Natural England Commissioned Report NECR103

Monitoring grey seals (*Halichoerus grypus*) in the Isles of Scilly during the 2010 pupping season (August to December 2010)

First published 22 October 2012

www.naturalengland.org.uk

NATURAL ENGLAND

Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Under the requirements of the EU *Habitats Directive* the UK Government has established a series of Special Areas of Conservation (SACs) which, with Special Protection Areas, form a series known as Natura 2000 (N2K). Articles 11 and 17(1) of the *Habitats Directive* require that member states regularly assess the ecological condition of the designated features within the N2K series. Condition Assessment of European Marine Sites is carried out on a six yearly cycle, and it is the responsibility of Natural England to report this to Europe through the JNCC (Joint Nature Conservation Committee).

One of the qualifying marine features for SAC designation is the Annex II species the grey seal (*Halichoerus grypus*). SAC sites for grey seals reflect both the largest breeding colonies, based on pup production, as well as the geographical range of breeding sites. The Isles of Scilly was designated a European Marine Site (EU code UK0013694) in 1996, with the grey seal, as one of its named features.

The objectives of this study were to carry out a comprehensive re-survey of the grey seal population breeding on the Isles of Scilly, following the 2005 survey (Westcott, 2008). Information on monitoring methods for marine mammals is contained in the guidance manual on Common Standards Monitoring (CSM) Guidance for Marine Mammals, JNCC (2005) and for this survey was based on essential attributes including (1) pup production; (2) the distribution of grey seal pups; (3) accessibility of SAC sites for breeding; (4) disturbance; (5) extent of breeding, moulting and haul out sites measured in terms of total area. The results of this study will enable any changes to be monitored and so inform the site managers as to any adaptations that may need to be made to the future management of the SAC.

This report is being published to inform managers and to allow others to review the work, as well as to develop and adapt monitoring programmes for this and other SACs.

This report should be cited as:

SAYER, S., HOCKLEY, C. & WITT, M.J. 2012. *Monitoring grey seals (Halichoerus grypus) in the Isles of Scilly during the 2010 pupping season*. Natural England Commissioned Reports, Number 103.

Natural England Project Manager - Sangeeta McNair, Pydar House, Pydar Street, Truro, Cornwall, TR1 1XU **sangeeta.mcnair@naturalengland.org.uk**

Contractor - Sue Sayer, Cornwall Seal Group, **www.cornwallsealgroup.co.uk**; **sue@cornwallsealgroup.co.uk**

Keywords - Condition assessment, monitoring, grey seals, Halichoerus grypus, pup production, breeding, distribution, disturbance, Special Area of Conservation (SAC), Isles of Scilly

Further information
This report can be downloaded from the Natural England website: **www.naturalengland.org.uk**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**.

ISSN 2040-5545

Plate i Photo of small group of grey seals of different age and sex classes

Summary

Background

The Isles of Scilly were designated a European Marine Site in 1996, with grey seals (*Halichoerus grypus*) as a named feature. The minimum standard for monitoring is once every six years.

The aim of this study was to conduct a full and thorough repeat of the seal surveys carried out in 2005 during the pupping season. In 2010, five boat-based counts of seals were made, along with monthly landings on four key pupping islands to conduct pup counts between 28/08/10 and 10/12/10.

Results: boat-based surveys of all seals

The variation in seal numbers observed between August and December was considerable, more than doubling from 331 to 763 seals, with increases seen across all age and sex classes. Most seals (mean ± 1 s.d.) were observed in the SSSI areas of the Western Rocks (238 ± 97), the Eastern Isles (184 ± 81), Island Eleven (51 ± 49) and the Norrards (27 ± 12).

During the pupping season, the top 15 haul out islands (ranked from the greatest in descending order) were Island Sixty seven, Island Sixty six, Island Five, Island Eleven, Island Six, Island Fourteen, Island Sixty two, Island Two, Island One, Island Seven, Island Nine, Island Three, Island Eight, Island Twenty one and Island Thirty one (by Island Thirty five).

The spatial distribution of age and sex classes was uneven with proportionally more adult females observed in the far western islands, proportionally more males in the central islands and proportionally more juveniles on the most easterly islands.

Results: land based surveys of pups

White coated pups were observed in all five surveys, suggesting the pupping season in 2010 extended from at least August to December.

Of the 85 unique (i.e. different) alive and dead pups counted, most were found on Island Eleven SSSI (46 pups) and Island Five in the Western Rocks SSSI (17 pups). Pups were observed at Island Twenty four in the Norrards SSSI (10 pups) and Island Thirty one in Island Thirty five's SSSI (12 pups).

In total, six unique dead pups were seen, suggesting an estimated pup mortality rate during the lactation period of 7%, with the highest rate on Island Five (18%; n=3) and the minimum rate on Island Eleven (2%; n=1).

Pups were unevenly distributed on the pupping islands. On Island Eleven and Island Thirty one, pups were mostly found on the more sheltered northern and eastern shores. On Island Twenty four and Island Five, pups were found across the islands, with pups born earlier in the season found closest to the shore and pups born later in the season found in more central, higher island locations. Some pups were observed above the highest astronomical tide level.

Photo identification of individual seals

14 different seals were re-identified from the Isles of Scilly Photo Identification Catalogue (PIC), 1 seal was identified from the Cornwall PIC and 1 female was identified from the Skomer Island PIC.

Conclusions

Directly comparable pup counts from the 2005 and 2010 surveys were probably stable, judged with moderate reliability (JNCC 2007).

The pup production estimate from 2005 was 55 to 70 (revised to at least 108) pups. For 2010, the pup production estimate was 89 to 134 pups (89 observed and 134 pups being the median of estimates; refer to Appendix 11.) It was not possible to determine a trend (increasing or decreasing) from these figures as they were not calculated in the same way, so not directly comparable; the 2005 figure was only tentative, being an estimation based on a partial survey.

