

SPECIAL COMMITTEE ON SEALS

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Scientific Advice on Matters Related to the Management of Seal Populations: 2001

Background

Under the Conservation of Seals Act 1970, the Natural Environment Research Council (NERC) has a duty to provide scientific advice to government on matters related to the management of seal populations. NERC has appointed a Special Committee on Seals (SCOS) to formulate this advice so that it may discharge this statutory duty. Terms of Reference for SCOS and its current membership are given at the end of this document.

Formal advice is given annually based on the latest scientific information provided to SCOS by the Sea Mammal Research Unit (SMRU – a NERC University Unit based at the University of St Andrews). SMRU also provides to government scientific review of applications for licences to shoot seals, and information and advice in response to parliamentary questions and correspondence.

This report provides scientific advice on matters related to the management of seal populations for the year 2001. It begins with some general information on British seals, gives information on their current status, and addresses specific questions raised by the Scottish Executive Environment Rural Affairs Department (SEERAD). Appended to the main report are two annexes giving more detail about the status of the two species of seal around Britain: grey and common (harbour) seals.

General information on British seals

Grey seals

The grey seal is the larger of the two species of seal that breed around the coast of the British Isles. It is found across the North Atlantic Ocean and in the Baltic Sea. There are two centres of population in the North Atlantic; one in the region of Nova Scotia and the Gulf of St Lawrence and the other around the coast of the UK and especially in Scottish coastal waters. The largest population is in Canada. British waters hold about 40% of the world population of grey seals. Populations in all three centres are increasing, although numbers are still relatively low in the Baltic after the population went through a long-term decline possibly caused by reproductive failure due to pollution.

Grey seals come ashore on remote islands and coastlines to give birth to their pups in the autumn, to moult in spring, and at other times of the year to haul out between trips to forage for food at sea. Female grey seals give birth to a single white-coated pup, which moults and is abandoned by its mother about 3 weeks later.

Over 90% of British grey seals breed in Scotland, the majority in the Hebrides and in Orkney. There are also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in southwestern Britain. Although the number of pups born at colonies in the Hebrides has remained approximately constant since 1992, the total number of pups born throughout Britain has grown steadily since the 1960s when records began. Total population size has also been growing at an average rate of about 6% per year. In 2000, there were an estimated 41,000 grey seal pups born in Britain. This equates to a total population of about 124,000 grey seals.

Adult male grey seals may weigh up to 350 kg and grow to over 2.3 m in length. Females are smaller at a maximum of 250 kg in weight and 2 m in length.

Grey seals feed mostly on fish that live on or close to the seabed. The diet is composed particularly of sandeels, whitefish (cod, haddock, whiting, ling), and flatfish (plaice, sole, flounder, dab) but varies

seasonally and from region to region. Food requirements depend on the size of the seal and oiliness of the prey but an average figure is 7 kg of cod or 4 kg of sandeels per day.

Common seals

Common seals are found around the coasts of the North Atlantic and North Pacific from the subtropics to the Arctic. In addition to the UK, in Europe they are found mainly in Icelandic, Norwegian, Danish, German and Dutch waters. Common seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted. The main concentrations are in the Moray Firth, the Tay Estuary and The Wash. Britain holds about 45% of the European population, and about 5% of the world population of common seals.

Between 1996 and 2000, 36,320 common seals were counted in the whole of Britain, of which 32,075 (88%) were in Scotland and 4,245 (12%) were in England. The total British population cannot be estimated accurately but is thought to be approximately 50-60 thousand animals. The population along the east coast of England (mainly in The Wash) was severely affected by the Phocine Distemper Virus epidemic in 1988. Numbers in England have increased since then, but they are still below the pre-epidemic level.

Common seals come ashore in sheltered waters typically on sandbanks and in estuaries but also in rocky areas. They give birth to their pups in June and July and moult in August. At other times of the year, common seals haul out on land regularly in a pattern that is often related to the tidal cycle. Common seal pups are born without a white coat and can swim almost immediately.

Adult common seals typically weigh about 80-100 kg. Males are slightly bigger than females.

Common seals feed locally around haul out sites taking a wide variety of prey including sandeels, whitefish, herring and sprat, flatfish, octopus and squid. Diet varies seasonally and from region to region. Because of their smaller size, common seals require less food than grey seals, perhaps 3-5 kg per day depending on the prey species.

Current status of British grey seal populations

Each year, SMRU conducts aerial surveys of the major grey seal breeding colonies in Britain to determine the number of pups born (pup production). These sites include about 85% of the number of pups born throughout Britain. The total number of seals associated with these regularly surveyed sites is estimated by applying a population model to the estimates of pup production. Estimates of the total number of seals at other breeding colonies that are surveyed less frequently are then added in to give an estimate of the total British grey seal population. Further details are given in Annex I.

Pup production

The total number of pups born in 2000 at all annually surveyed colonies was estimated to be 36,915. A further 4,200 pups were likely to have been born at other scattered sites. Regional estimates were 3,223 in the Inner Hebrides, 13,396 in the Outer Hebrides, 15,993 in Orkney, and 4,303 at North Sea sites.

Trends in pup production

Between 1984 and 1996, estimates of the total number of pups born at regularly surveyed colonies increased year on year. A small decline was observed in 1988 that was probably related to the effect of a phocine distemper epizootic that mainly affected common seals at that time. Following this event, estimated total pup production did not show any decline until 1997. It recovered again in 1998 then declined at all major breeding colonies in 1999. The greatest decline was at the Farne Islands, where pup counts are made by National Trust staff on the ground. That declines have occurred at the Farne Islands and at other sites where pup production is monitored by aerial survey suggested that this was a general phenomenon and not related to differences in methods or survey conditions from previous years.

In 2000, estimated pup production increased at all regularly surveyed breeding sites. Increases during the year 1999-2000 ranged from 5% in Orkney to 39% in the Farne Islands and was 11.5% overall. However, this increase should be viewed in the context of the trends over the 5 years 1996-2000. Calculating rates of change over longer periods is more indicative of recent trends at major breeding sites. It shows, for example, that pup production in the Hebrides has been relatively stable over the past 5 years and that the average annual increase in pup production at the main breeding sites between 1996 and 2000 was 2.1% (see table). This compares with 6.1% between 1991 and 1995 (see Annex I). It is clear that, despite the increase in 2000, the overall increase in pup production has slowed in recent years.

Pup production and total population size estimates for the main colonies surveyed in 2000

Location	2000 pup production	Annual change in pup production over the period 1996-2000	Total 2000 population (to nearest 100)
Inner Hebrides	3,223	-0.3%	9,700
Outer Hebrides	13,396	+0.1%	40,200
Orkney	15,993	+3.3%	48,000
Isle of May + Fast Castle	2,514	+9.9%	7,500
Farne Islands	1,171	-2.2%	3,500
Donna Nook	618	+18.0%	1,900
Subtotal	36,915	+2.1%*	110,700
SW England & Wales (last surveyed 1994)	1,500		4,700
All other sites	2,700		8,900
Total	41,115		124,300

*Annual change in pup production calculated from annually monitored sites only

The total number of pups born is the sum of pup production at many individual colonies, and because this varies from year to fluctuations in total pup production should also be expected. However, declines in pup production in 1999 appeared to be too great and too widespread to be explained solely by changes in survival and fecundity related to shortage of space at breeding colonies. Environmental changes, possibly related to the availability of prey, may be implicated in and may underlie the year to year variation observed since 1997. Overall, the variability in the rate of change in pup production observed in recent years suggests that grey seal pup production may be stabilising.

Population size

The size of the British grey seal population at the start of the 2000 pupping season is estimated to be 124,300 animals. Of these, 114,200 (92%) are associated with breeding colonies in Scotland and 10,100 (8%) are associated with colonies in England and Wales.

Trends in population size

The average rate of increase in the grey seal population associated with annually monitored sites over the past 5 years has been +5.5%, with 95% confidence limits of 2.8%-8.6%. This rate of increase is greater than the rate of increase in the pup production (+2.1%) because of the characteristics of the model used to calculate the total population size from the pup production. The model involves a time lag of at least 5 years between changes in pup production and changes in the rate of increase of the population as a whole. The time lag is caused by the time taken for female grey seals to begin producing pups at about 5 years of age .

Data from the 2000 survey of grey seal colonies adds to previous indications that the grey seal population could be showing signs of approaching stability. For this to be happening, it has to be assumed that declines in pup production are not being compensated by increases in survival rate, especially during the first year of life.

Pup production is very sensitive to small changes in adult female survival. The change in the average annual increase in pup production from 6.1% in the early 1990s to 2.1% in the late 1990s could result from declines in adult female survival rate of about 5% although it is also possible that it could have resulted from a decline in the pregnancy rate.

Taking a longer-term view of the population, however, it should be noted that from 1986-1990 the annual rate of increase was only 3.9% (Annex I). The relatively low rate of increase in the late 1980s is thought to have been associated with an epidemic of phocine distemper. Although we have no knowledge of an equivalent event in the past 5 years, this shows that declines in the rate of increase of the type seen in the past 5 years can be transient.

Current status of British common seal populations

Scotland

During 2000, common seal distribution and abundance was estimated for the Inner Hebrides, Outer Hebrides, the Firth of Tay and the Inner Moray Firth. These surveys were targeted at sites proposed as Special Areas for Conservation under the European Habitats Directive and were funded by Scottish Natural Heritage.

A previous analysis of data from surveys of common seals along the north and west coasts of Scotland as far south as the southern tip of the Mull of Kintyre, and in Orkney, Shetland and the Hebrides indicated that there was an overall increase of 2.9% per year in the number of animals counted at haul-out sites between 1988 and 1997. There appeared to be some regional variation in these rates of change with values that ranged from -1.1% to 8.5%, but none of the rates of change were statistically significant. Comparing the surveys carried out in 2000 with those in 1996/97 suggested that there were substantially more common seals in the west Highland and Strathclyde regions with small declines in the Outer Hebrides and

the Inner Moray Firth. However, it is not possible to determine whether these changes are statistically significant and, in the case of the Inner Moray Firth, it was not possible to carry out the surveys at the optimal time of tide. Consequently this may account for the reduced numbers recorded in this area.

The Wash and eastern England

Two surveys of common seals in eastern England were carried out during August 2000. These surveys were carried in an identical way to those in previous years and provided an index of the population size. The Wash counts averaged 2,778 which was 16% greater than the count in 1999. The average annual rate of increase in the number of seals counted in The Wash since 1989 has been 6.1% (per year) and this was significantly greater than that estimated between 1968 and 1988 (3.5% per year). The 2000 count in The Wash is comparable with that in 1988 made before the Phocine Distemper Virus epidemic. Common seal populations in Denmark, Germany and the Netherlands have recovered more rapidly from the effects of this epidemic and had returned to, or surpassed, their pre-epidemic levels by 1994.

Minimum estimate of the British common seal population

The most recent minimum estimate of the number of common seals in Scotland is 32,075 from surveys carried out in 1996, 1997 and 2000. The most recent minimum estimate for the east coast of England is 4,245. This comprises 4,110 seals in Lincolnshire and Norfolk in 1999 plus 135 seals in Northumberland, Cleveland, Essex and Kent between 1994 and 1997.

Counts by region are given in the Table below. These are minimum estimates of the British common seal population which is thought to be approximately 50-60 thousand animals.

Region	1996-2000
Shetland	5,991
Orkney	8,522
Outer Hebrides	2,413
Highland	6,291
Strathclyde	7,909
Dumfries & Galloway	6
Grampian	126
Tayside	165
Fife	611
Lothian	40
TOTAL SCOTLAND	32,075
Blakney Point	895
The Wash	2,785
Donna Nook	390
Scroby Sands	45
Other east coast sites	135
South and west England (estimated)	20
TOTAL ENGLAND	4,270
TOTAL BRITAIN	36,345

Questions from the Scottish Executive Environment and Rural Affairs Department

Grey seal populations.

What are the implications of recent grey seal pup production estimates for the future size of the total Scottish grey seal population?

The Hebrides and Orkney are the two main breeding centres of the UK grey seal population and they account for 89% of all pups born at annually monitored colonies. The pup production of grey seals in the Hebrides has been relatively constant since 1992 whereas the population in Orkney increased until 1998. There has been no significant increase in pup production in Orkney over the past 3 years.

If these trends are sustained and if no substantial new seal colonies are formed, the levelling off in pup production is likely to result in a reduced rate of increase in the population as a whole.

Is there any evidence that the rate of increase in the Scottish grey seal population is slowing down?

