-0.27	**0.09**
SCOTLAND	49[5]	**0.31+**	61[5]	**0.28**	104[7]	**0.77**	83[6]	**0.24**	134[11]	0.0-1.64	**0.41**	93[10]	0.0-0.40	**0.09**
NE England	261[9]	**0.55**	233[8]	**0.78**	243[10]	**0.69**	252[9]	**0.64**	190[7]	0.0-1.51	**0.86**	198[10]	0.0-0.90	**0.25**
E England	463[9]	**0.63**	613[9]	**0.93**	835[18]	**0.68**	757[18]	**0.44**	835[22]	0.0-1.50	**0.44**	822[23]	0.0-1.25	**0.17**
SE England	297[9]	**0.56**	358[11]	**0.97**	262[7]	**0.32**	266[9]	**0.21**	274[9]	0.0-0.30	**0.07**	313[12]	0.0-2.00	**0.15**
SW England	39[1]	**0.20**	30[1]	**0.26**	38[1]	**0.52**	42[1]	**0.66**	37[1]	-	**0.41**	55[1]	-	**0.22**
Wales	37[2]	**0.00**	62[2]	**1.13**	55[2]	**1.18**	53[1]	**1.32**	51[1]	-	**0.00**	54[1]	-	**0.56**
NW England	55[4]	**0.64**	59[3]	**0.32**	46[4]	**0.43**	52[4]	**0.04**	53[3]	-	**0.26**	48[4]	0.0-2.00	**0.92**
ENGLAND/WALES	1152[24]	**0.56**	1355[36]	**0.83**	1479[42]	**0.63**	1488[44]	**0.49**	1440[43]	0.0-1.51	**0.40**	1490[51]	0.0-2.00	**0.20**
SE Ireland	80[4]	**0.68+**	113[2]	**1.23**	-	-	66[2]	**1.18**	58[2]	0.0-0.04+	**<0.03**	-	-	-
TOTAL	1281[43]	**0.56**	1529[43]	**0.88**	1583[49]	**0.64**	1637[52]	**0.51**	1632[56]	0.0-1.64	**0.39**	-	-	-

3.22 Guillemot *Uria aalge*

Breeding numbers (table 3.22.1, figures 3.22.1-2)

Sample populations in most regions either increased or showed little change between 1990 and 1991 in the numbers of adults attending colonies in June. In Shetland, where monitored populations decreased by 18% overall in 1990, there was a marked recovery (+28%) to near-1988 levels. Six out of seven colonies there showed a significant increase, but much of the increase seemed to involve non-breeding or off-duty birds. Numbers at Orkney study-plots were ca. 4.5% higher than the last full coverage in 1988. In Caithness, numbers have increased significantly during 1986-91 (the only region showing a significant trend over this period), but there was a slight decrease in 1991. Away from Shetland, most regions showed no majot change between 1990 and 1991. However, in Wales the sample population at two colonies increased markedly, by 33% (range 26-43%).

Breeding success (table 3.22.2)

The average productivity at 11 monitored colonies, mainly in Scotland, was again high (0.73 +s.e.0.02 chicks "fledged" per regularly-occupied site). This represented no significant change from 1990 figures, and only Marwick Head (Orkney) showed any marked change in productivity (from 0.59 to 0.79 chicks/site). Sumburgh Head (Shetland) was the least successful colony (0.62 chicks/site), largely because of predation of eggs by herring gulls. As seems to be usual with this species, there was relatively little variation between colonies, and no geographical patterns were obvious.

Discussion

Guillemot numbers in Shetland study-colonies have declined markedly since about 1983, but this trend was partly reversed in 1991. Much of the decline seen in 1989 and, especially, 1990 may have involved non-breeding or off-duty birds, although increased winter mortality of adults and immatures is believed to be the main factor behind longer-term decline (Heubeck *et al.* 1991).