Comparable pup mortality rates during the lactation period were 10% in 2005 and 18% in 2010, but it was not possible to determine a trend from these figures, due to the small number of pups found.

From 2010, recruitment at year one is likely to be between 36 (number of live pups from landings and other sources with 60% mortality) and 92 (maximum pup production estimate with 40% mortality) juvenile seals, given reported mortality rates at their age class.

No issues of accessibility to seal sites were observed in either 2005 or 2010.

In 2005, the extent of the seal pupping season was thought to be July (anecdotal) to December and in 2010 it was found to be at least August to December.

Recommendations

Landings are essential for accurate pup counts and surveys conducted should be as near to the 17 to 23 day optimal window as possible (this represents the period between birth and weaning/moulting to eliminate over counting). Contingency funding for future surveys will make this more achievable considering the highly challenging logistics of conducting these surveys.

Surveys during the 2011 pupping season would establish inter-annual variation in pupping and site fidelity by breeding male and female seals.

The results of this survey may be used to inform Natural England's review of SSSI coverage for grey seals in England through the SSSI Notification Strategy, and particularly the reviews of existing SSSIs in the Isles of Scilly.

The grey seal attribute of 'the extent of breeding, moulting and haul out sites' could be reworded for increased clarity.

Additional training on seals could be provided for boatmen, as a follow up to WiSe training provided in March 2010.

Acknowledgements

This report summarises research commissioned by Natural England under contract reference SWR/CONTRACTS/10-11/15. Natural England's nominated officer was Sangeeta McNair.

The surveys represented a considerable team effort by numerous people.

Permission to conduct surveys was granted by Natural England and Dave Mawer of the Isles of Scilly Wildlife Trust. Steve Hicks of the Isles of Scilly Boatman's Association was kept informed of survey activities.

Seal specialist boat services were provided by Dave McBride of Tiburon Boating / Dive Scilly.

Health and safety cover was provided by Sarah McBride on the Isles of Scilly and Dave Jarvis in Cornwall. Insurance was organised by Ba Whitehead of Cornwall Wildlife Trust.

Cornwall Seal Group members provided additional volunteer survey and landing support.

British International Helicopters, the Heliport Shuttle and Airport staff ensured our safe commute to and from the Islands.

We are grateful to Sarah McBride and the rest of her family for their excellent hospitality, encouragement, flexibility and support.

Proof reading various manuscript revisions was done by Roger Covey, Rob Enever, Sangeeta McNair and Julie Webber at Natural England. Stephen Westcott provided additional feedback and revisions to the manuscript.

We are grateful to everyone who assisted with these surveys and resulting report.

Contractors

Sue Sayer and Kate Hockley

Cornwall Seal Group

www.cornwallsealgroup.co.uk

Technical assistance

Dr Matthew J. Witt and Dr Brendan J. Godley

University of Exeter

http://biosciences.exeter.ac.uk/cec/

Contents

Appendices

List of tables

List of figures

List of plates

1 Introduction

1.1 Special Areas of Conservation (SACs) were established under the European Union's Habitat's Directive 1992 to protect Europe's best examples of specified habitats and species. SAC sites for the Annex II species the grey seal (*Halichoerus grypus*), reflect both the largest breeding colonies, based on pup production, as well as the geographical range of breeding sites. The Isles of Scilly was designated a European Marine Site (EU code UK0013694) in 1996, with the grey seal, as one of its named features. SAC features, such as the grey seals on the Isles of Scilly, should ideally be monitored within the same year, and certainly within a three-year period. The minimum standard is to monitor once every six years (JNCC, 2005) to ensure that the conservation objectives for seals are being met in relation to the assessment attributes and to enable reporting to Europe. Information on monitoring methods for marine mammals is contained in the guidance manual on Common Standards Monitoring (CSM) Guidance for Marine Mammals, JNCC (2005).

1.2 A condition assessment of marine mammal interest features should be based on essential attributes, which for grey seals are described in CSM (JNCC, 2005) as:

1) Pup production

Also of interest are:

- The number of breeding females - females are assumed to give birth to one pup in any one breeding season, pup production can be used as a suitable indicator of breeding female abundance.
- Mortality in the breeding colonies – for newborn pups this can be as high as 15%, with a further mortality rate of between 40 and 60% occurring within 12 to 18 months of birth.

Possible methods for measuring the pup production are either using aerial photo-monitoring or direct counts from boat or shore.

2) The distribution of grey seal pups

The most practical method of assessing the distribution of pups is by displaying aerial photographs in a Geographical Information System (GIS) or direct mapping from boat or shore.

3) Accessibility of SAC sites for breeding

- Seals require free access to and from their breeding colonies throughout the course of the breeding season. Restrictions to this access are likely to deter seals from using a site and may result in a reduced pup production.
- Habitat quality and extent. Some shore sites are not used by grey seals despite appearing to have ideal characteristics. More investigation is required to explain this.

1.3 Two additional attributes are monitored for grey seals in the Isles of Scilly condition review:

4) Disturbance, using reduction in seal numbers during surveys or displacement.
5) Extent of breeding, moulting and haul out sites measured in terms of total area.

2 Location

2.1 The Isles of Scilly is an archipelago situated 28 miles (45 km) from Land's End on the south west peninsular of England and it is the most south westerly part of the British mainland. The Isles of Scilly consists of over 200 low-lying granite islands and rocks.

2.2 The Isles of Scilly is nationally important for its rich biodiversity and unique natural environment, recognised through its designation as an Area of Outstanding Natural Beauty (AONB), a Conservation Area and a Heritage Coast. In addition, there are several nature conservation designations reflecting the importance of these features - 26 Sites of Special Scientific Interest (SSSI), many of which form part of the Isles of Scilly Special Protection Area (SPA), a Ramsar site for breeding seabirds and a Marine Special Area of Conservation (SAC).