The relatively constant pup production in the Hebrides, and its reduced rate of increase in Orkney in recent years, has been sufficient to cause an overall decline in the rate of increase in pup production for the UK grey seal population as a whole. The current indications are that that this will continue if the situation that appears to be developing in Orkney follows the pattern in The Hebrides. While it is possible that these changes in pup production could be compensated for by increases in juvenile or adult survival rates the expectation is that the population rate of increase will decline in coming years.

Common seal populations.

What could be done to improve current estimates of the number of common seals in Scottish waters and particularly to identify trends in population?

The SMRU currently carries out a total survey of common seals around the Scottish coast every 5 years and an annual survey in the Wash. The 5-year interval between surveys is dictated by the resources available to carry out the work involved. The coastline is surveyed by regions (e.g. Hebrides, Orkney & Shetland) and it takes at least 2 years to survey the entire coastline. Large-scale movements of seals among these regions between years could, therefore, result in biased estimates of the population size of common seals because seals might be counted twice or not at all. Although there is no evidence supporting the existence of such large-scale movements, improvements in the estimates would be achieved by carrying out additional studies of the movements made by common seals around the Scottish coast. Trends in abundance could be more easily detected with more frequent surveys. There may be a case for annual surveys in specific regions, such as those carried out annually in the Moray Firth by Dr Paul Thompson (University of Aberdeen) since 1988.

The current survey method also does not provide an estimate of variance associated with the counts of common seals. A further improvement would be to undertake repeated counts at specific sites as well as behavioural observations of the movement and haul-out patterns of common seals in order to provide an estimate of the uncertainty associated with the counts.

Obtaining additional information about trends in populations and absolute numbers will require changes to the design of surveys involving additional research to validate the new designs. These would most probably involve automated, remote monitoring of specific sites but they would most likely have to take place within the context of the current synoptic surveys. Overall, therefore, they would require considerably increased research effort from the current level.

Do current survey methods allow us to distinguish between the effects of changes in distribution and changes in population size on the numbers of common seals present within particular areas?

Apart from large-scale movements of animals (see response to previous question) the current survey methods are carried out at a sufficiently large scale to be able to distinguish between changes in distribution and changes in population size. In general, the larger the area that is surveyed in one year then the less the effects of the redistribution of seals is likely to be on the estimate of population size. Therefore, difficulties with using the current data to examine trends in abundance increase as the size of the area being considered is reduced.

The current methods show that it is potentially misleading to use changes in abundance at local scales, such as individual haul-out sites, to imply changes at the wider-scale. The variation in the number of animals at a particular haul-out site can be large so that careful consideration has to be given to the most appropriate scale over which surveys are likely to be effective. The designation to Special Areas of Conservation (SACs) for common seals means there is a more pressing requirement for regionally-based surveys at scales that provide an accurate view of the trends in abundance of seals within SACs and surrounding areas.

Research on seal diet.

What is being done to update information on the diet of seals and the amounts of fish consumed?

The diet of grey seals in Scottish waters as a whole was last estimated in 1985 but these estimates will be updated over the next 3 years with studies in the North Sea and Orkney funded by DEFRA decision by SEERAD/FRS about funding an extension of these studies to the west coast will be made in Autumn 2001. It is recognised that the diet of British seals could have changed considerably since 1985 in response to changes in the abundance of prey species. Regional estimates of both common and grey seal diet have been made more recently for the Moray Firth and the Tay Estuary.

The measure of the amount of fish consumed by seals requires knowledge of the diet and energy budgets of seals, the energy density of prey and the total number of seals feeding in a region. SMRU is continuing to pursue research in all of these areas with a view to providing estimates of fish consumption by grey seals.

What additional information is required to improve assessments of the impact of this consumption on fisheries?

We do not currently have the ability to assess the effects that consumption by seals has upon fisheries. To understand how fisheries could be influenced by impacts from seals requires improved integration of models and measurements of seal predation with knowledge of prey distribution and population dynamics. For many fish species, however, there is relatively little information. Some of these are not commercially important which means that there is little or no information about their populations. In addition, fisheries may take size and age classes of prey that differ from those taken by seals. This means that it is difficult to generalise about what impact predation by seals is likely to have on fisheries. Greater efforts could be made to integrate the fisheries and fish population data that are currently available with current knowledge of seal diets and distributions in order to define more clearly the spatial and temporal overlap of seals with fisheries. In addition, more work is required to compare predation by seals with other causes of natural mortality in fish.

The impact of seals on salmonids.

What is the scope for establishing the effects of seal predation on salmonid populations through more focused research on seal/salmon interactions?

It is necessary to view seal predation in the context of all the other forms of mortality experienced by salmon. At present in Scotland there is a relatively large population of seals, in terms of potential consumption of food, and small populations of salmon. Therefore, it needs only a small proportion of the seal population to eat adult salmon occasionally in order for seals to have a potentially significant effect upon salmon populations. This has two consequences: first that salmon predation is likely to be a rare event when viewed in terms of the average seal and, second, that it becomes difficult to measure salmon predation using the methods that are currently available.

It is likely that the greatest effects of seals on salmon occurs in the entrances to the main rivers and this is the region in which we suggest that future research should be concentrated. There may be a case for carrying out experimental studies of seals that specifically occupy river systems to establish the extent to which they predate salmon, whether there are methods that could be used to create seal exclusion zones at some sites and whether the removal of "rogue" seals would be an effective strategy to reduce predation of salmon.

What scope is there for modelling the impact of seals on salmonid populations using the best available data?

The most effective modelling approach would be to examine how additional mortality of salmon caused by seals is likely to influence the salmon populations. Based upon current data, and from research funded by DEFRA, it may be possible to estimate the usage by grey seals of estuaries where salmon may be most vulnerable to predation by seals. Apart from the Moray Firth, no data of an equivalent type are currently available to allow the estimation of habitat use by common seals so it would probably be more difficult to derive estimates of the impact of this species upon salmonid populations. However, current work by SMRU should provide data about the dispersion of common seals during foraging within the next two years. Based upon knowledge of the food requirements of these seals it would be possible to develop an estimate of the possible effect of seals on salmon with salmon making up different proportions of the diet of these seals. At best, these data could only be used to provide a very broad indication of the impact of seals upon salmon and it would be most unlikely that they could be used as a basis for management.

New developments in non-lethal methods of population control.

Have there been any developments in relation to non-lethal methods of seal population control which mean that they could now be effectively applied to Scottish seal populations?

A non-lethal method of population control, that involves the immunization of seals against the covering that surrounds the very early embryo has been tested on grey seals in Canada and has been shown to be effective amongst adults. There is some evidence that immunising pups may also be successful. Vaccination by hypodermic injection is more effective than delivery of the vaccine using a remote injection method. Therefore, the vaccine and the system of delivery are in an advanced form but doubts still exist about the practicality of carrying out this type of vaccination. Sustained effort would be required over many years in order to have a significant impact upon grey seal populations. The method could probably not be applied with any success to common seals.

However, there may be a case for carrying out a small-scale, experimental vaccination programme in the UK with the aim of understanding the effects that such an approach would have upon the long-term trajectory and the dynamics of grey seal populations. The SMRU will be considering ways of funding and carrying out such an experimental project over the coming year.

NERC Special Committee on Seals

Terms of Reference

1. To undertake, on behalf of Council, the provision of scientific advice to the Scottish Executive and the Home Office on questions relating to the status of grey and common seals in British waters and to their management, as required under the Conservation of Seals Act 1970.
2. To comment on SMRU's core strategic research programme and other commissioned research, and to provide a wider perspective on scientific issues of importance, with respect to the provision of advice under Term of Reference 1.
3. To report to Council through the Science and Technology Board

Current membership

Professor JR Beddington (Chairman), Imperial College, London;
Dr WD Bowen, Bedford Institute of Oceanography, Halifax, Nova Scotia, Canada;
Professor IL Boyd, University of St Andrews;
Dr PS Hammond, SMRU, University of St Andrews;
Professor JH Lawton, Chief Executive, NERC, Swindon;
Dr A McLay, FRS Marine Laboratory, Aberdeen;
Dr EJ Millner-Gulland, Imperial College, London;
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Dr MV Bravington, CEFAS Fisheries Laboratory, Lowestoft;
Professor W Sutherland, University of East Anglia;
Dr PM Thompson, University of Aberdeen;
Professor F Trillmich, University of Bielefeld, Germany;
Dr M Webb (Secretary), NERC, Swindon.

The Status of British Grey Seal Populations

Callan Duck & Lex Hiby

1. Surveys conducted in 2000

Each year SMRU conducts aerial surveys of the major grey seal breeding colonies in Britain to determine the number of pups born. In addition, new sites where grey seal pups have been reported or which appear to be suitable for colonisation are visited regularly. During 2000, between four and six surveys were flown over all the major sites in the Hebrides, Orkney, and in the Firth of Forth. Ground counts of the numbers of pups born at the Farne Islands were made by National Trust staff. Similar counts at Donna Nook on the Humber Estuary were made by members of the Lincolnshire Trust for Nature Conservation and on South Ronaldsay by SNH staff. Locations of the main British grey seal breeding sites are shown in Figure 1.

2. Estimated pup production

The number of pups born (pup production) at regularly surveyed colonies is estimated each year from counts from the aerial survey photographs using a model of the birth process and the development of pups. The method used to obtain the estimates for this year's advice was similar to that used for the past several years (but see section 4 below).

Total pup production in 2000 at all annually surveyed sites is estimated to be 36,915. Estimates of pup production at all major breeding sites in England and Scotland (except Loch Eriboll, Helmsdale and Shetland) between 1984 and 2000 are shown in Figure 2. Pup production estimates for the main island groups (the Inner Hebrides, the Outer Hebrides and Orkney) are shown in Figure 3a and for the North Sea sites in Figure 3b. The time series of data for these groups are given in Table 1. For colonies not surveyed by air, pup numbers are counted directly on the ground either annually (Farne Islands, Donna Nook, South Ronaldsay) or less frequently (SW England, Wales, Shetland).

3. Trends in pup production

Between 1984 and 1996 estimates of the total number of pups born at regularly surveyed colonies have increased year on year. In 1997 estimated pup production fell for the first time, but recovered again in 1998 in line with the previously observed upward trend.

In 2000, estimated total pup production increased, following the marked decline observed in 1999. The increases between 1999 and 2000 are shown in Text-table 1.

Text-table 1

Location	Change 1999-2000	Change 1998-2000
Outer Hebrides	+15%	+8%
Orkney	+5%	-2%
Inner Hebrides	+16%	+4%
Isle of May	+24%	+12%
Farne Islands	+39%	-11%
Donna Nook	+23%	+41%

In 1999, overall pup production unexpectedly declined at all the main island groups, although there was variation between individual colonies. The biggest decline was at the Farne Islands, where pups are counted by National Trust staff. Their count provided an independent corroboration of the decline observed at other colonies. In 2000, pup production at the main island groups increased. Although the proportional increase from 1999 appears to be large, varying between 5% and 39%, the annual change from the 1998 production (see Text-table 1) differed considerably from those in between 1999 and 2000. For example, the Farne Islands and Orkney showed overall declines in numbers (11% and 2% respectively).

There are two particularly interesting aspects to the 2000 results. Firstly, there is evidence of slowing in the average rate of increase in pup production in Orkney (see Text-table 2). It is possible that the factors underlying the reduction in the rate of increase in pup production at the Hebridean colonies are now affecting colonies in Orkney.

Secondly, the relatively large increase in the Outer Hebrides given the present trend at these colonies. Almost all of this increase occurred at two of the Monach Isles, Ceann Iar and Ceann Ear. Production at Ceann Iar in 2000 was similar to the production in 1995 and 1996 (approx. 6,500) while in the intervening years production was approx. 5,700. This island is 'fully colonised' in the sense that pups occur all over the island. Thus between 1996 and 2000, the density of pups dropped and recovered by approximately 14%. On Ceann Ear, there has been a continued gradual increase in production, reflecting the colonisation of new sections of the island's coast. Pups are now born all round the island and production is likely to stabilise in the next 3-4 years.

4. Pup production model assumptions

The model used to estimate pup production from aerial survey counts of whitecoat and moulted pups assumes that the parameters defining the distribution of birth dates are variable from site to site and year to year, but that those defining the time to moult and time to leave the colony remain constant. The pup production estimate is sensitive to the value used for the latter parameter and hence there is an argument for allowing this parameter to vary between colonies.

Figure 4 compares the total pup production estimate for all annually monitored sites using the constant value for mean time-to-leave (Method I) with that generated when time-to-leave is estimated together with the parameters of the birth curve (Method II).