Most populations elsewhere appear to have been stable or increasing over the period 1986-91, although some major changes can be seen from year to year. As in Shetland, such changes may reflect attendance behaviour in addition to breeding numbers - e.g., if food availability or feeding conditions are good, adults and non-breeding immatures may have more time available to spend ashore. This could account for at least part of the increase at Welsh colonies in 1991 (especially Elegug Stacks, where a 46% increase in average June counts followed a 22% decrease in 1990).

Guillemots continue to rear good numbers of chicks at all monitored colonies, and even in Shetland there has been only limited evidence that low sandeel availability during 1988-90 had any effect on productivity. Productivity-monitoring plots were established at two additional colonies, Bempton (Humberside) and Berry Head (Devon), in 1991, usefully increasing the geographical spread of coverage.

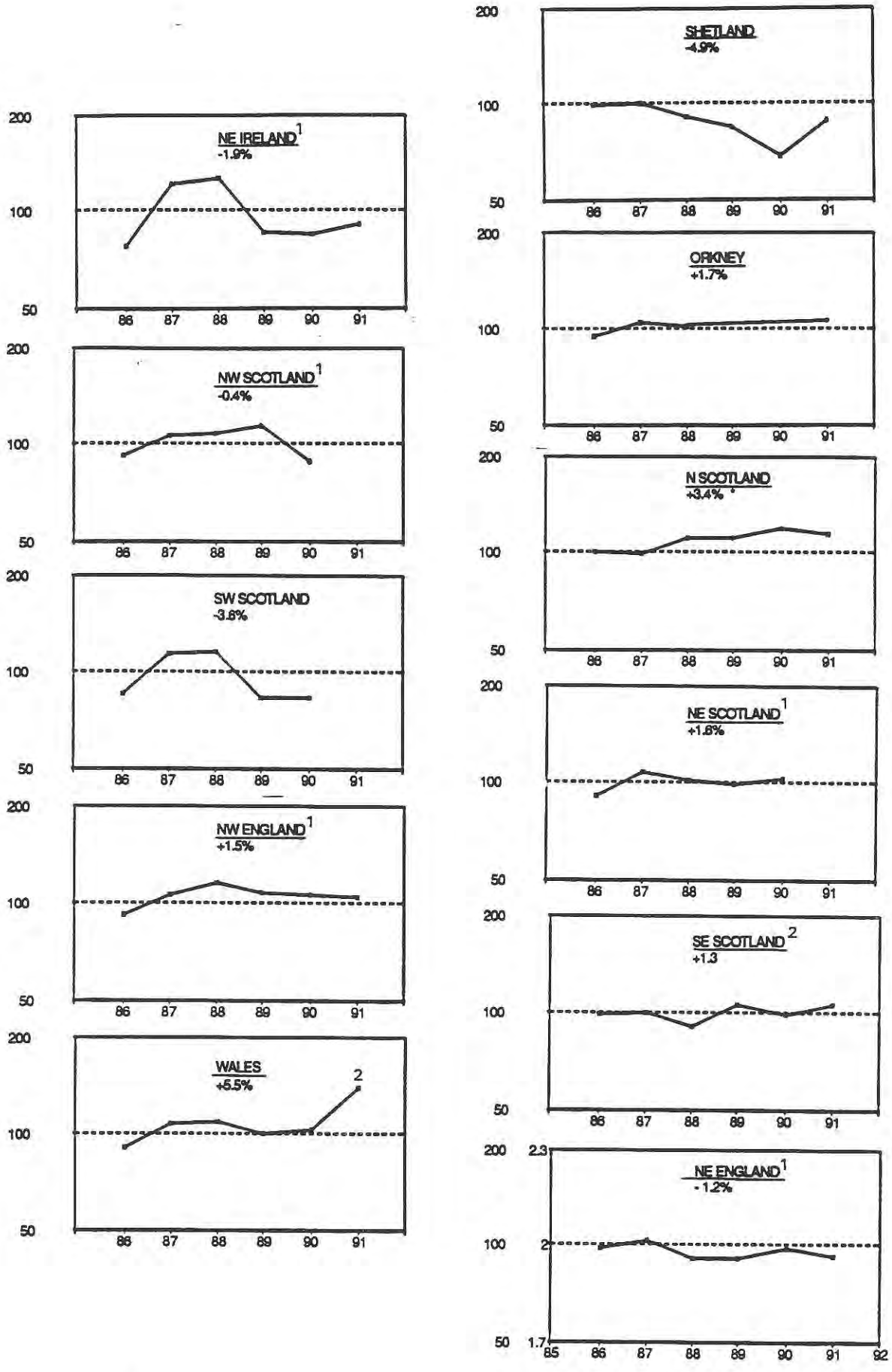

FIGURE 3.21.1 **Regional population indices for breeding guillemots, 1986-91 (adults at colonies in June).** Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05). Region names underlined indicate indices based on 5-10 counts per colony each year. Number of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

TABLE 3.22.1 **Population changes at monitored guillemot colonies, 1990-91** (adults attending colony in June). Superscript = number of colonies counted in both years. Figures for regions in block capitals are based on means of 5-10 counts per year at each colony.

	SHETLAND	N SCOT.	SE SCOT.	NE ENGL.
1990	8 816	7 775	4 139	1 529
1991	11 283	7 425	4 484	1 446
% change	+28.0[7]	-4.5[5]	+8.3[2]	(-5.4)[1]

	WALES	NW ENGL.	NE IREL.
1990	2 664	792	2 274
1991	3 557	783	2 446
% change	+33.5[2]	(-1.1)[1]	(+7.6)[1]

FIGURE 3.22.2 **1990-91 population changes at individual guillemot colonies (based on 5-10 counts per year).**