2.3 The three main areas providing habitat for grey seals are the Western Rocks, Northern Rocks (Norrards) and the Eastern Isles are shown in Figure 1.

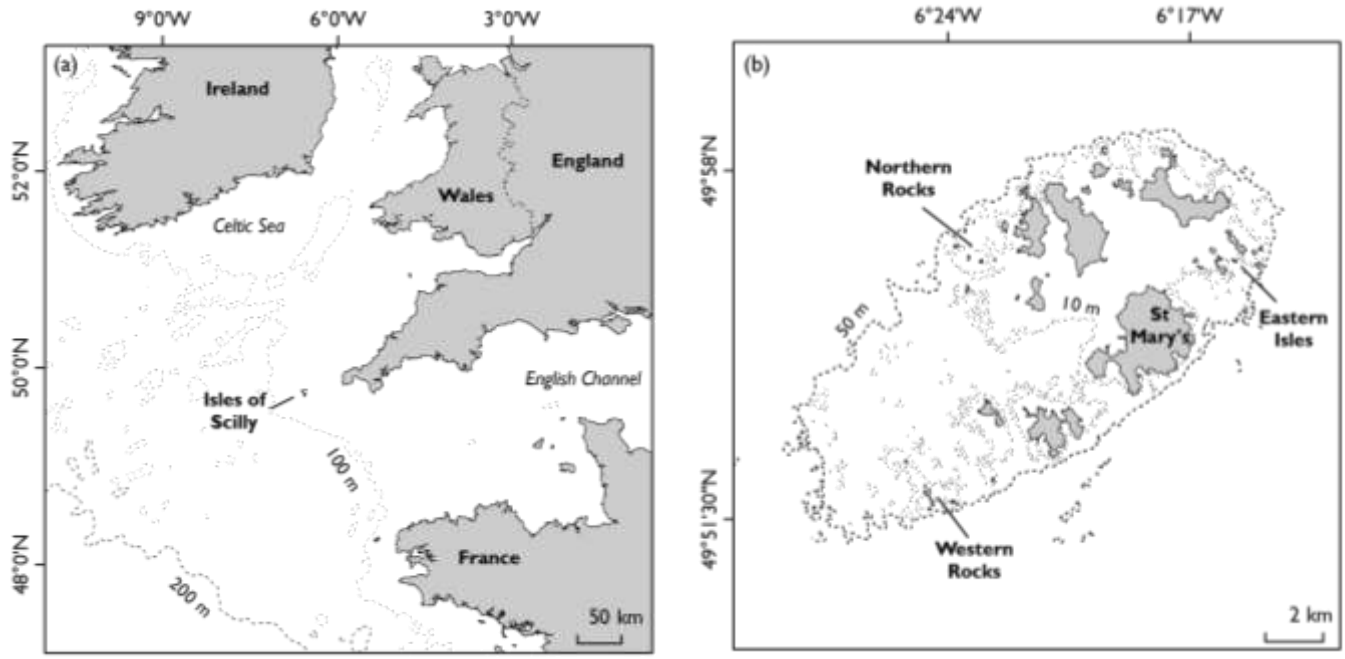

Figure 1 Maps showing the location of the Isles of Scilly and the three main seal areas

3 Aims and objectives

Aims

3.1 In July 2010, Natural England contracted Cornwall Seal Group (CSG) to monitor grey seals on the Isles of Scilly, funding a minimum of four and a maximum of six boat and land based surveys. The aim of this study was to conduct a full and thorough repeat of the seal surveys carried out in 2005 using the same methodology and to highlight differences, potential limitations, offer possible explanations for observed patterns and to make recommendations for the future.

Objectives

1) To adopt the survey methodology detailed in the procedural guidelines for studying grey seals in southwest England (Westcott, 2008).
2) To conduct a comprehensive survey of the grey seal population breeding on the Isles of Scilly in 2010, in particular:

- To identify and survey the sites where seal pups were born.
- To count the number of pups born.
- To follow the fate of individual pups for the duration of the survey period, as feasible.
- To obtain identification photographs of seal mothers and of male seals present in the vicinity of the nursery sites and to ensure the information is readily available for comparison with known individuals by establishing an electronic library of the breeding population.
- To make low tide counts of seals in each island group, noting sex and age.
- To monitor levels of disturbance encountered, both at nursery sites (including by researchers) and at other seal haul-out sites in the archipelago.
- Noting the WiSe training carried out on St Mary's in March 2010, if appropriate, make recommendations to the Isles of Scilly Wildlife Trust and Natural England designed to ameliorate potential disturbance.

3) Analyse collected data to establish numbers of pups and pupping females, identify pupping and haul out sites, and detail grey seal use of the different areas round the islands.
4) Produce a final report and data sheets and a separate electronic photo library.

3.2 The results from this monitoring activity will inform the site managers of any changes that may be required for the future management of the SAC, as well as providing data to thoroughly cover the full range of CSM attributes, to enable NE to make a judgement on the Favourable Conservation Status (FCS) of this feature *i.e.* condition assessment of grey seals. This report has been produced to inform managers and to allow others to review the work, as well as to develop and adapt monitoring programmes for this and other SACs.