The main difference in results from the two methods is a discrepancy from 1992 onwards which may be due to a change in survey protocol. For example, from that year photographic coverage was extended inland on some islands and, as moulted pups tend to move inland, this may have resulted in an increase in the moulted pup count, equivalent to a slight increase in the time-to-leave parameter. However, no difference has been found between the trajectories from islands where coverage has or has not increased. Another possible explanation is that some late moulted pups may have been missed in the counts from earlier years. Allowing time-to-leave to be a free parameter may account for some of these changes. Some minor year-to-year differences are apparent in Figure 4. For example, the decline in pup production estimated for 1997 is less pronounced when time-to-leave is a free parameter in the model.

Previously, the time-to-leave parameter has not been re-estimated on a regular basis because the data series for many breeding sites were too short to allow reliable estimation of both the time-to-leave and the birth date parameters, especially given the difficulty of classifying pups to stage from the photographs. One possible consequence of using a fixed time-to-leave is that changes in pup production may be overestimated. For example, an increased number of seals on a breeding site may delay the departure of pups born early in the season and hence bias the pup production estimate upwards. Figure 4 shows that the pup production trajectory is slightly lower using the method in which time-to-leave is allowed to vary, as expected.

Given the above uncertainties, it is appropriate to consider results from both methods of estimating pup production. Results from the previously used method (Method I) are presented in the main body of this

report. Results from the new method (Method II) are given for comparison in Appendix 1. Work will continue to determine the most appropriate method for future use.

5. Estimation of population size associated with regularly surveyed sites

The total number of seals associated with the sites surveyed regularly since 1984 (when the current survey methodology was established) is estimated by fitting a population model to the series of total pup production estimates from these sites, to data on population pregnancy rates collected between 1978 and 1981, and to data on population age structure from management culls at the Farne Islands. This method was substantially modified in 1996. It takes account of year to year variation in juvenile survival and age at first pregnancy, and makes use of more of the available data on these population parameters.

The estimated sizes of the (age 1+) female and total population at all annually monitored breeding sites are 64,276 and 110,688 respectively. Table 2 gives these estimates for the period 1984-2000. Figure 5 shows the initial pup production estimates and the revised pup productions estimated by the population model. The corresponding results calculated using the new method (Method II) for estimating pup production (see above) are given in Appendix 1.

Population size is estimated in the model for Britain as a whole, not regionally. Estimates of pup production and total population size (in proportion to pup production) for the main colonies surveyed in 2000 are given below. These colonies account for more than 85% of all pups born each year.

Text-table 2. Pup production and total population size estimates for the main colonies surveyed in 2000. The annual changes over successive 5-year periods are also shown. These annual changes represent the exponential rate of change in the pup production.

Location	2000 pup production	Annual change in pup production			Total 2000 population (to nearest 100)
		1986-1990	1991-1995	1996-2000	
Inner Hebrides	3,223	+3.3%	+4.4%	-0.3%	9,700
Outer Hebrides	13,396	+3.6%	+3.5%	+0.1%	40,200
Orkney	15,993	+4.4%	+10.1%	+3.3%	48,000
Isle of May + Fast Castle	2,514	+5.5%	+2.6%	+9.9%	7,500
Farne Islands	1,171	+1.6%	+3.3%	-2.2%	3,500
Donna Nook	618	+37.8%	+13.0%	+18.0%	1,900
Total	36,915	+3.9%	+6.1%	+2.1%	110,700

6. Rate of change in the population

The overall rate of increase in the pup production has declined from 6.1% in the early 1990's to 2.1% in the late 1990's. The effect has been driven mainly by declines in the rate of increase in Orkney and the Outer Hebrides which hold the main concentrations of grey seals in the UK.

7. Confidence limits

Ninety-five percent confidence limits on the pup production estimates at each site are within 14% of the

point estimate. The exact limits depend on a number of factors including the number of surveys flown in a particular year. It is also possible to calculate 95% confidence limits for the estimate of the female component of the population; for 2000, these are $\pm 18\%$ of the estimate (i.e. 55,000 - 75,000 for the estimate of the female population in 2000). The size of the male component has been estimated by assuming that the number of sexually mature males is 60% of the number of mature females, and that males become sexually mature at four years of age. The procedure used to generate confidence limits on the estimate of female population size could, in principle, be repeated for the combined female and male population. However, there are no current data on the relative numbers of males and females in the population that could be used for this purpose.

8. Population size at sites surveyed less frequently

The total population associated with breeding sites not surveyed regularly has been calculated using the ratio of total population to pup production for the main areas. Less than 15% of all pups are born at these sites each year. Confidence limits cannot be calculated for these estimates because they are obtained by simple extrapolation of single counts. The resulting figures are given below.

Pup production and total population size estimates for breeding sites not surveyed regularly

Location	Date of last survey	Pup production (to nearest 100)	Total population (to nearest 100)
Mainland Scotland & South Ronaldsay	Helmsdale (including Berriedale) 1999 Loch Eriboll 2000 South Ronaldsay 1998	1,700	5,600
Shetland	1977	1,000	3,300
Southwest Britain	Southwest England 1973 Wales 1994	1,500	4,700

Table 3 shows Scottish breeding sites which are either not surveyed annually or have recently been included in the survey programme. These and other potential breeding sites are checked when flying time, flying conditions and additional circumstances permit.

9. Total size of the British grey seal population

Taken together, these figures provide an estimate of 124,300 for the size of the British grey seal population (age 1+) at the start of the 2000 pupping season: 114,200 (92%) seals are associated with breeding sites in Scotland and 10,100 (8%) with breeding sites in England and Wales. Britain holds approximately forty percent of the world population of about 300,000 grey seals.

10. Trends in population size

The current trend in pup production may reflect a change in the size of the adult population. A simple model of the grey seal population suggests that, if the trend in pup production seen from 1991-1995 was sustained, there could be 160,000 grey seals in the UK population by 2005 and 216,000 by 2010. In contrast, if the more recent trend continues and is reflective of the population as a whole then there could be about 144,000 greys seals in the UK population by 2005 and about 162,000 by 2010.

Table 1. Estimates of pup production for the North Sea, Orkney, Outer Hebrides and Inner Hebrides, 1960-1999, using Method I (see text for details).

YEAR	North Sea	Orkney	Outer Hebrides	Inner Hebrides
1960	1020	2048		
1961	1141	1846	3142	
1962	1118			
1963	1259			
1964	1439	2048		
1965	1404	2191		
1966	1728	2287	3311	
1967	1779	2390	3265	
1968	1800	2570	3421	
1969	1919	2316		
1970	2002	2535	5070	
1971	2042	2766		
1972	1617		4933	
1973	1678	2581		
1974	1668	2700	6173	
1975	1617	2679	6946	
1976	1426	3247	7147	
1977	1243	3364		
1978	1162	3778	6243	
1979	1620	3971	6670	
1980	1617	4476	8026	

Table 1 continued.

YEAR	North Sea	Orkney	Outer Hebrides	Inner Hebrides
1981	1531	5064	8086	
1982	1637	5241	7763	
1983	1238			
1984	1325	4741	7594	1332
1985	1711	5199	8165	1190
1986	1834	5796	8455	1711
1987	1867	6389	8777	2002
1988	1474	5948	8689	1960
1989	1922	6773	9275	1956
1990	2278	6982	9801	2032
1991	2375	8412	10617	2411
1992	2437	9608	12215	2816
1993	2710	10790	11915	2923
1994	2652	11593	12054	2719
1995	2757	12412	12713	3050
1996	2938	14195	13176	3117
1997	3698	14051	11946	3076
1998	3989	16231	12373	3087
1999	3380	15253	11683	2787
2000	4303	15993	13396	3223

Table 2. Estimated size of the population associated with all major grey seal breeding sites in Scotland and eastern England, except Loch Eriboll, Helmsdale and Shetland. Estimates refer to the number of seals aged 1 and over at the start of the breeding season using Method I (see text for details).

YEAR	Pup Production	Female Population	Female + Male Population
1984	14,992	25,671	44,356
1985	16,265	27,120	46,823
1986	17,796	28,774	49,673
1987	19,035	30,666	52,975
1988	18,071	32,648	56,431
1989	19,926	34,509	59,620
1990	21,093	36,565	63,164
1991	23,815	38,598	66,621
1992	27,075	40,711	70,195
1993	28,338	43,129	74,345
1994	29,018	45,719	78,802
1995	30,932	48,424	83,455
1996	33,426	51,458	88,733
1997	32,771	54,665	94,308
1998	35,680	57,766	96,620
1999	33,103	61,062	105,269
2000	36,915	64,276	110,688

Table 3. Scottish grey seal breeding sites that are not surveyed annually or have recently been included in the survey programme.

	Location	Survey method	Last surveyed, frequency	Number of pups
Inner Hebrides	Colonsay/Oronsay mainland	SMRU visual	1994, every 2-3 years	None seen
	Loch Tarbert, Jura	SMRU visual	1998, every 3-4 years	None seen
	West coast Islay	SMRU visual	1998, every 3-4 years	None seen
	Ross of Mull, south coast	SMRU visual	1998, infrequent	None seen
	Treshnish small islands, incl. Dutchman's Cap	SMRU photo & visual	1999, annual	~20 in total
	Staffa	SMRU visual	1998, every other year	~5
	Little Colonsay, by Ulva	SMRU visual	1998, every 3-4 years	6
	Meisgeir, Mull	SMRU visual	1998, every 3-4 years	1
	Craig Inish, Tiree	SMRU photo	1998, every 2-3 years	2
	Cairns of Coll	SMRU photo	1998, every 2-3 years	13
	Muck	SMRU photo	1998, every other year	12
	Rum	SNH ground	1999, annual	10-15
	Canna	SMRU photo	1998, every other year	34
	Rona	SMRU visual	1989, infrequent	None seen
	Ascrib Islands, Skye	SMRU photo	1998, every other year	32
	Heisgeir, Dubh Artach, Skerryvore	SMRU visual	1995, every other year 1989, infrequent	None None
Outer Hebrides	Barra Islands Fiaray & Berneray	SMRU visual	1999, every other year	76
	Sound of Harris islands	SMRU photo	1999, every 2-3 years	317
	St Kilda	Warden's reports	Infrequent	Few pups are born
	Shiantas	SMRU visual	1998, every other year	None
	Flannans	SMRU visual	1994, every 2-3 years	None
	Berneray, Lewis	SMRU visual	1991, infrequent	None seen
	Summer Isles	SMRU visual	1989, infrequent	None seen
	Faraid Head	SMRU visual	1989, infrequent	None seen
	Eilean Hoan, Loch Eriboll	SMRU visual	1998, annual	None
	Rabbit Island, Tongue	SMRU visual	1998, every other year	None seen
Orkney	Sule Skerry	SMRU photo	1998, 1999, 2000	15, 7, 7
	Sanday, Point of Spurness	SMRU photo	1999, every 2-3 years	30
	Sanday, east and north	SMRU visual	1994, every 2-3 years	None seen
	Papa Stronsay	SMRU visual	1993, every 3-4 years	None seen
	Holm of Papa, Westray	SMRU visual	1993, every 3-4 years	None seen
	North Ronaldsay	SMRU visual	1994, every 2-3 years	None seen
	Eday mainland	SMRU photo	2000, first	23
	Calf of Flotta	SMRU photo	2000, annual	154
South Fara, Cava & Rysa	SMRU photo	2000, annual	134	
Others	Firth of Forth islands & Inchcolm	Anecdotal SMRU photo	Infrequent 1997	<10 4