Solid triangles = significant increases (▲) or decreases (▼);
stippled triangles = non-significant increases (△) or decreases (▽) by ≥ 5%;
stippled circles (⊛) = non-significant changes by < 5%.
Symbol sizes indicate population sample in 1990 (101-1000, 1001+ adults).

TABLE 3.22.2 **Guillemot breeding success, 1986-91:** number of chicks fledged per site regularly-occupied by a pair or per laying. Productivity is quoted as mean ±S.E. of figures from three or more plots (or midpoint ±half-range of two figures). (See 1989 & 1990 reports for 1986-89 sample sizes.)

Colony	1986 Fledged/ site	1987 Fledged/ site	1988 Fledged/ site	1989 Fledged/ site	1990 Sites (plots)	1990 Fledged/ site	1991 Sites (plots)	1991 Fledged site	
Canna (Lochaber) impression	good	good	good	good	-	good	-	good	
Hirta, St Kilda (W Isles)	-	-	-	-	169(2)	0.64 ±0.08	-	-	
Handa (Sutherland)	-	-	0.76 ±0.06	0.70 ±0.06	223(4)	0.62 ±0.02	233(4)	0.67 ±0.02	a*
Hermaness (Shetland) impression	-	-	-	< average	-	< average	-	-	
Foula (Shetland) impression	good	good	good	good	-	good	-	good	b
Sumburgh Head (Shetland)	-	-	-	0.69	(2)	0.58 ±0.25	99(1)	0.62	c
Fair Isle (Shetland)	good	0.80	0.78 ±0.02	0.78 ±0.01	106(2)	0.71 ±0.01	193(2)	0.70 ±0.09	d
Rest of Shetland impression	good	good	good	good	-	good	-	-	
Papa Westray (Orkney)	-	-	-	0.76 ±0.11	141(2)	0.72 ±0.02	148(2)	0.70 ±0.03	e
Marwick Head (Orkney)	0.71	0.70	0.78	0.72	81(1)	0.59	87(1)	0.78	f
Row Head (Orkney)	-	-	-	0.75	-	-	79(1)	0.83	f
Mull Head (Orkney)	-	-	-	0.72	88(1)	0.77	90(1)	0.70	f
Isle of May (NE Fife) egg**	0.82 ±0.02	0.76 ±0.02	0.85 ±0.02	0.85 ±0.03	748(5)	0.78 ±0.03	754(5)	0.81 ±0.03	g
Farne Isds (Northumberland)	0.61 ±0.13	0.70 ±0.16	0.79 ±0.02	-	-	-	67(2)	<0.87	h
Bempton (Humberside)	-	-	-	-	-	-	150(4)	0.70 ±0.03	i
Berry Head (Devon) egg**	-	-	-	-	-	-	52(2)	0.73 ±0.01	j
Skomer (Dyfed)	good	good	good	0.79 ±0.05	112(5)	0.70 ±0.05	140(6)	0.75 ±0.11	k
Rathlin (Antrim) impression	-	-	-	poor	-	improved	-	-	