4 Method

2005 survey by Westcott (2008)

4.1 In 2005, Westcott undertook a discrete partial pup production survey, published as part of a wider project compiling the Procedural Guidelines for studying seals in southwest England, 2006 (Westcott, 2008). Between 14/08/05 and 11/09/05, visits were intended five times a week to grey seal sites. Most visits were made to the nursery sites on the Western Rocks and Norrards, in order to count pups, track their development and photograph adult seals observed in the vicinity. One visit per week was made to the Eastern Isles with the main intention of monitoring any disturbance of the seals. Pups were sprayed, aged, coded, observed and adults counted, aged and sexed. Additional disturbance records were made from the Eastern Isles. Westcott reported that white-coated pups had been seen between July and October in some years by boatmen and that pups could be born in November or even December, as happened in west Cornwall. Due to the availability and nature of survey transport used, seal counts were only possible over a small number of islands in one day. This survey method was used to maximise the accuracy of pup counts, rather than seal numbers. Images of 20 mothers and 7 attendant males were added to a newly inaugurated SCILPHOT catalogue.

2010 survey by Cornwall Seal Group

4.2 In July 2010, Cornwall Seal Group (CSG) was contracted by Natural England to conduct a pup production survey for the Isles of Scilly. Given that Westcott (2008) thought the pupping season lasted from July (anecdotal) to December, it was necessary to extend the surveying period from Westcott's original monitoring of 14/08/05 and 11/09/05. Initially, Natural England funded four surveys, but subsequently extra funding was made available for up to two additional surveys. CSG had funded and conducted a boat-based Isles of Scilly seal survey on 17/07/10, where no white coated pups were observed. As it was now necessary for the surveying period to last at least 5 months, it was not possible, cost effective, best value or desirable in winter conditions, to undertake island landings by a lone surveyor on a wave ski. CSG had conducted preliminary surveys of islands where pups had been seen by Westcott in 2005 (Island Eleven, Island Twenty four, Island Nine, Island Two, Island Twenty five and Island Five) on 17/07/10. From this it was decided that landing on Island Two was not necessary, as much of the island could be viewed from the sea. It was considered essential to land on Island Eleven, Island Twenty four and Island Five because of their steep geographical profile and large boulder beaches. Landings on Island Nine and Island Twenty five were considered too dangerous. Recent experience from the 2009 pupping season surveys conducted by CSG (funded by the IoS AONB Partnership) indicated that Island Thirty one (Island Thirty five SSSI) was an important pupping island. Island Thirty one was originally thought to be low and flat enough to make landings unnecessary, but during the September 2010 boat-based survey six pups were seen. As such, Island Thirty one was subsequently added to the landings survey schedule. In 2005, Westcott used dye marking of pups to avoid double counting and to identify inter island movements. Whilst dye was considered ethical (no mother pup bonds disturbed) and mainly helpful (occasional disturbance of mothers and poor adhesive quality) by Westcott (2008) it was only the faintest of colour shadows after 5 days and faded completely within 10 days, so was considered an unsuitable survey method for 17 day intervals and unnecessary due to the enhanced survey methodology to be adopted in 2010. In order to make it possible to estimate the total number of seals observed across the Isles of Scilly, the seal counting techniques utilised in 2005 were enhanced. A systematic route was planned to be taken by boat, covering the three main seal pupping areas (the Western Rocks, Eastern Isles and Norrards) and additional coastline in between.

Survey frequency

4.3 Pup counts were to be conducted once every three weeks, from prior to the start of the pupping season until after the end of the pupping season to ensure complete and thorough coverage of the extent of pupping. Female grey seals give birth to a single white coated pup which they suckle for 17 to 23 days (SCOS 2009). Pups moult their white natal coat around the time of weaning (SCOS 2009). More frequent surveys increase seal disturbance at their most vulnerable time, with possible increases in pup mortality associated with broken maternal bonds and less frequent surveys increase the complexity of calculating pup production estimates. During the first survey, all white coated pups (2 to 3 weeks old) and fully moulted pups (over 3 weeks old) were counted. During subsequent surveys at around three week intervals, all previously counted white coated pups were expected to have fully moulted, so only white coated pups were added to the previous totals, to provide a cumulative number of unique pups encountered. Between August and December 2010, five boat-based seal surveys using the same platform were conducted along with, weather and sea state permitting, land based pup counts on four key pupping islands. As discussed, these islands were identified from a previous report by Westcott (2008), recent local knowledge and a preliminary assessment of safe landing potential carried out by CSG in July 2010. Where the survey interval was greater than the optimum, adjustments were made using different calculation methods to estimate the likely number of missed pups, to produce a pup production estimate with a moderate level of reliability (JNCC 2007; refer to Appendix 11).

Survey planning

4.4 Appropriate permissions to undertake survey work were obtained from Natural England and the Isles of Scilly Wildlife Trust. The Boatman's Association were also informed of planned survey activities. Suitable days with low tides during daylight hours between 01/08/10 and 31/01/11 were identified as potential survey slots and personnel were put on standby. Weather and sea conditions were constantly monitored for low wind (less than 10 knots) and swell conditions (less than 1.5m) around St Martin's and St Mary's. When at least two days of calm weather were forecast, key personnel were informed, flights and accommodation booked, health and safety briefing procedures initiated and survey equipment mobilised.