Grey seal breeding sites
in Great Britain

Figure 1

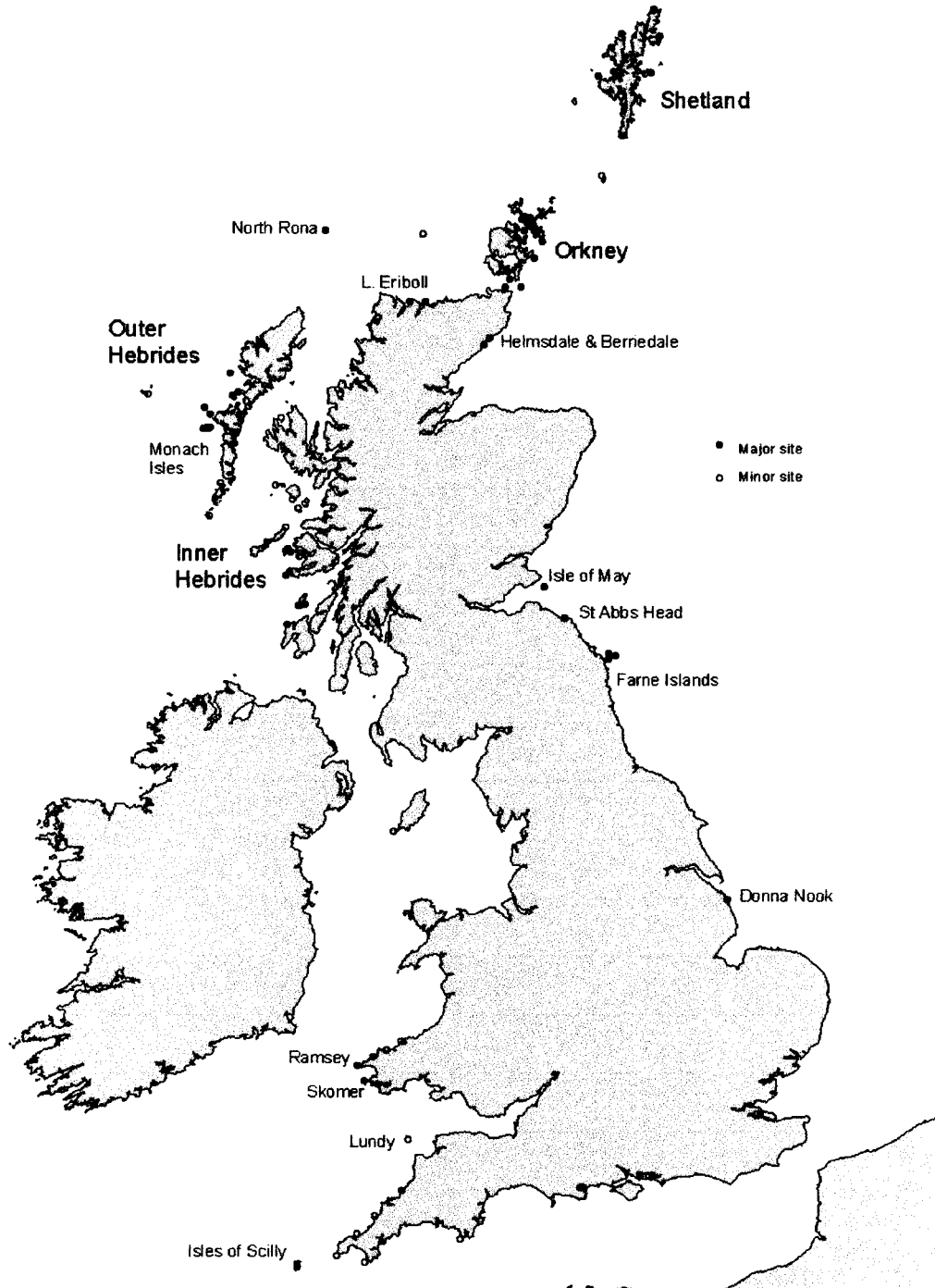


Figure 2 Total estimated pup production for all major breeding colonies in Scotland and England (excluding Loch Eriboll, Helmsdale and Shetland) from 1984 to 2000.

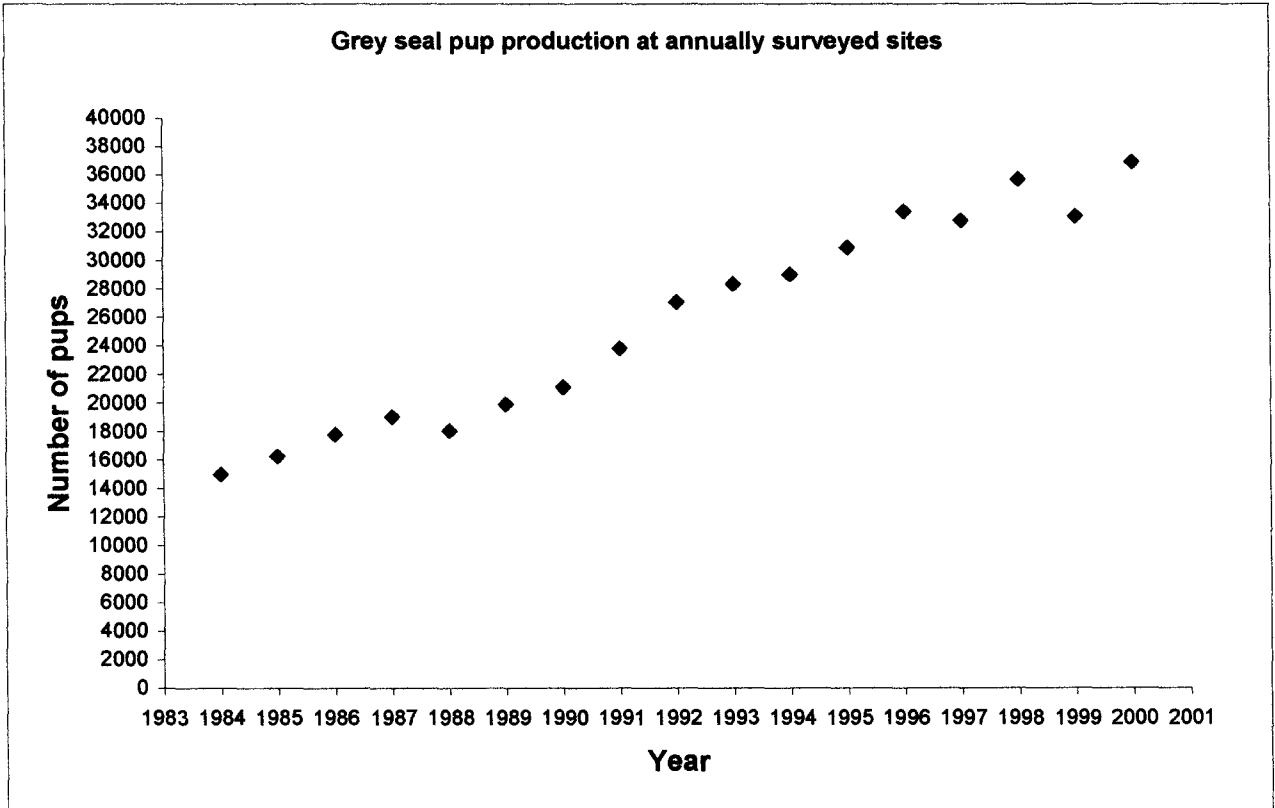
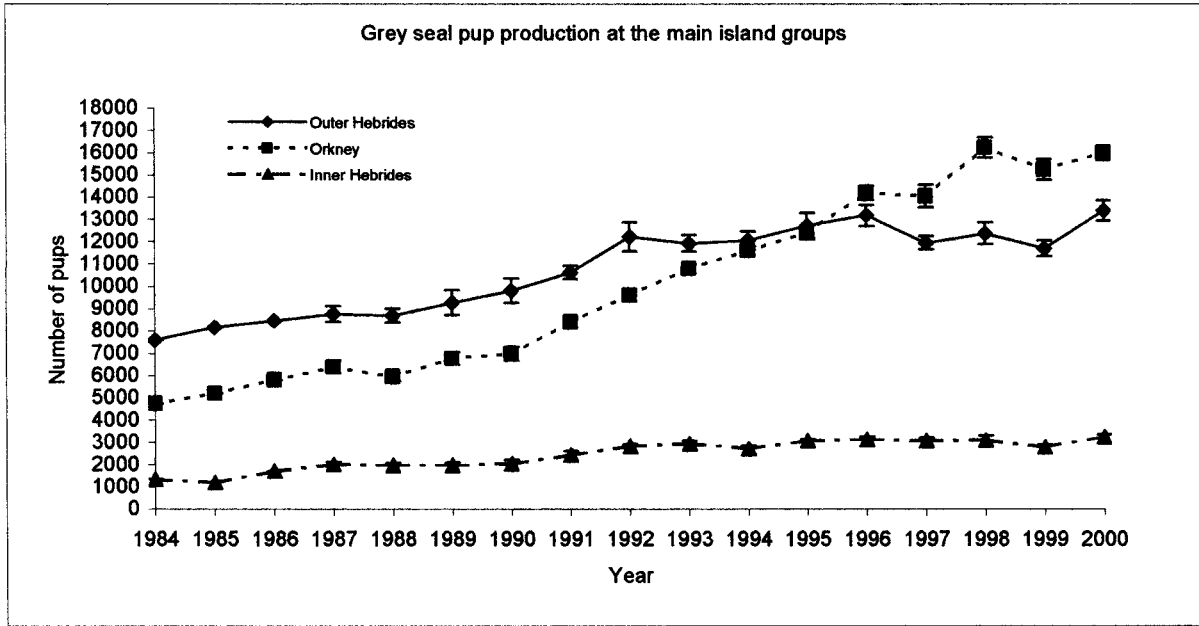


Figure 3 Trends in pup production at the major grey seal breeding areas since 1984. Production values are shown with their upper and lower 95% confidence limits where these are available. These limits assume that the various pup development parameters which are involved in the estimation procedure remain constant from year to year. Although they therefore underestimate the total variability in the estimate, they are useful for comparison of the precision of the estimates in different years. Note that the scale of these two figures differs by an order of magnitude.

(a) Outer Hebrides, Orkney and Inner Hebrides



(b) Isle of May, Farne Islands and Donna Nook

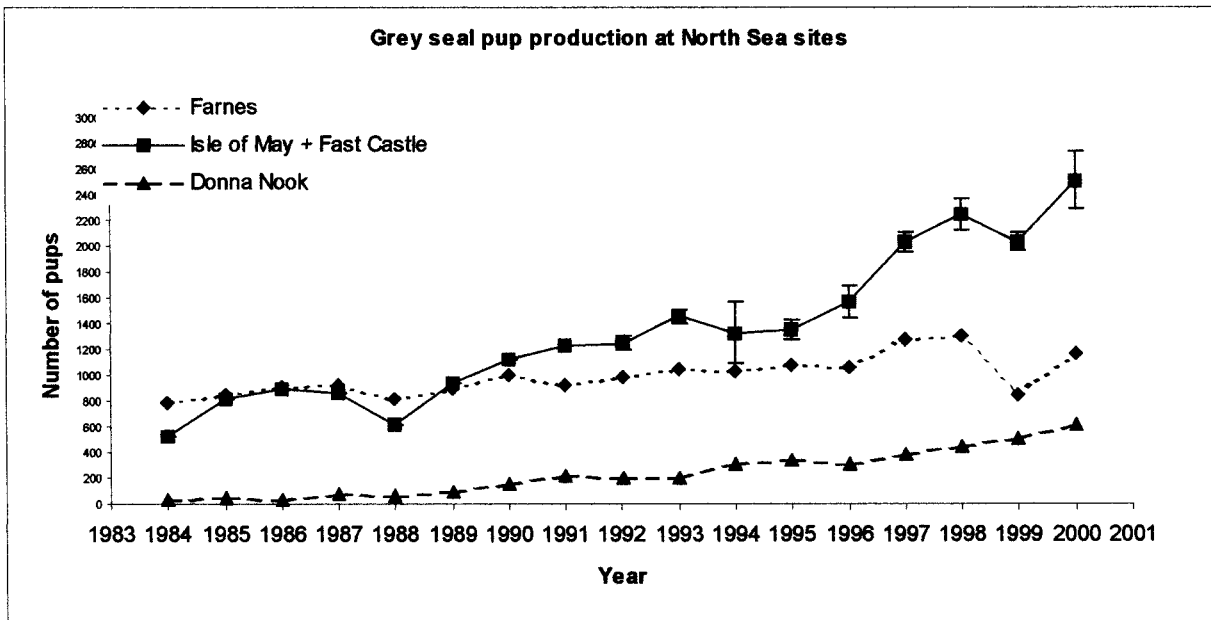
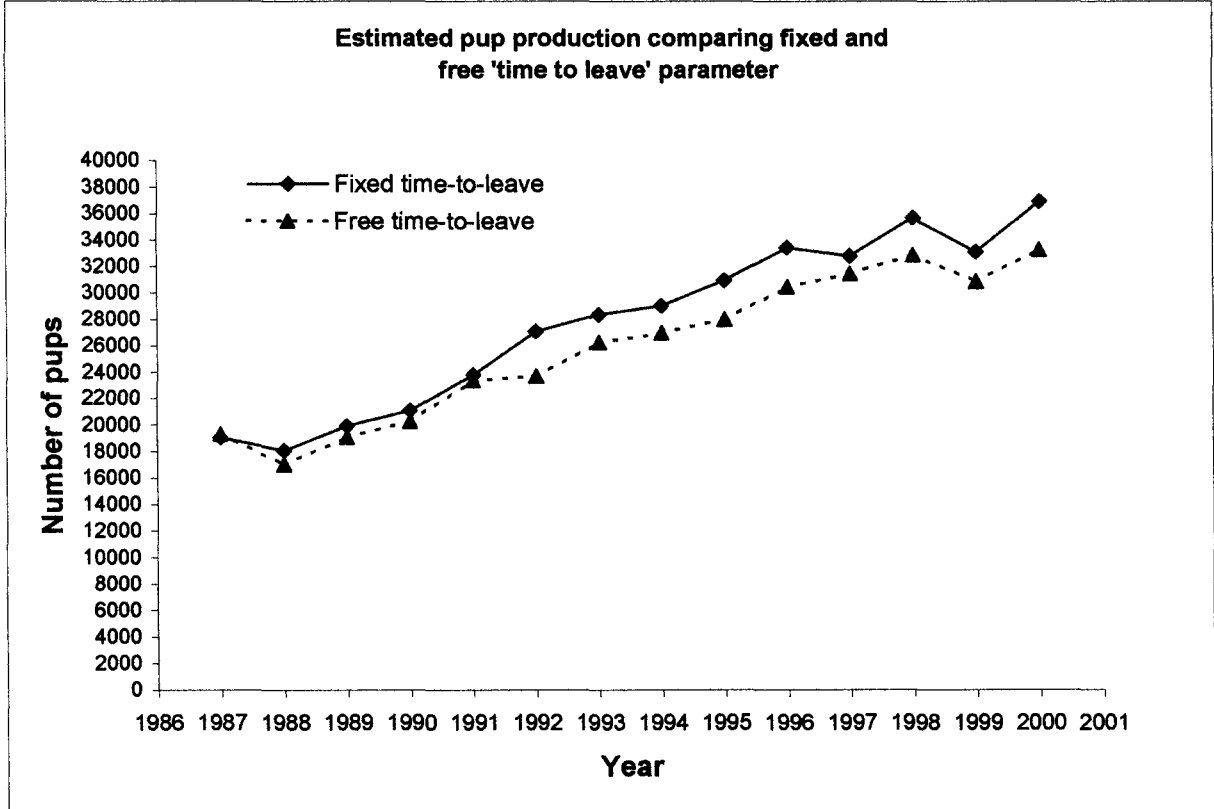