*1991 sources: a. Furness & Aitken (1992). b. Furness (1991). c. SOTEAG. d. Harvey & Orsman (1991). e. T Dodman (RPSB). f. P M Walsh. g. Harris (1991). h. National Trust. i. D O'Hara (RSPB). j. M Smallbones. k. Poole & Sutcliffe (1991).
**At several colonies, observations are intensive enough to confirm egg-laying for sampled pairs; figures for other sites generally include additional sites regularly occupied by a pair (mostly failed breeders continuing to attend the site, cf. Harris 1989).

3.23 Razorbill *Alca torda*

Breeding numbers (table & figure 3.23.1)

The pattern of change in razorbill numbers at monitored colonies in Scotland was similar to the pattern for guillemots in 1991. As with the latter, there was a marked increase (+38%) in attendance at Shetland colonies, following a 16% decrease in 1990. Significant increases were noted in study plots at Fowlsheugh (NE Scotland) and Handa (NW Scotland) over the periods 1986-90 and 1986-88, respectively, but no 1991 figures were available. Outside of Scotland, the only marked change was a 21% increase at monitored Welsh colonies (cf. guillemot), and no significant trends were noted.

Breeding success (table 3.23.2)

Productivity was again high (0.71 chicks "fledged"/egg) on the Isle of May (SE Scotland), the only colony monitored in detail. Breeding success did appear to improve at Shetland colonies, notably on Foula and at Hermaness, where chick survival seemed poor during 1988-89/90. Growth rates of chicks at Hermaness were better than in 1989-90, when many chicks were severely underweight (Pennington *et al.* 1990).

Discussion

As with guillemot, population changes of razorbills are difficult to measure (even at colonies where repeat counts of birds in study plots are made), and changes in the attendance behaviour of non-breeding or off-duty birds may cloud trends. Nevertheless, the increase at Shetland colonies in 1991 partly reverses the recent decline there and is an encouraging sign.

Breeding success of this species is poorly covered at present, largely because it is difficult, at most colonies, to study large enough samples of easily-viewable nest-sites. Evidence from several colonies (mainly in Shetland during 1988-90) does indicate that razorbills are more vulnerable than guillemots to food shortages during chick-rearing. More comprehensive monitoring would thus be useful.

TABLE 3.23.1 **Population changes at monitored razorbill colonies, 1990-91** (adults attending colony in June). Superscript = number of colonies counted in both years. Figures for regions in block capitals are based on means of 5-10 counts per year at each colony.