Boat-based counts of all seals

4.5 An experienced and licensed Isles of Scilly boatman with a specialism in seals and navigation of the shallow and complex waters of the Isles of Scilly was accompanied by at least three trained seal surveyors following a pre-determined route around the islands. As it was not possible to achieve full coverage of the entire Isles of Scilly coastline within a six hour window (three hours either side of low tide) even over two days, a route was devised to ensure full coverage of all three of the main areas of seal haul out habitat around the entire Eastern Isles, Norrards and Western Rocks, along with as much additional coastline as was feasible within the tide window. Boat survey routes were recorded using a Garmin GPSMAP 60CSx marine mobile hand-held GPS receiver. Boat surveys were carried out over two consecutive days, within a window of three hours either side of low tide in sea states less than four, at a maximum speed of five knots and at a slow, no wake speed when in proximity to seals. The boat remained at a distance from the seals to minimise disturbance with only a subsequent closer approach made once seals were acclimatised to the presence of the boat and only where seals' reactions and safety permitted. Decisions were made prior to leaving harbour about which survey areas were most suitable to visit first – usually based on the prevailing wind direction forecast over the two day period. On days with an easterly wind, the Western Rocks and Norrards would be preferentially surveyed, whilst the Eastern Isles were surveyed when westerly winds made conditions calmer there. Once on board, the lead surveyor issued life jackets and the boatman gave all surveyors a safety briefing. The lead surveyor allocated roles to the other survey team members – seal spotters, data recorder and where possible photographers to facilitate photo identification. Seal spotters alerted the lead surveyor to the presence of seals. Firstly the lead surveyor counted the maximum number of seals in and out of the sea, then sexed and aged them, counting the

predominant adult sex first, followed by juveniles and then the secondary adult sex remaining. The method of recording enabled errors to be easily identified and rectified when transferring results to digital format. To limit confusion, the recorder was instructed to only record information from the lead surveyor and it was necessary for both people to remain in close proximity to avoid disturbance. Where large numbers of seals were observed, photographs were taken to enable retrospective counting, ageing and sexing of seals (Plate 1). The data recorder collected key survey data and all environmental conditions in consultation with the boat and survey team. A GPS was used to obtain way points (Latitude, Longitude, WGS84) for any seals being recorded. To assist with data collection / analysis and in case of GPS failure, the Isles of Scilly were divided into 67 island sites each with its own unique reference number which was also recorded. Additional information was then recorded about previously identified threats to the seals, such as the number of seals observed that were net entangled, disturbed into the sea, being fed by humans or dead, along with any other interesting features, such as the presence of a common seal.

From the boat 78 seals were counted as hauled and 2 in the sea
From the photo, 79 seals were retrospectively counted as hauled and 2 in the sea

Plate 1 Photo of seal haul out on Island Eleven, individuals annotated with ‘count’ tool