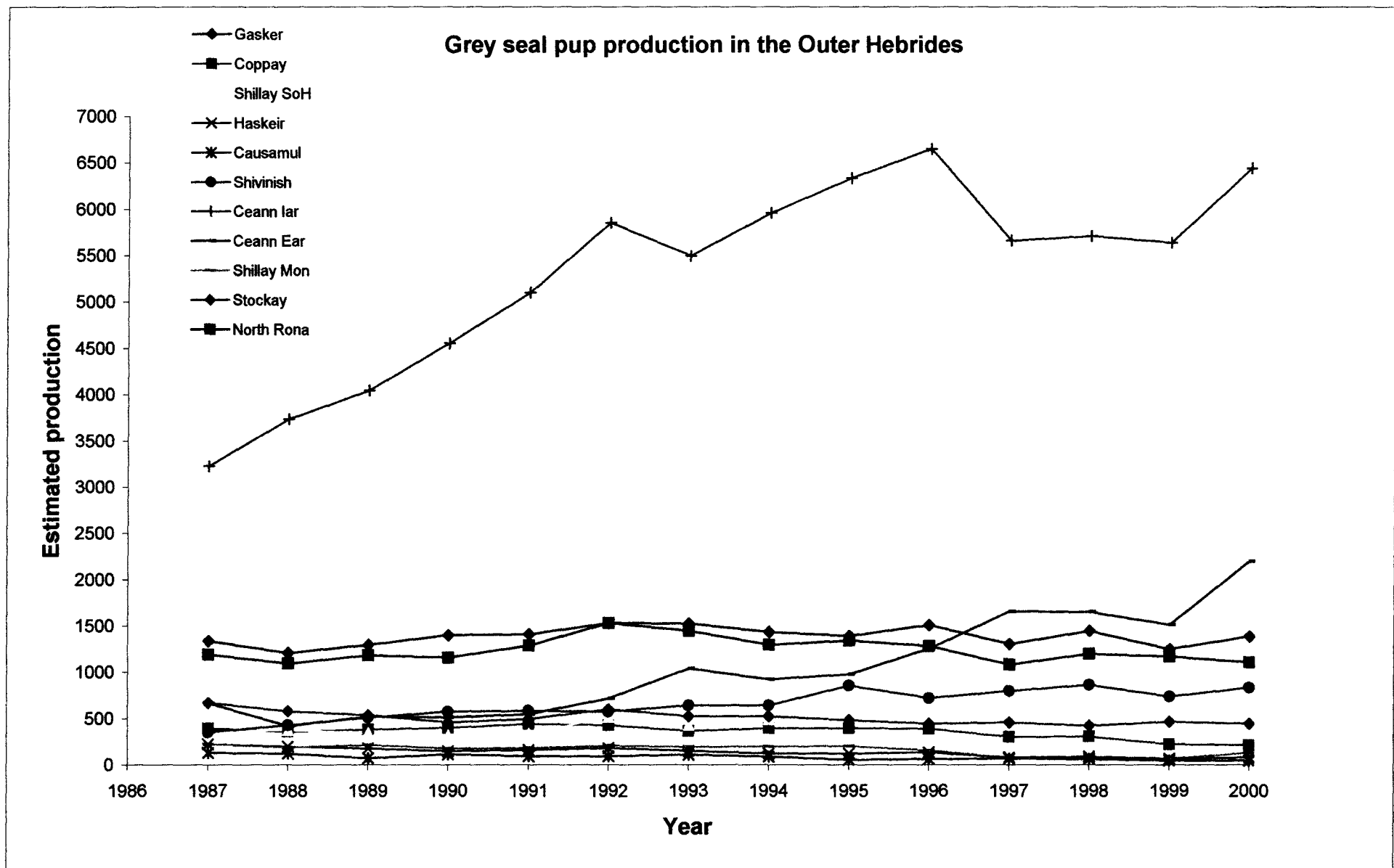
Figure 4 Comparison of pup production trajectory estimated using a constant time to leave parameter (as in Figure 1) with that generated when this parameter is re-estimated for each breeding colony in each year.



GREY SEAL PUP PRODUCTION IN THE OUTER HEBRIDES

Year	Gasker	Coppay	Shillay SoH	Haskeir	Causamul	Shivinish	Ceann Iar	Ceann Ear	Shillay Mon	Stockay	North Rona	TOTAL
1987	1337	393	365	224	131	353	3227	666	223	670	1188	8777
1988	1205	354	372	195	122	429	3733	418	189	579	1093	8689
1989	1294	383	348	176	73	512	4041	518	212	535	1183	9275
1990	1398	396	321	146	115	574	4554	510	174	457	1156	9801
1991	1406	440	334	159	94	582	5098	543	181	494	1286	10617
1992	1527	427	514	179	91	576	5852	716	204	599	1530	12215
1993	1525	366	431	150	107	640	5498	1037	192	524	1445	11915
1994	1432	394	491	123	86	640	5956	921	196	522	1293	12054
1995	1389	392	570	120	55	856	6332	977	200	480	1342	12713
1996	1508	391	574	133	64	721	6648	1254	157	445	1281	13176
1997	1301	303	470	79	67	795	5660	1656	76	458	1081	11946
1998	1444	307	552	90	64	865	5711	1649	70	422	1199	12373
1999	1247	224	508	66	45	739	5637	1514	69	464	1170	11683
2000	1388	212	519	80	48	834	6439	2199	129	443	1105	13396

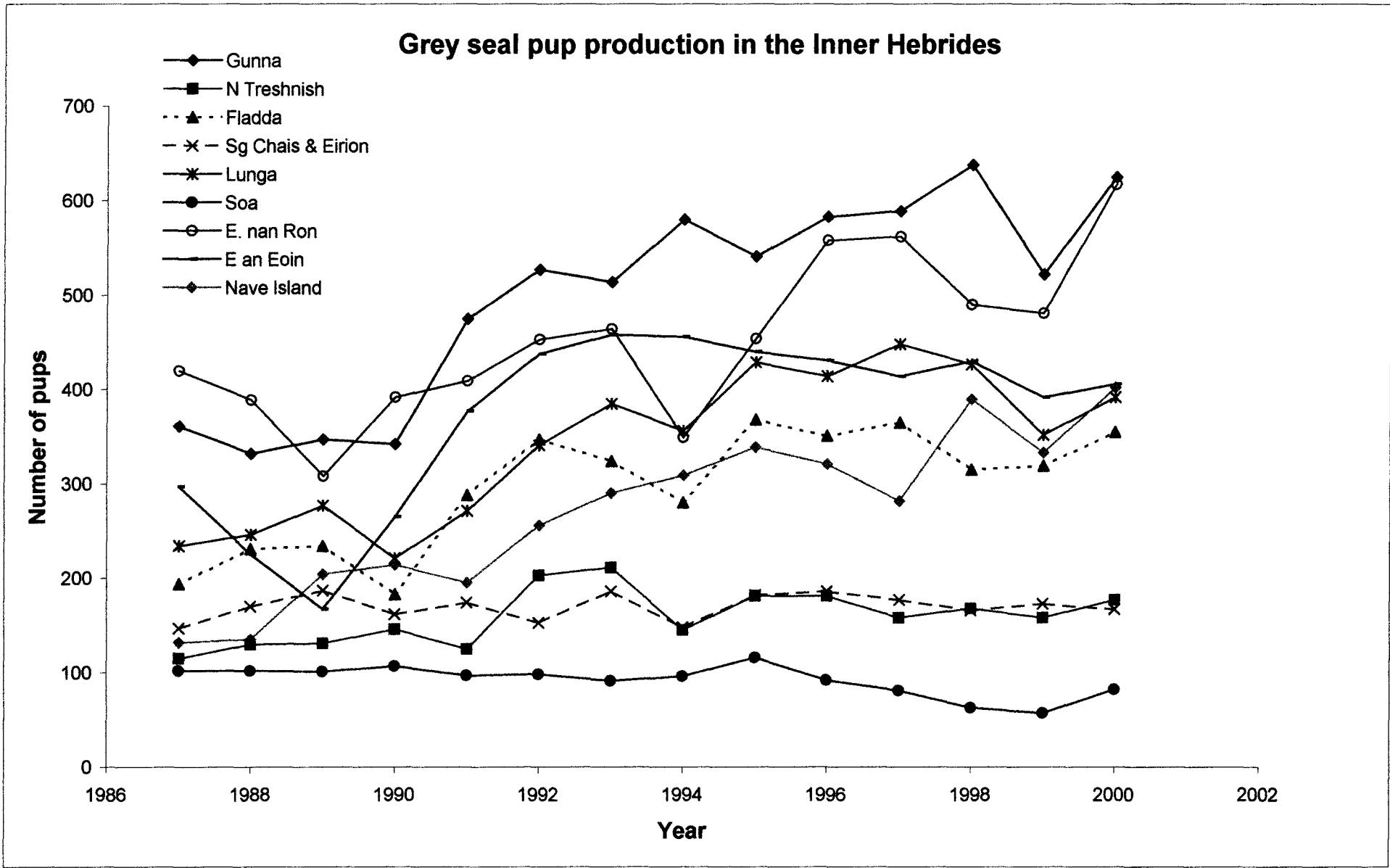
Year	Monachs	Others
1987	5139	3638
1988	5348	3341
1989	5818	3457
1990	6269	3532
1991	6898	3719
1992	7947	4268
1993	7891	4024
1994	8235	3819
1995	8845	3868
1996	9225	3951
1997	8645	3301
1998	8717	3656
1999	8423	3260
2000	10044	3352



Grey Seal Pup Production
Outer Hebrides

GREY SEAL PUP PRODUCTION IN THE INNER HEBRIDES

YEAR	Gunna	N Treshnish	Fladda	Sg Chais & Eirion	Lunga	Soa	E. nan Ron	E an Eoin	Nave Island	Total
1987	361	115	194	147	234	102	420	297	132	2002
1988	332	130	231	170	246	102	389	225	135	1960
1989	347	131	234	187	277	101	308	167	204	1956
1990	342	146	183	162	221	107	392	265	214	2032
1991	475	125	288	174	271	97	409	377	195	2411
1992	527	203	347	153	341	98	453	438	256	2816
1993	514	211	324	186	385	91	464	458	290	2923
1994	580	145	280	148	356	96	349	456	309	2719
1995	541	181	368	182	429	116	454	440	339	3050
1996	583	181	351	186	414	92	558	431	321	3117
1997	589	158	365	177	448	81	562	414	282	3076
1998	638	168	315	166	427	63	490	430	390	3087
1999	522	158	319	173	352	57	481	392	333	2787
2000	625	177	355	167	392	82	617	406	402	3223