	SHETLAND	N SCOT.	SE SCOT.	WALES	NE IREL.
1990	238	867	660	762	612
1991	329	802	692	924	610
% change	+38.2[4]	-7.5[5]	+4.8[2]	+21.2[2]	(-0.3)[1]

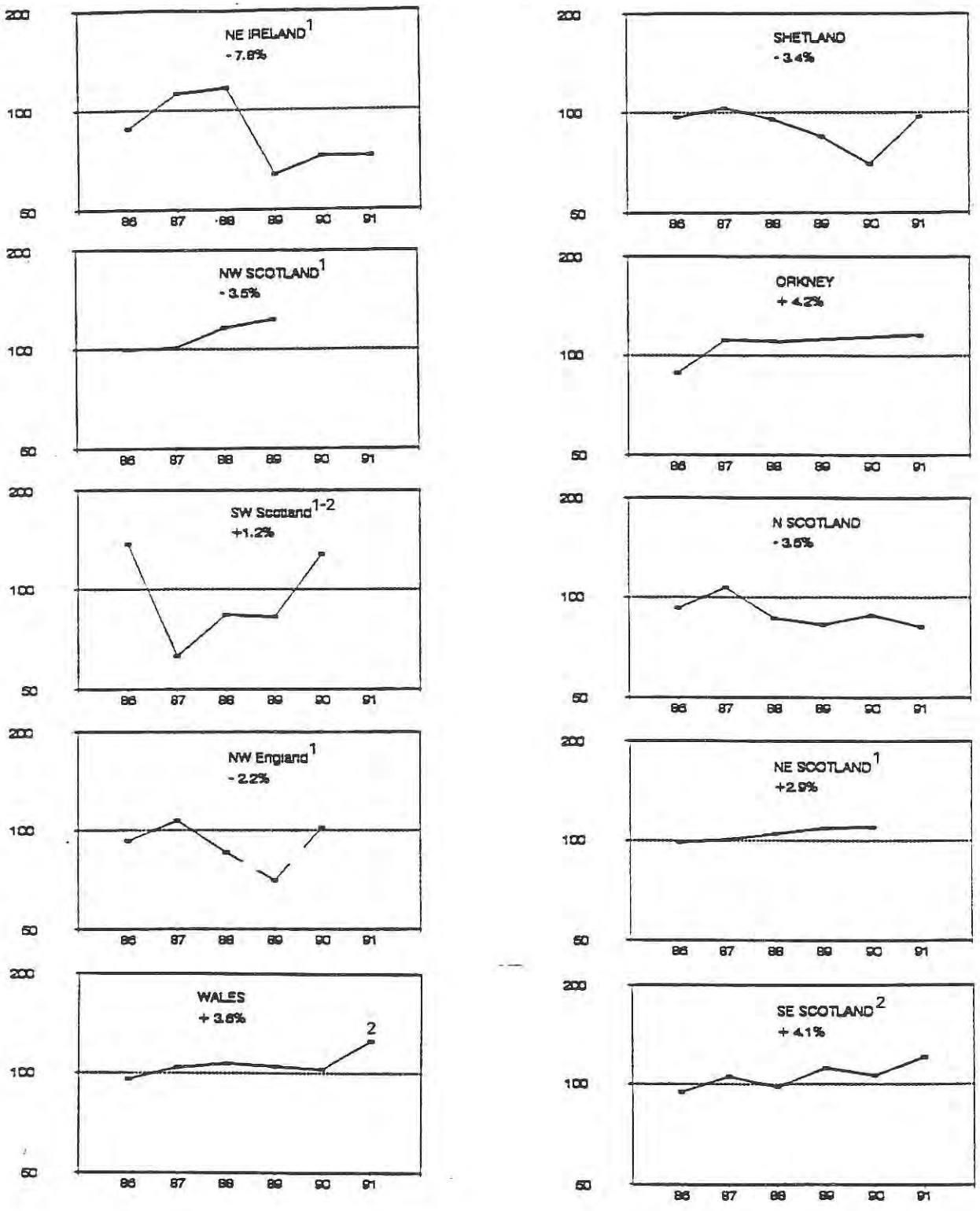

FIGURE 3.23.2 Regional population indices for breeding razorbills, 1986-91 (adults at colonies in June). Average annual rates of change are calculated by regression of log of index against year (significant trends: * P<0.05; ** P<0.01). Broken trend-lines are based on sample counts of 100-200 individuals. Region names in capitals indicate indices based on 5-10 counts per colony each year. Number of colonies counted in each region each year = 3+ (unless [1] or [2] indicated).