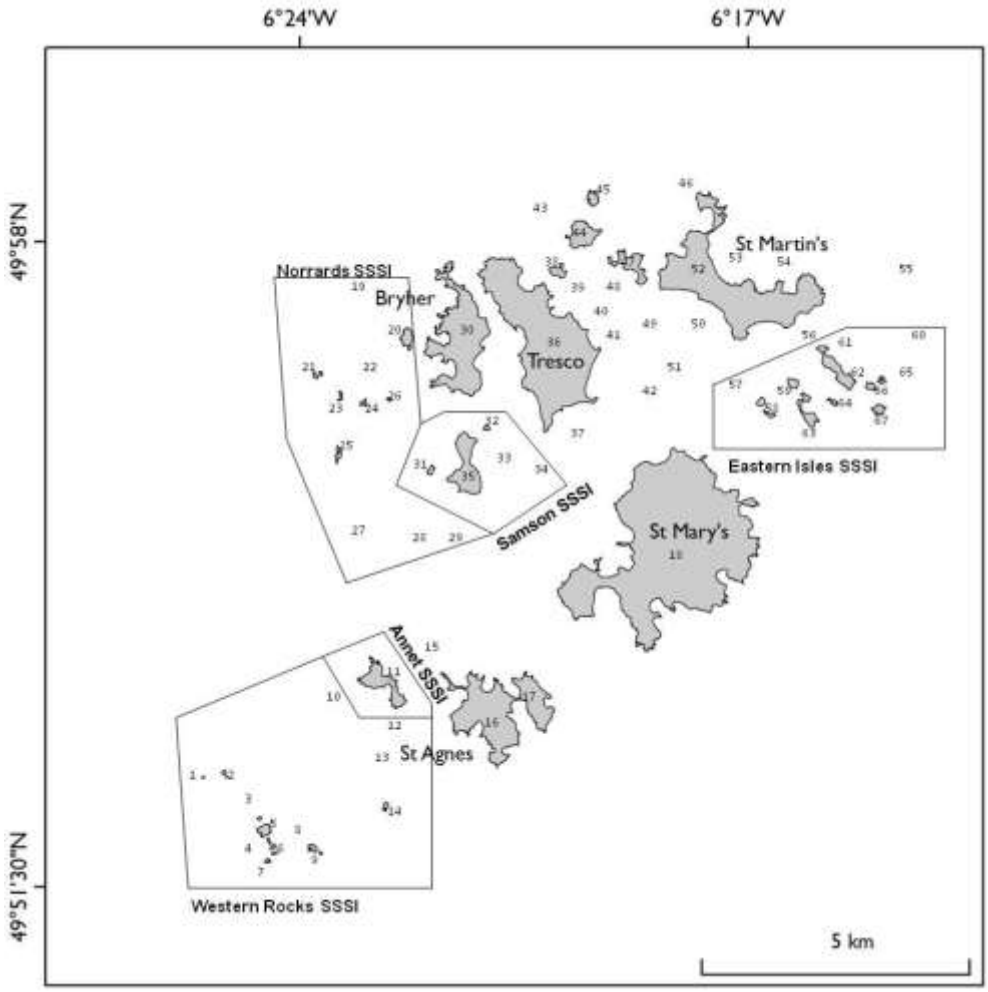

Figure 2 Map of Isles of Scilly showing SSSI areas most relevant to seals

Land based counts of pups

4.6 From surveys undertaken in 2005 by Westcott (2008) and by Sayer *et al* (2011) during the pupping season of 2009, four islands were identified as key pupping sites where safe landings were possible – Island Eleven, Island Twenty four, Island Five and Island Thirty one (off Island Thirty five). Decisions about the timing of landings were less tide dependent with the majority of pups being found above the water line, even above the highest astronomical tide level. A small number of pups were recorded in the sea. Priority was placed on health and safety issues when making decisions about whether to land on these remote rocky islands, followed by survey boat proximity, the amount of time remaining within the low tide window (to complete boat-based surveys) and on the swell conditions around the island. An island landing team was comprised of a minimum of two surveyors. Landing teams were issued with health and safety and survey equipment prior to accessing the tender, including a two way radio and mobile phone for communication between landing and boat personnel. At all locations a small inflatable tender was used to access a suitable landing location. Landings on Island Five and Island Twenty four were considered the most challenging, so survey personnel wore wet or dry suits for landing, whilst a dry landing was usually possible on Island Eleven and Island Thirty one. Island Eleven, being the largest of the islands, required as many surveyors to land as possible and a minimum of two hours to complete a full circuit of the island with two paired survey teams covering different pre-arranged sections of the island. Once a pup was sighted it was allocated a sequential number and its location was recorded either by GPS or on a map. It was then coded in three ways – stage, week and best fit method and photographs were taken where possible. To ensure data backup and to prevent double counting, each pup's details were reported to boat personnel by radio.

Pup Stages

1 Umbilicus – chip with neck

2 Fat (not barrel)

3 Barrel - white

4 Barrel - moulting

5 Barrel - moulted

Dead pups : Weeks

1 White and thin/small teeth

2 White and fat/teeth well through

3 Week 3 Partly moulted

Pup weeks

Week 1(Thin or slightly fat)

1a Umbilicus & neck

1b Slightly fat

Week 2 (Fat)

2 Fat (may even be a bit of moult)

Week 3 (Barrel)

3a Barrel (**white**)

3b Barrel (**moulting**)

3c Barrel (**moulted**)

Best fit code

Code	Umbilicus	Teeth	Pelage	Fatness	Demeanour
1	Present in any form	Gums only or tiny	White	Thin	Wobbly and lacking shoulder strength
2	None	Medium/Large	White with possibly some moult	Fat	Mother in control
3	None	Large	Moulting or moulted	Very fat	Pup in control. Rock pooling. Independent. Exploring.

Figure 3 Pup coding classes – stages, weeks, best fit

Plate 2 Landing team being closely watched by a curious seal

Post survey results collation

4.7 Safety contacts were informed of the survey team's safe arrival back at the harbour. A meeting was convened after returning to the accommodation, to collate records for boat-based seal counts for each island where seals had been observed and to confirm pup codings and GPS or map locations from land based surveys. Photographs were analysed for sites where large seal numbers had made counting, sexing and ageing difficult using the count tool in Adobe Photoshop and secondly to identify at least one photo of each individual seal pup observed. After the data collation, files were transferred onto the lead surveyors laptop and memory stick for back up.

5 Results

5.1 A total of five boat-based counts were completed between 27/08/10 and 12/12/10 (Table 1). Landings were only possible on Island Twenty four and Island Five during the August survey (although no seal pups were observed from the boat, or mothers in the sea around Island Eleven Eleven and Island Thirty one during the boat-based survey) and a complete set of four landings per survey were completed during all four remaining surveys. No survey was possible during January 2011, as no two day window of suitable weather and sea conditions occurred during days with low tide during daylight hours.

Survey details

Table 1 Survey details

Survey	Date	Areas surveyed	Landings	Sea force	Wind force	Wind Direction	Surveyors
1	27/08/10	Eastern Isles	None	Choppy	Breeze	NNW	Boatman, surveyors 1, 2, 3 and 4
1	28/08/10	Western Rocks and Norrards	Island 24 Island 5	Choppy	Breeze	N	Boatman, surveyors 1, 2, 3 and 4
2	17/09/10	Eastern Isles	None	Choppy	Breeze	NE	Boatman, surveyors 1, 2, 3 and 5
2	18/09/10	Western Rocks and Norrards	Island 11 Island 24 Island 5 Island 31	Calm	Still	E	Boatman, surveyors 1, 2, 3 and 5
3	16/10/10	Norrards and Eastern Isles	None	Choppy	Breeze	NE	Boatman, surveyors 1 and 3
3	17/10/10	Western Rocks	Island 11 Island 24 Island 5 Island 31	Choppy	Still	N/A	Boatman, surveyors 1, 2, 3 and 4
4	23/11/10	Western Rocks	Island 24 Island 5 Island 31	Calm	Breeze	E	Boatman, surveyors 1, 6 and 7
4	24/11/10	Norrards and Eastern Isles	Island 11	Choppy	Breeze	NNW	Boatman, surveyors 1, 6 and 7
5	10/12/10	Western Rocks and Eastern Isles	Island 5	Calm	Still	NW	Boatman, surveyors 1, 6 and 7
5	11/12/10	Norrards	Island 11 Island 24	Calm	Breeze	NE	Boatman, surveyors 1, 5, 6 and 7
5	12/12/10	None	Island 31	Choppy	Windy	E	Boatman, surveyors 1, 5, 6 and 7

Survey frequency

5.2 The ideal survey interval was 17 to 23 days, but surveys were tide, sea condition and weather dependent. As such, achieving this optimum interval was immensely challenging (Table 2). There were only two suitable tide windows during daylight hours each month of between 8 days (in August) and 5 days (In December) duration, within which optimal sea and weather conditions had to coincide for a survey to be viable.

Table 2 Duration of time in days between surveys

Survey start date	No. of days between surveys
28/08/2010	
17/09/2010	19
16/10/2010	29
23/11/2010	37
10/12/2010	17
Mean	26
Standard deviation	9

Boat-based seal counts: Isles of Scilly

5.3 GPS tracks of the five boat-based seal counts demonstrate the coverage of the three main seal areas on the Isles of Scilly – the Eastern Isles, the Norrards and the Western Rocks (Figure 4).