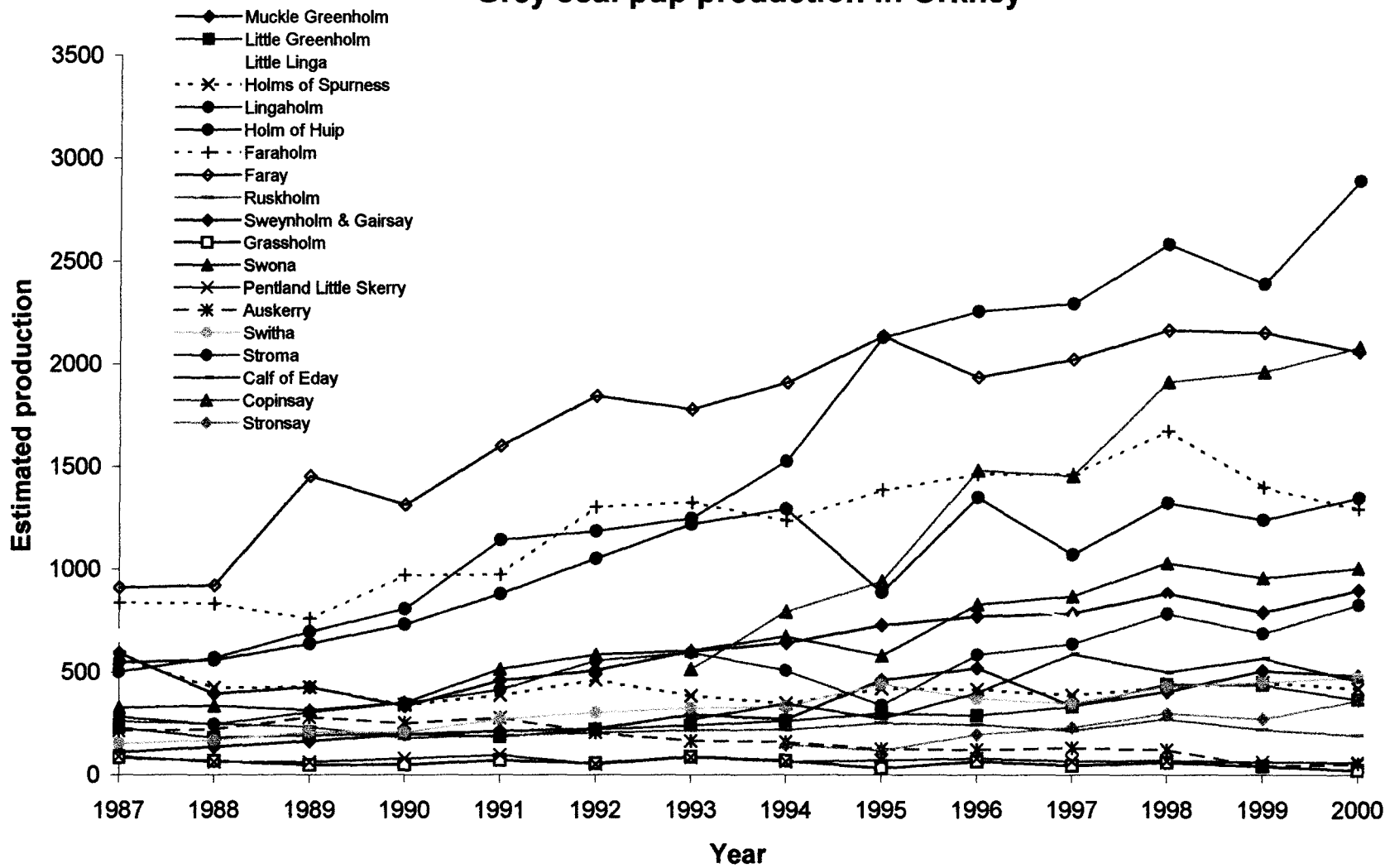
Grey Seal Pup Production
Inner Hebrides

GREY SEAL PUP PRODUCTION IN ORKNEY

Year	Muckle Greenholm	Little Greenholm	Little Linga	Holms of Spurness	Lingaholm	Holm of Huip	Faraholm	Faray	Ruskholm	Sweynholm & Gairsay	Grassholm	Swona
1987	592	231	678	570	502	548	837	910	261	109	83	327
1988	393	181	590	424	569	557	833	921	247	135	66	336
1989	426	191	574	426	696	638	760	1452	232	164	48	314
1990	334	201	625	341	807	731	970	1313	179	195	49	351
1991	459	186	728	388	1144	880	976	1602	192	214	70	514
1992	507	222	845	462	1186	1052	1304	1845	204	223	56	585
1993	601	241	830	385	1249	1221	1325	1781	218	292	88	604
1994	642	262	786	348	1527	1294	1238	1909	220	272	69	674
1995	728	300	795	420	2128	887	1387	2136	251	461	32	578
1996	770	289	834	416	2255	1349	1464	1935	243	518	64	829
1997	786	332	771	387	2294	1071	1464	2024	215	336	46	870
1998	883	442	842	429	2583	1323	1675	2166	272	405	61	1032
1999	790	438	632	449	2390	1240	1399	2152	220	505	40	957
2000	898	367	704	419	2890	1347	1293	2061	191	482	22	1005

Pentland Little Skerry	Auskerry	Switha	Stroma	Calf of Eday	Copinsay	Stronsay	TOTAL
90	216	153	282				5648
62	222	167	245				5252
62	279	207	304				5921
79	252	206	349				6096
96	277	272	414				7353
51	206	304	556				8491
86	166	324	595	270	514		8835
65	161	331	508	346	795	146	9241
71	125	442	339	274	940	118	10103
79	123	370	583	399	1480	195	10966
66	131	347	638	587	1455	231	10596
69	123	430	784	499	1914	299	12113
62	44	449	686	567	1962	271	11212
60	54	474	826	456	2082	362	11679

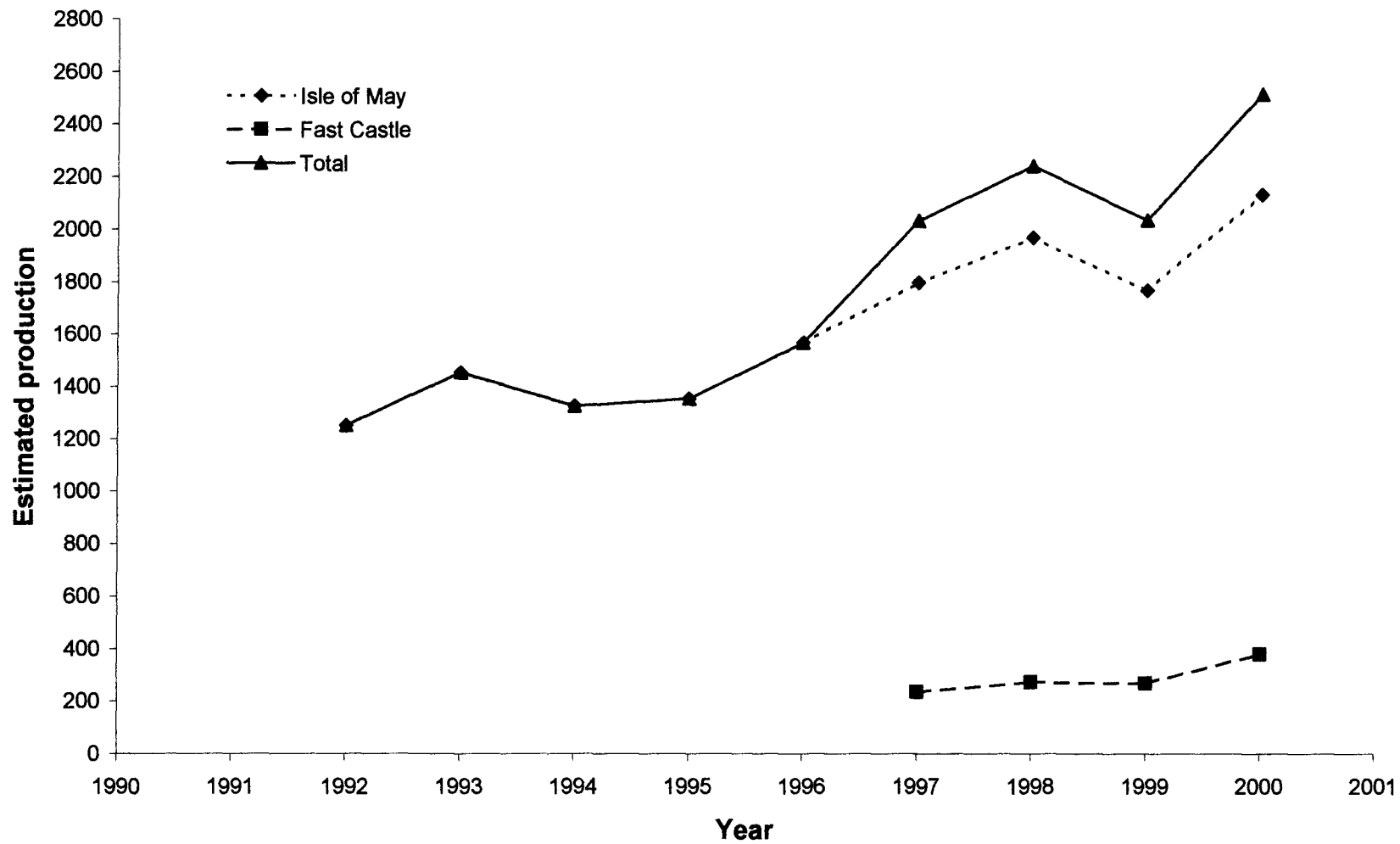
Grey seal pup production in Orkney



GREY SEAL PUP PRODUCTION AT ISLE OF MAY AND FAST CASTLE

Year	Isle of May	Fast Castle	Total
1992	1251		1251
1993	1454		1454
1994	1325		1325
1995	1353		1353
1996	1567		1567
1997	1796	236	2032
1998	1968	273	2241
1999	1766	268	2034
2000	2133	381	2514

Grey seal pup production at the Isle of May and Fast Castle



Estimates of pup production

Table 1. Pup production estimates for islands in the Inner Hebrides group

YEAR	Gunna	Northern Treshnish	Fladda	Sgeir a' Chaisteil & Eirionnach	Lunga	Soa	Eilean nan Ron	Eilean nan Eoin	Nave Island	TOTAL
1984	206	87	169	136	226	63	180	190	75	1332
1985	192	84	109	113	136	63	158	269	66	1190
1986	263	114	149	119	204	111	302	305	144	1711
1987	361	115	194	147	234	102	420	297	132	2002
1988	332	130	231	170	246	102	389	225	135	1960
1989	347	131	234	187	277	101	308	167	204	1956
1990	342	146	183	162	221	107	392	265	214	2032
1991	475	125	288	174	271	97	409	377	195	2411
1992	527	203	347	153	341	98	453	438	256	2816
1993	514	211	324	186	385	91	464	458	290	2923
1994	580	145	280	148	356	96	349	456	309	2719
1995	541	181	368	182	429	116	454	440	339	3050
1996	583	181	351	186	414	92	558	431	321	3117
1997	589	158	365	177	448	81	562	414	282	3076
1998	638	168	315	166	427	63	490	430	390	3087
1999	522	158	319	173	352	57	481	392	333	2787
2000	625	177	355	167	392	82	617	406	402	3223

Table 2. Pup production estimates for islands in the Outer Hebrides group

YEAR	Gasker	Coppay	Shillay (Sound of Harris)	Haskier	Causamul	Deasker	Shivinish (Monachs)	Ceann Iar (Monachs)	Ceann Ear (Monachs)	Shillay (Monachs)	Stockay (Monachs)	Monachs total	Others	North Rona	TOTAL
1960															
1961	847	62	120	81	67	13						0	0	1949	3142
1962															
1963															
1964															
1965															
1966	1084	230	120	96	242	0	0					38	0	1499	3311
1967	1084	153	80	96	161	0	0					114	0	1574	3265
1968	1084	115	161	96	161	0	0					152	0	1650	3421
1969															
1970	1129	324	714	130	103	41	0	0	84	60	460	605	0	2023	5070
1971															
1972	1141	316	605	167	271	67	0	0	274	49	730	1054	0	1309	4933
1973															
1974	1756	286	692	176	224	83	0	49	459	44	754	1307	0	1647	6173
1975	1538	367	631	212	202	51	0	141	690	217	932	1982	0	1961	6946
1976	1813	394	553	278	217	57	0	111	628	152	1053	1946	0	1886	7147
1977															
1978	1101	321	508	320	172	51	0	560	371	205	626	1764	0	2002	6243
1979	992	377	546	269	159	80	0	672	810	164	826	2474	0	1770	6670
1980	1345	462	794	351	163	31	0	1077	880	242	647	2848	162	1867	8026