TABLE 3.23.2 **Razorbill breeding success, 1986-91:** number of chicks fledged per egg laid or regularly-occupied site. Productivity is quoted as mean ±S.E. of figures from three or more plots (or midpoint ±half-range of two figures). (See 1989 & 1990 reports for 1986-89 sample sizes.)

Colony	1986 Fledged/ site	1987 Fledged/ site	1988 Fledged/ site	1989 Fledged/ site	1990 Sites (plots)	1990 Fledged/ site	1991 Sites (plots)	1991 Fledged/ site	
Canna (Lochaber) impression	good	good	good	good	-	good	-	good	
St Kilda (W Isles) impression	-	-	-	-	-	poor	-	-	
Handa (Sutherland) site	-	-	0.84 ±0.02	0.73 ±0.01	82(2)	0.64 ±0.05	-	-	
Hermaness (Shetland) impression	-	-	-	poor	-	poor	-	good	a
Foula (Shetland) impression	-	good	poor	poor	-	improved	-	good	b
Fair Isle (Shetland) site	-	-	-	-	48-60	0.55-0.69**	64	(0.58	c
Rest of Shetland impression	-	normal	normal	normal	-	moderate+	-	normal	
Isle of May (NE Fife) egg	0.72 ±0.06	0.71 ±0.02	0.70 ±0.05	0.72 ±0.05	100(4)	0.76 ±0.14	104(4)	0.71 ±0.06	d
Rathlin (Antrim) impression	-	-	-	very poor	-	improved	-	-	

*1991 sources: a. Swale (1991). b. Furness (1991). c. Harvey & Orsman (1991). d. Harris (1991)990b).

3.24 Black guillemot *Cepphus grylle*

Breeding numbers (figure 3.24.1)

Sample population counts in Shetland suggest that the population is generally stable or increasing. The Yell Sound population, in particular, continues to grow, with a peak count of 1088 adults in spring 1991, the highest total yet recorded there. Numbers in Yell Sound have increased significantly since counts began in 1983 (at an average of ca. 10% per year overall), although growth was slower during 1987-91 (ca. 5.5% per year, non-significant). The peak spring count on Noss (73 adults) was similar to 1990 (72), but numbers on the east coast of Fair Isle fell from 281 in 1988 to 241 this year. On part of the SE coast of Shetland Mainland, numbers fell by 24% between 1989 and 1991 (206 birds Aithsetter and Virkie - Boddam), following a spillage of crude oil in March.

Breeding success (table 3.24.1)

The only detailed figures available are for Fair Isle, where productivity was moderately high (0.85 chicks fledged/pair, compared to 0.73 in 1990). On Foula, success may have improved following three years of apparent total failure, but few adults were seen carrying food in 1991, suggesting few chicks had hatched. Elsewhere in Shetland, good numbers of fledged young were seen. In Orkney, the colony on Holm of Papa Westray was moderately successful (ca. 1 chick/pair), but colonies on some islands, including the Pentland Skerries and Papa Westray, produced few young.

Discussion

As usual, little or no information on population changes or productivity is available for colonies outside of the northern isles. The Shetland population appears to be healthy, although the species remains very vulnerable to inshore oil spills. At least 600 black guillemots were killed by an oil spill in Yell Sound in 1978, and the high rate of increase seen there since monitoring began in 1983 evidently reflects recovery through immigration from other parts of Shetland. Breeding success in Shetland and seems to be rather variable between colonies, and may be reflecting very local variations in predation or, perhaps, food availability. It remains unclear whether or not Shetland colonies, in general, were adversely affected by low sandeel availability during 1988-90.