5.4 Seal numbers increased during the survey period from 331 (Aug) to 763 (Dec) seals (507 ± 177 mean ± 1 s.d.) This difference in seal numbers (Table 3) most likely reflects seasonal (intra-annual) variation in the number of seals observed on the Isles of Scilly.

Figure 4 Map showing spatial distribution of seals using density shading and GPS tracks

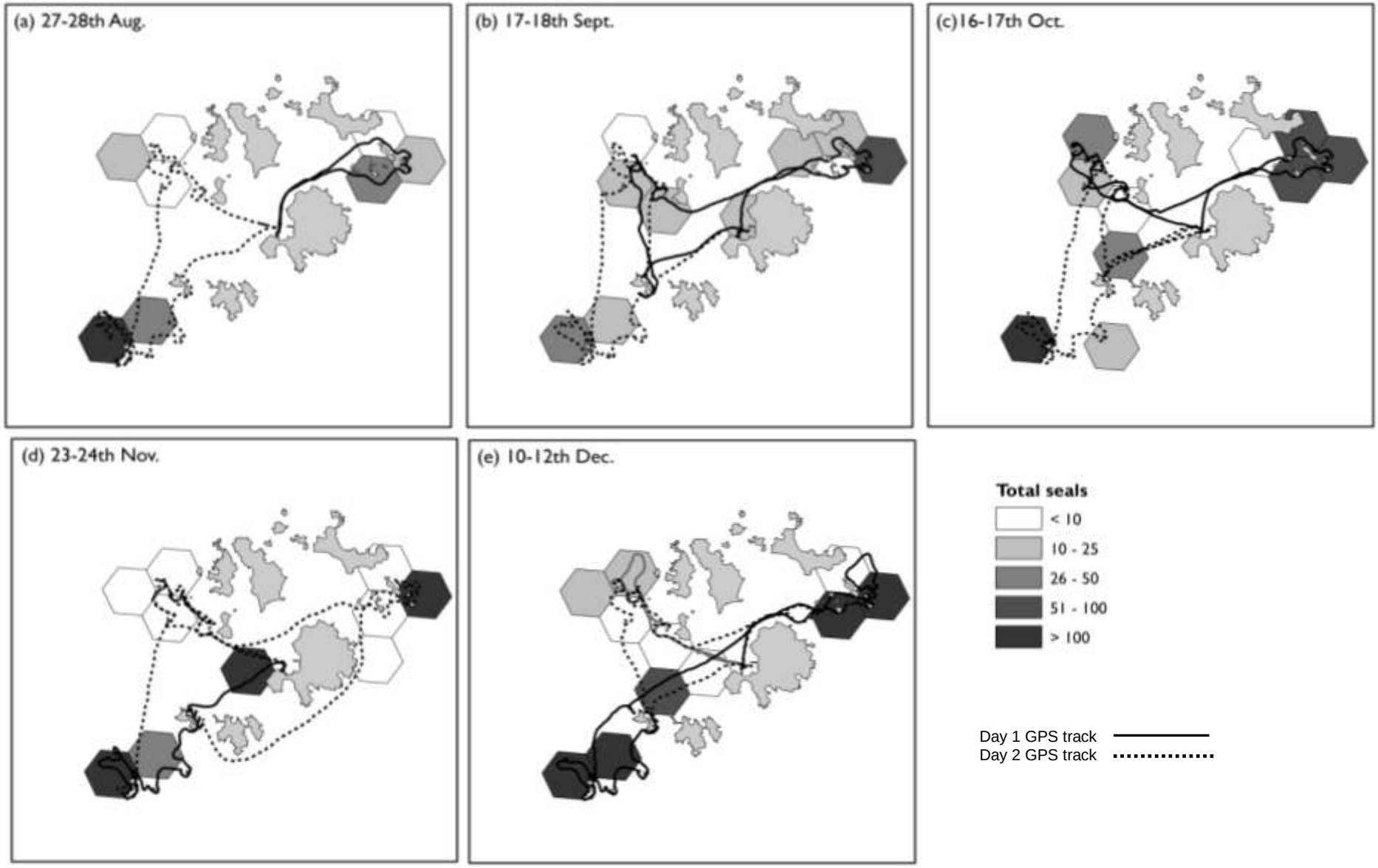

Table 3 Seal numbers observed from boat based counts

Survey	Month	Total (Max no. of seals seen)	Incl no. of seals hauled out	Including no. of seals in sea	Adult MALE	Adult FEMALE	Juvenile TOTAL	Weaners/Moulters	White coat pups	Unknown sex/age	Including no. net entangled	Number of seals disturbed into sea
1	Aug	331	252	79	132	101	84	0	2	12	5	33
2	Sep	358	269	89	123	114	107	0	10	4	4	46
3	Oct	495	424	71	167	174	134	0	9	11	4	68
4	Nov	587	491	96	247	178	122	8	11	24	5	71
5	Dec	763	654	109	308	234	210	1	1	9	4	39

(NB. Boat-based weaner, moulter and white coat numbers were included for completeness only, please refer to the land based survey sections for pup numbers.)

5.5 All sex and age classes contributed to the overall increase in seal numbers by proportionally the same amount - just over a two-fold increase for adult males and adult females and with a slightly greater increase for juveniles proportionally.