Table 2 (continued). Pup production estimates for islands in the Outer Hebrides group

YEAR	Gasker	Coppay	Shillay (Sound of Harris)	Haskier	Causamul	Deasker	Shivinish (Monachs)	Ceann Iar (Monachs)	Ceann Ear (Monachs)	Shillay (Monachs)	Stockay (Monachs)	Monachs total	Others	North Rona	TOTAL
1981	1255	423	1016	278	178	68	0	1279	486	331	847	2944	136	1785	8086
1982	1443	634	219	322	260	110	0	1329	557	199	712	2798	85	1888	7763
1983															
1984	1120	389	386	277	143	0	83	2175	616	209	555	3638	0	1641	7594
1985	1303	408	335	254	168	0	261	2365	748	193	641	4208	0	1489	8165
1986	1258	378	356	225	108	0	283	2931	822	222	572	4830	0	1300	8455
1987	1337	393	365	224	131	0	353	3227	666	223	670	5139	0	1188	8777
1988	1205	354	372	195	122	0	429	3733	418	189	579	5348	0	1093	8689
1989	1294	383	348	176	73	0	512	4041	518	212	535	5818	0	1183	9275
1990	1398	396	321	146	115	0	574	4554	510	174	457	6269	0	1156	9801
1991	1406	440	334	159	94	0	582	5098	543	181	494	6898	0	1286	10617
1992	1527	427	514	179	91	0	576	5852	716	204	599	7947	0	1530	12215
1993	1525	366	431	150	107	0	640	5498	1037	192	524	7891	0	1445	11915
1994	1432	394	491	123	86	0	640	5956	921	196	522	8235	0	1293	12054
1995	1389	392	570	120	55	0	856	6332	977	200	480	8845	0	1342	12713
1996	1508	391	574	133	64	0	721	6648	1254	157	445	9225	0	1281	13176
1997	1301	303	470	79	67	0	795	5660	1656	76	458	8645	0	1081	11946
1998	1444	307	552	90	64	0	865	5711	1649	70	422	8717	0	1199	12373
1999	1247	224	508	66	45	0	739	5637	1514	69	464	8423	0	1170	11683
2000	1388	212	519	80	48	0	834	6439	2199	129	443	10044	0	1105	13396

Table 3. Pup production estimates for islands in the Orkney group

YEAR	Muckle Green-holm	Little Green-holm	Little Linga	Holm of Spur-ness	Point of Spur-ness	Linga-holm	Holm of Huip	Fara-holm	Faray	Rusk-holm	Wart-holm	Sweyn-holm & Gairsay	Grass-holm	Swona	Pent-land Skerry	Aus-kerry	Switha	Stroma	Calf of Eday	Copin-say	Stron-say	TOTAL	
1960	734	190	239	90	0	0	0	441	0	208	41	0	0	2	98	0	0	0	0	0	0	2048	
1961	537	290	251	124	0	0	0	300	0	256	33	0	0	2	48	0	0	0	0	0	0	1846	
1962
1963
1964	934	469	154	25	0	0	0	22	117	208	16	55	3	14	24	0	0	0	0	0	0	2048	
1965	671	366	279	138	0	0	0	113	151	247	29	21	66	19	85	0	0	0	0	0	0	2191	
1966	688	454	344	138	0	0	0	270	154	87	8	59	18	14	48	0	0	0	0	0	0	2287	
1967	600	445	395	98	0	0	0	270	165	252	8	111	0	6	36	0	0	0	0	0	0	2390	
1968	650	310	399	278	0	13	0	257	258	195	8	81	36	27	52	0	0	0	0	0	0	2570	
1969	567	298	576	189	8	28	0	214	28	208	4	77	59	35	20	0	0	0	0	0	0	2316	
1970	747	318	519	135	45	42	22	171	95	223	4	13	66	43	85	0	0	0	0	0	0	2535	
1971	588	351	708	158	49	137	30	320	88	103	16	70	40	67	36	0	0	0	0	0	0	2766	
1972
1973	503	207	519	233	66	177	88	351	35	15	12	86	92	51	52	87	0	0	0	0	0	2581	
1974	525	190	479	146	21	61	137	500	72	132	0	134	69	71	73	84	0	0	0	0	0	2700	
1975	483	230	483	271	49	39	117	477	65	63	4	111	21	59	48	152	0	0	0	0	0	2679	
1976	605	175	648	328	53	68	68	398	85	60	4	198	21	92	65	375	0	0	0	0	0	3247	
1977	679	210	684	305	78	50	130	477	58	111	4	194	21	92	65	199	0	0	0	0	0	3364	
1978	333	210	800	471	136	79	192	700	58	219	4	149	36	104	57	134	0	90	0	0	0	3778	
1979	546	294	344	430	127	144	368	672	92	280	4	142	69	92	65	145	0	152	0	0	0	3971	
1980	496	166	676	415	107	315	275	817	165	336	0	167	74	108	81	97	0	174	0	0	0	4476	
1981	442	199	860	449	45	293	510	712	202	319	4	108	92	225	125	249	0	223	0	0	0	5064	

Table 3 (continued). Pup production estimates for islands in the Orkney group

YEAR	Muckle Green-holm	Little Green-holm	Little Linga	Holm of Spurness	Point of Spurness	Linga-holm	Holm of Huip	Fara-holm	Faray	Rusk-holm	Wart-holm	Sweyn-holm & Gairsay	Grass-holm	Swona	Pent-land Skerry	Aus-kerry	Switha	Stroma	Calf of Eday	Copin-say	Stron-say	TOTAL	
1982	454	87	716	665	29	326	521	817	146	295	4	104	103	148	147	294	153	227	0	0	0	5241	
1983
1984	517	127	601	518	0	303	368	834	376	335	0	111	79	85	70	219	119	79	0	0	0	4741	
1985	483	191	568	643	0	342	245	796	526	315	0	115	60	260	82	261	151	161	0	0	0	5199	
1986	637	227	602	533	0	390	358	752	811	345	0	145	81	191	70	278	157	219	0	0	0	5796	
1987	592	231	678	570	0	502	548	837	910	261	0	109	83	327	90	216	153	282	0	0	0	6389	
1988	393	181	590	424	0	569	557	833	921	247	0	135	66	336	62	222	167	245	0	0	0	5948	
1989	426	191	574	426	0	696	638	760	1452	232	0	164	48	314	62	279	207	304	0	0	0	6773	
1990	334	201	625	341	0	807	731	970	1313	179	0	195	49	351	79	252	206	349	0	0	0	6982	
1991	459	186	728	388	0	1144	880	976	1602	192	0	214	70	514	96	277	272	414	0	0	0	8412	
1992	507	222	845	462	0	1186	1052	1304	1845	204	0	223	56	585	51	206	304	556	0	0	0	9608	
1993	601	241	830	385	0	1249	1221	1325	1781	218	0	292	88	604	86	166	324	595	270	514	0	10790	
1994	642	262	786	348	0	1527	1294	1238	1909	220	0	272	69	674	65	161	331	508	346	795	146	11593	
1995	728	300	795	420	0	2128	887	1387	2136	251	0	461	32	578	71	125	442	339	274	940	118	12412	
1996	770	289	834	416	0	2255	1349	1464	1935	243	0	518	64	829	79	123	370	583	399	1480	195	14195	
1997	786	332	771	387	0	2294	1071	1464	2024	215	0	336	46	870	66	131	347	638	587	1455	231	14051	
1998	883	442	842	429	0	2583	1323	1675	2166	272	0	405	61	1032	69	123	430	784	499	1914	299	16231	
1999	790	438	632	449	0	2390	1240	1399	2152	220	0	505	40	957	62	44	449	686	567	1962	271	15253	
2000	898	367	704	419	0	2890	1347	1293	2061	191	0	482	22	1005	60	54	474	826	456	2082	362	15993	

Table 4. Pup production estimates for other sites routinely monitored.

YEAR	Farne Islands	Isle of May	Fast Castle	SW England	Wales	Donna Nook	Helmsdale	Loch Eriboll	E. nan Ron, Tongue	Shetland	S. Ronaldsay (Orkney)
1956	751	.	.	.	.	.	.	.	.	.	.
1957	854	.	.	.	.	.	.	.	.	.	.
1958	869	.	.	.	.	.	.	.	.	.	.
1959	898	.	.	.	.	.	.	.	.	.	.
1960	1020	.	.	.	.	.	.	.	.	.	123
1961	1141	.	.	.	.	.	.	.	.	.	152
1962	1118	.	.	.	.	.	.	.	.	.	.
1963	1259	.	.	.	.	.	.	.	.	.	.
1964	1439	.	.	.	.	.	.	.	.	.	115
1965	1404	.	.	.	.	.	.	.	.	.	74
1966	1728	.	.	.	.	.	.	.	.	.	107
1967	1779	.	.	.	.	.	.	.	.	.	132
1968	1800	.	.	.	.	.	.	.	.	.	152
1969	1919	.	.	.	.	.	.	.	.	.	127
1970	1987	.	.	.	.	15	.	.	.	.	103
1971	2041	.	.	.	.	1	.	.	.	.	148
1972	1617	.	.	.	.	0	.	.	.	.	.
1973	1678	.	.	107	.	0	.	.	.	578	123
1974	1668	.	.	.	.	.	.	.	.	.	136
1975	1617	.	.	.	.	.	.	.	.	.	197
1976	1426	.	.	.	.	.	.	.	.	.	160
1977	1243	.	.	.	645	.	.	.	.	700	156
1978	1162	.	.	.	.	.	.	.	.	.	169
1979	1320	300	.	.	.	.	.	.	.	.	164
1980	1118	499	.	.	.	.	.	.	.	.	140
1981	992	505	.	.	.	34	.	.	.	.	82
1982	991	603	.	.	.	43	.	.	.	.	103
1983	902	336	.	.	.	.	.	.	.	.	.
1984	778	517	.	.	.	30	94	406	.	.	.
1985	848	810	.	.	.	53	.	.	.	.	.
1986	908	891	.	.	.	35	.	.	.	.	.
1987	930	865	.	.	.	72	.	.	.	.	.
1988	812	608	.	.	.	54	.	.	.	.	.
1989	892	936	.	.	.	94	280	666	.	.	.
1990	1004	1122	.	.	.	152	.	.	.	.	.
1991	927	1225	.	.	.	223	321	.	.	.	241
1992	985	1251	.	.	1308	200	225	612	.	.	246
1993	1051	1454	.	.	1372	205	.	700	.	.	244
1994	1025	1325	.	.	1350	302	.	700	.	.	258
1995	1070	1353	.	.	.	334	300	516	.	.	250
1996	1061	1567	.	.	.	310	300	726	.	.	250
1997	1284	1796	236	.	.	382	523*	719	.	.	250
1998	1309	1968	273	.	.	439	.	649	200	.	250
1999	843	1766	268	.	.	503	.	(422)"	(83)"	.	.
2000	1171	2133	381	.	.	618	.	670	235	.	.

* Includes pups on Berridale beaches. " One flight only

Table 5a. Estimated size of the population associated with all major grey seal breeding sites in Scotland and eastern England, except Loch Eriboll, Helmsdale and Shetland. Estimates refer to the number of seals aged 1 and over at the start of the breeding season. Pup production estimated using a fixed time to leave.

YEAR	Estimated pup production	Female population	Female + male population
1984	14,992	25,671	44,356
1985	16,265	27,120	46,823
1986	17,796	28,774	49,673
1987	19,035	30,666	52,975
1988	18,071	32,648	56,431
1989	19,926	34,509	59,620
1990	21,093	36,565	63,164
1991	23,815	38,598	66,621
1992	27,075	40,711	70,195
1993	28,338	43,129	74,345
1994	29,018	45,719	78,802
1995	30,932	48,424	83,455
1996	33,426	51,458	88,733
1997	32,771	54,665	94,308
1998	35,680	57,766	99,620
1999	33,103	61,062	105,269
2000	36,915	64,276	110,688

Table 5b. Estimated size of the population associated with all major grey seal breeding sites in Scotland and eastern England, except Loch Eriboll, Helmsdale and Shetland. Estimates refer to the number of seals aged 1 and over at the start of the breeding season. Pup production estimated using a free time to leave.