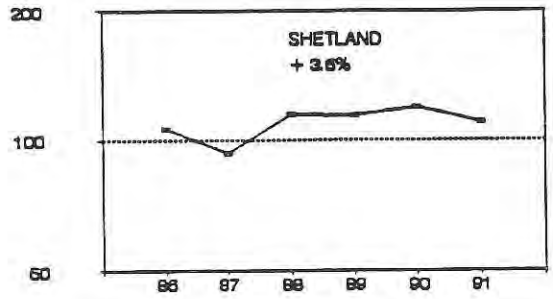

FIGURE 3.24.1 **Population indices for black guillemots in Shetland, 1986-91 (adults at colonies in April).** Average annual rate of change calculated by regression of log of index against year is +3.6% (not significant).

TABLE 3.24.1 **Black guillemot breeding success, 1986-91: number of chicks fledged per site where eggs laid.**

	1987		1988		1989		1990		1991		
	Sites	Y/site	Sites	Y/site	Sites	Y/site	Sites	Y/site	Sites	Y/site	
Foula (Shetland) (impression)	-	-	-	0.0	-	0.0	-	0.0	-	poor?	a*
Fair Isle (Shetland)	25	0.56	14	0.57	43	1.07	33	0.73	48	**0.85**	b
N Ronaldsay (Orkney)	37	0.54	-	-	-	-	-	-	-	-	
Holm of Papay (Orkney)**	-	<1.46	-	<1.08	-	<0.90	-	<1.05	63	**<1.09**	c
Papa Westray (Orkney)	-	-	-	-	-	-	-	-	27	**<0.15**	c

*1991 sources: a. Furness (1991). b. Harvey & Orsman (1991). c. Meek (1991). **'Ringable' chicks.

3.25 Puffin *Fratercula arctica*

Breeding numbers (table & figure 3.25.1)

Numbers in study transects on the Isle of May (SE Scotland) showed little change from 1990, and have been generally stable over 1986-91 as a whole. On Fair Isle (Shetland), sample numbers fell markedly compared to 1990 (-19%), but the continuing decline may be a result of soil-erosion in the single transect used. No significant trends are evident at these colonies or at Hermaness (Shetland) for the period since 1986.

Breeding success (table 3.25.2)

Productivity was high at monitored colonies, with an average of 0.8 chicks fledged per pair at burrows followed from the egg stage. On Fair Isle, success improved markedly (0.87 chicks/pair) from the low 1990 figure (0.57). Breeding success at other Shetland colonies also appeared to be good, based on survival rates of small chicks to fledging (77% of 30 chicks at Sumburgh Head, 63% of 30 chicks at Hermaness) or observations of large numbers of adults carrying food (e.g. Foula). Success improved on the Isle of May after a below-average year in 1990 (when 0.66 chicks fledged/pair), and birds on Skomer (Wales) and St Kilda (NW Scotland) were at least as successful as in 1990.

Discussion

The sequence of years in the late 1980s when Shetland colonies reared few chicks appears to have passed, most likely reflecting increased availability of sandeels in 1991. Nevertheless, monitoring of productivity should continue (including burrows sampled from the egg stage onwards), as this seems be the auk species most vulnerable to food-shortage in the breeding season. Additional study colonies in other regions are also to be encouraged.

There is little evidence to suggest any major or sustained population changes at Puffin colonies recently. However, a wider network of monitored sites, and attempts to improve the representativeness of study plots at existing sites, are needed.

TABLE 3.25.1 **Population changes at monitored puffin colonies, 1990-91** (occupied burrows in sample plots).

	Fair Isle (Shetland)	Isle of May (SE Scot.)
1990	148	2172
1991	120	2140
% change	-18.9	-1.5

TABLE 3.25.2 **Puffin breeding success, 1986-91:** number of chicks fledged per egg laid or per occupied burrow. (1989-91 sample sizes in parentheses; see 1989 report for earlier years.)