YEAR	Estimated pup production	Female population	Female + male population
1984	14992	24744	42391
1985	16,265	26,018	44,536
1986	17,796	27,411	46,899
1987	19,341	28,995	49,628
1988	16,999	30,643	52,468
1989	19,061	32,234	55,172
1990	20,291	33,895	57,994
1991	23,373	35,592	60,853
1992	23,700	37,398	63,897
1993	26,244	39,312	67,131
1994	26,964	41,392	70,670
1995	27,995	43,576	74,391
1996	30,422	45,895	78,354
1997	31,431	48,373	82,602
1998	32,855	50,965	87,039
1999	30,871	53,551	91,426
2000	32,974	56,220	95,936

Table 6. Scottish grey seal breeding sites that are not surveyed annually or have recently been included in the survey programme. These potential breeding sites are checked when flying time, conditions and additional circumstances permit.

	Location	Survey method	Last surveyed, frequency	Number of pups
Inner Hebrides	Colonsay/Oronsay mainland	SMRU visual	1994, every 2-3 years	None seen
	Loch Tarbert, Jura	SMRU visual	1998, every 3-4 years	None seen
	West coast Islay	SMRU visual	1998, every 3-4 years	None seen
	Ross of Mull, south coast	SMRU visual	1998, infrequent	None seen
	Treshnish small islands, incl. Dutchman's Cap	SMRU photo & visual	1999, annual	~20 in total
	Staffa	SMRU visual	1998, every other year	~5
	Little Colonsay, by Ulva	SMRU visual	1998, every 3-4 years	6
	Meisgeir, Mull	SMRU visual	1998, every 3-4 years	1
	Craig Inish, Tiree	SMRU photo	1998, every 2-3 years	2
	Cairns of Coll	SMRU photo	1998, every 2-3 years	13
	Muck	SMRU photo	1998, every other year	12
	Rum	SNH ground	1999, annual	10-15
	Canna	SMRU photo	1998, every other year	34
	Rona	SMRU visual	1989, infrequent	None seen
	Ascrib Islands, Skye	SMRU photo	1998, every other year	32
	Heisgeir, Dubh Artach, Skerryvore	SMRU visual	1995, every other year 1989, infrequent	None None
	Outer Hebrides	Barra Islands Fiaray & Berneray	SMRU visual	1999, every other year	76
Sound of Harris islands		SMRU photo	1999, every 2-3 years	317
St Kilda		Warden's reports	Infrequent	Few pups are born
Shiants		SMRU visual	1998, every other year	None
Flannans		SMRU visual	1994, every 2-3 years	None
Berneray, Lewis		SMRU visual	1991, infrequent	None seen
Summer Isles		SMRU visual	1989, infrequent	None seen
Faraid Head		SMRU visual	1989, infrequent	None seen
Eilean Hoan, Loch Eriboll		SMRU visual	1998, annual	None
Rabbit Island, Tongue		SMRU visual	1998, every other year	None seen
Orkney		Sule Skerry	SMRU photo	1998, 1999, 2000	15, 7, 7
	Sanday, Point of Spurness	SMRU photo	1999, every 2-3 years	30
	Sanday, east and north	SMRU visual	1994, every 2-3 years	None seen
	Papa Stronsay	SMRU visual	1993, every 3-4 years	None seen
	Holm of Papa, Westray	SMRU visual	1993, every 3-4 years	None seen
	North Ronaldsay	SMRU visual	1994, every 2-3 years	None seen
	Eday mainland	SMRU photo	2000, first	23
	Calf of Flotta	SMRU photo	2000, annual	154
South Fara, Cava & Rysa	SMRU photo	2000, annual	134	
Others	Firth of Forth islands & Inchcolm	Anecdotal SMRU photo	Infrequent 1997	<10 4

The Status of British Common Seal Populations

Callan Duck & Dave Thompson

1. Common seals surveys in eastern England 2000

In 1988, the numbers of common seals in The Wash declined by approximately 50% as a result of the phocine distemper virus (PDV) epidemic. Prior to this, numbers had been increasing. Following the epidemic, from 1989, the area has been surveyed once or twice annually in the first half of August each year (Figure 1, Table 1).

Two aerial surveys of common seals were carried out in Lincolnshire and Norfolk during August 2000 (Table 1). The mean of the two counts for The Wash (2,778) was the highest to date and 16% greater than the mean of the 1999 counts (2,397). The average annual rate of increase in the number of seals counted in The Wash since 1989 is 6.1% (SE = 0.64%). This is significantly greater than the average annual rate of increase between 1968 and 1988 of 3.5% (SE = 0.29%).

The mean of the 2000 counts in The Wash remains lower (now by just 8%) than the pre-epidemic count in 1988, although the second Wash count (3,029) was close to the last pre-epidemic count (3,087). This is in contrast to populations on the east and south sides of the North Sea which recovered rapidly from the effects of PDV and, by 1996, were similar to or exceeded their pre-epidemic levels. The 1999 counts at Blakeney Point (Table 1) were similar to those in 1998, remaining higher than previous years.

2. Common seals in Scotland

In August 2000, parts of the west and east coasts of Scotland were surveyed for common seals. This third round Scotland survey was due to begin in 2001 but, as they required additions breeding and moulting season data for prospective Special Areas of Conservation for common seals, Scottish Natural Heritage agreed to fund the first part of the survey on condition the timing was advanced by one year.

The west coast from Loch Torridon to Machrihanish on west Kintyre (excluding Lochs Alsh, Duich and Hourn and the Small Isles) was surveyed by helicopter using a thermal imaging camera. On the east coast, fixed-wing surveys were carried out in the Firth of Tay and the Inner Moray Firth. The total counts for the areas surveyed, with comparable counts from previous surveys, are given below. There were notable increases in the numbers of common seals in the surveyed areas of west Highland and Strathclyde.

Location	1988-1994	1996-1997	2000
Outer Hebrides (all)	2,329	2,820	2,413
Highland (part of west coast)	2,362	2,803	4,280
Highland (east, Inner Moray Firth)	1,061	1,141	838
Grampian (part)	58	47	111
Strathclyde (part)	3,807	4,330	5,906
Firth of Tay (all)	575	633	700

3. Minimum estimate of the British common seal population

The most recent minimum estimate of the number of common seals in Scotland is 32,075 from surveys carried out in 1996, 1997 and 2000. The most recent minimum estimate for England is 4,245. This comprises 4,110 seals in Lincolnshire and Norfolk in 1999 plus 135 seals in Northumberland, Cleveland, Essex and Kent between 1994 and 1997 plus an estimated 20 seals from the south and west coasts.

Counts by region are given in the Table below. These are presented as the means of all counts from each region during the periods 1996-1997 and 1996-2000.

Region	1996-1997	1996-2000
Shetland	5,991	5,991
Orkney	8,522	8,522
Outer Hebrides	2,820	2,413
Highland	5,117	6,291
Strathclyde	6,333	7,909
Dumfries & Galloway	6	6
Grampian	62	126
Tayside	92	165
Fife	617	611
Lothian	40	40
TOTAL SCOTLAND	29,600	32,075
East coast England (1994 to 1999)	3,568	4,250
South & west England (estimated)		20
TOTAL BRITAIN	33,168	36,345

4. Common seal surveys proposed for 2001

Harbour seals in Orkney and Shetland will be surveyed in August 2000. There are three prospective Special Areas of Conservation for harbour seals in these islands and Scottish Natural Heritage is contributing towards the cost of the survey.

Table 1. Numbers of commons seals counted on the east coast of England since 1988. Data are from fixed-wing aerial surveys carried out during the August moult.

Date of survey	13.8.88	8.8.89	11.8.90	2.8.91	1.8.92	8.8.93	6.8.94	5.8.95	2.8.96	2.8.97	7.8.98	3.8.99	4.8.00
		12.8.89		11.8.91	16.8.92		12.8.94	15.8.95		8.8.97	14.8.98	13.8.99	12.8.00
Blakeney Point	701	-	73	-	-	267	-	438	372	250	535	715	895
		307		-	217		196	392		371	738	602	dist.
The Wash	3087	1531	1532	1226	1724	1759	2277	2266	2151	2561	*2367	2320	2528
		1580		1551	1618		1745	1902		2360	2381	2474	3029
Donna Nook	173	-	57	-	18	88	60	115	162	240	294	321	435
		126		-	-		146	36		262	201	286	345
Scroby Sands	-	-	-	-	-	-	61	-	51	58	52	69	84
		-		-	-		-	49		72	-	74	9
The Tees	-	-	-	-	-	-	-	-	-	-	-	-	-
		-		-	-		35	-		-	-	-	-
Holy Island (Northumberland)	-	-	-	-	-	-	-	-	-	-	-	-	-
		-		-	-		13	-		12	-	-	10
Essex & Kent	-	-	-	-	-	-	-	90	-	-	-	-	-
		-		-	-		-	-		-	-	-	-

* One area used by common seals was missed on this flight (100 – 150 seals); this data point has been excluded from analyses

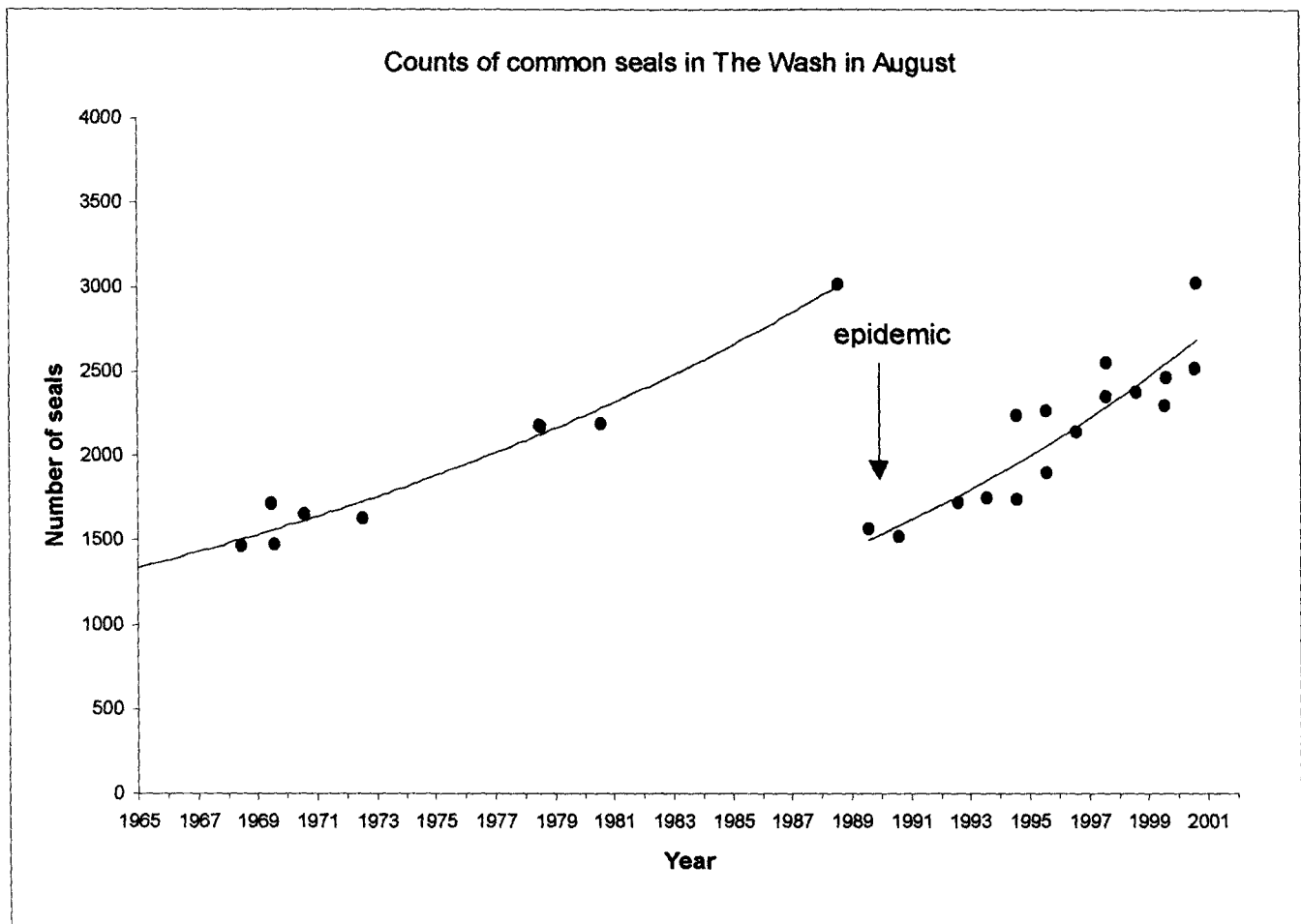


Figure 1. Counts of common seals in The Wash in August. These data are an index of the population size through time.