	Unit	1986	1987	1988	1989	1990	1991	
Dun, St Kilda (W Isles)	egg	-	-	-	-	0.68 (69)	**0.72** (93)	a*
Hermaness (Shetland)	occ. burrow	very poor	very poor	very poor	0.03-0.15 (220)	improved?	improved?	b
Foula (Shetland)	impression	poor	poor	poor	c0.10	improved?	good/normal	c
Sumburgh Hd (Shetland)	occ. burrow	-	-	-	**0.00 (239)	improved?	improved?	b
Fair Isle (Shetland)	egg	-	0.70	0.75	0.76 (101)	0.57 (96)	**0.87** (120)	d
Isle of May (NE Fife)	egg	0.80	0.93	0.88	0.88 (144)	0.66 (176)	**0.78** (153)	e
Skomer (Dyfed)	occ. burrow	0.87	0.76	-	0.73 (78)	0.89 (108)	**0.83-0.87** (103)	f

*1991 sources: a. J Vaughan (NCCS). b. RSPB. c. Furness (1991). d. Harvey & Orsman (1991). e. Harris (1991). f. Poole & Sutcliffe (1991). **Sumburgh Head 1989: some chicks probably fledged elsewhere in colony.

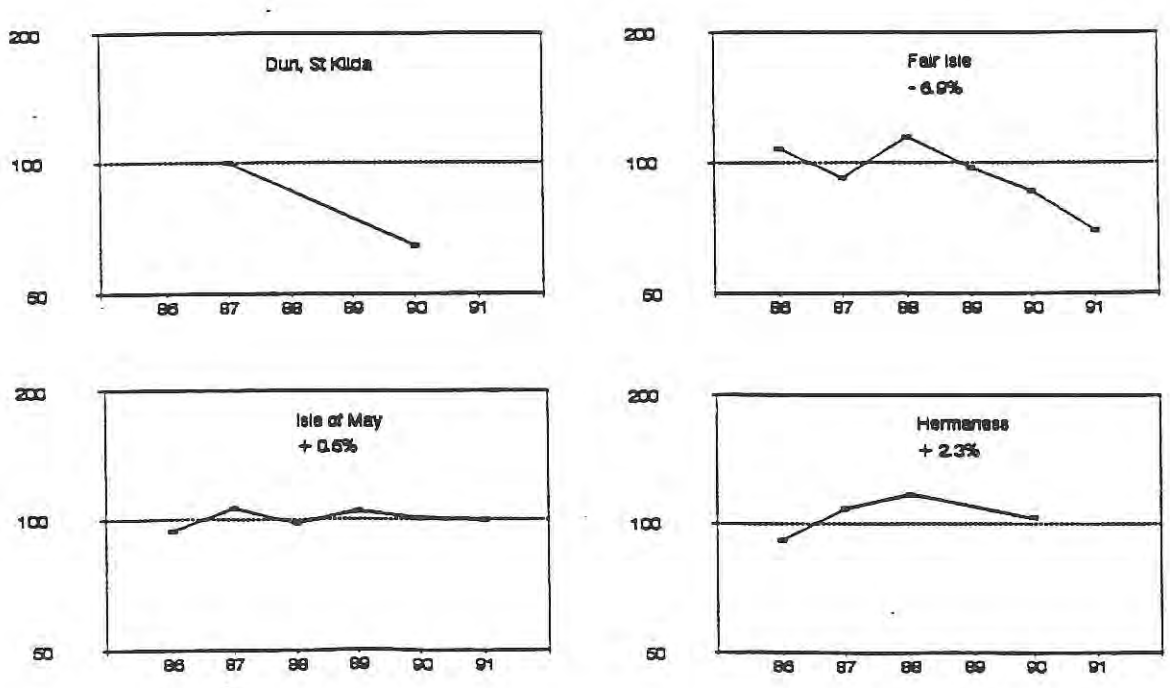

FIGURE 3.25.1 **Population indices for breeding puffins, 1986-91 (occupied burrows in study plots).** Average annual rates of change are calculated by regression of log of index against year (no significant trends, but 1987-90 change for Dun is significant).

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