Table 4 Threats and sex ratios summarised from boat based counts

	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
% of adults that were male	57%	52%	49%	58%	57%
% of adults that were female	43%	48%	51%	42%	43%
% live net entangled	1.5%	1.1%	0.8%	0.9%	0.5%
% disturbed into the sea	10%	13%	14%	12%	5%

5.6 More adult males (195 ± 80 mean ± 1 s.d.) were observed than adult females (160 ± 54 mean ± 1 s.d.) and juveniles (131 ± 48 mean ± 1 s.d.) Only at the peak of the pupping season in October did adult females outnumber adult males (Table 5). Only a small number of seals were not sighted well enough to be able to determine their age/sex (unknown age/sex was 12 ± 7 seals per survey; mean ± 1 s.d.). Between four and five different live net entangled seals were recorded during each survey representing approximately 1% of the mean number of seals observed, although these figures gradually decreased during the surveys from 1.5% in August to 0.5% in December 2010. Despite taking considerable care to avoid disturbing seals, a mean of 10% of seals observed hauled out moved into the sea whilst the survey boat was in their vicinity.

Boat-based seal counts: Sites of Special Scientific Interest (SSSI)

5.7 See Figure 2 for a map of all SSSI areas relevant to seals. Most seals (mean ± 1 s.d.) were observed at two SSSI designated areas – the Western Rocks (238 ± 97) and the Eastern Isles (184 ± 81). Important numbers of seals were observed at two other SSSI designated areas – Island Eleven (51 ± 49) and the Norrards (27 ± 12). A small number of seals were also observed at Island Thirty one (5 ± 7) which is part of the Island Thirty five SSSI. Most seals on Island Thirty one were adult females (mothers) and white coated pups (counted during landings). The SSSI areas had differing proportions of males, females and juveniles (Plate 3) – Island Eleven SSSI had proportionally more adult males (68%), Norrards SSSI, Western Rocks SSSI and Island Thirty five SSSI (Island Thirty one) had proportionally more females (42%, 43% and 40%

respectively). The Eastern Isles SSSI had proportionally more juvenile seals (40%) than other sites. These figures are shown in Table 5. Overall when considering total counts, the seal sex ratio was male dominated.

Plate 3 Photos showing seals from each age and sex class

Table 5 SSSI seal numbers observed from boat-based counts (means rounded to one or two significant figures)

Survey months	Total (Max no. of seals seen)	Incl no. of seals hauled out	Including no. of seals in sea	Adult MALE	Adult FEMALE	Juvenile TOTAL	Weaners/Moulters	White coat pups	Unknown sex/age	Including no. net entangled	Number of seals disturbed into sea	Humans feeding seals (Tick if yes)	Strandings if any (Tick if any)
Island Eleven SSSI													
Aug	4	2	2	0	2	2	0	0	0	0	0	0	0
Sep	10	5	5	3	5	0	0	2	0	0	0	0	0
Oct	36	24	12	12	17	3	0	4	0	0	1	0	0
Nov	117	107	10	81	23	0	3	10	0	0	8	0	0
Dec	86	74	12	76	4	4	1	1	0	0	3	0	0
Av	51	42	8	34	10	2	1	3	0	0	2	0	0
Stdev	49	46	4	41	9	2	1	4	0	0	3	0	0
%				68%	20%	4%	2%	7%	0%	0%	5%	0%	0%
Eastern Isles SSSI													
Aug	71	43	28	23	19	26	0	0	3	1	1	0	0
Sep	126	96	30	55	28	40	0	0	3	4	20	0	0
Oct	250	223	27	103	46	95	0	0	6	4	57	0	0
Nov	229	207	22	81	39	91	5	0	13	3	39	0	0
Dec	246	216	30	80	43	118	0	0	5	2	9	0	0
Av	184	157	27	68	35	74	1	0	6	3	25	0	0
Stdev	81	82	3	31	11	39	2	0	4	1	23	0	0
%				37%	19%	40%	1%	0%	3%	2%	14%	0%	0%

Table continued

Survey months	Total (Max no. of seals seen)	Incl no. of seals hauled out	Including no. of seals in sea	Adult MALE	Adult FEMALE	Juvenile TOTAL	Weaners/Moulters	White coat pups	Unknown sex/age	Including no. net entangled	Number of seals disturbed into sea	Humans feeding seals (Tick if yes)	Strandings if any (Tick if any)
Norrards SSSI													
Aug	36	20	16	16	15	3	0	2	0	0	0	0	0
Sep	19	9	10	6	10	2	0	1	0	0	0	0	0
Oct	44	40	4	6	19	13	0	2	4	0	1	0	0
Nov	16	13	3	7	7	1	0	1	3	0	1	0	0
Dec	22	18	4	12	7	3	0	0	0	0	3	0	0
Av	27	20	7	9	12	4	0	1	1	0	1	0	0
Stdev	12	12	6	4	5	5	0	1	2	0	1	0	0
%				34%	42%	16%	0%	4%	5%	0%	4%	0%	0%
Western Rocks SSSI													
Aug	219	186	33	93	65	53	0	0	8	4	32	0	0
Sep	188	149	39	58	64	65	0	1	0	0	24	0	0
Oct	156	130	26	43	89	23	0	0	1	0	8	0	0
Nov	223	164	59	77	109	29	0	0	8	2	23	0	0
Dec	405	346	59	139	180	82	0	0	4	2	24	0	0
Av	238	195	43	82	101	50	0	0	4	2	22	0	0
Stdev	97	87	15	37	48	25	0	0	4	2	9	0	0
%				34%	43%	21%	0%	0%	2%	1%	9%	0%	0%
Island Thirty five SSSI													
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	15	10	5	1	7	0	0	6	1	0	2	0	0
Oct	9	7	2	3	3	0	0	3	0	0	1	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	1	0	1	0	0	1	0	0	0	0	0	0	0
Av	5	3	2	1	2	0	0	2	0	0	1	0	0
Stdev	7	5	2	1	3	0	0	3	0	0	1	0	0
%				16%	40%	4%	0%	36%	4%	0%	12%	0%	0%
Island Sixteen SSSI													
Aug	1	1	0	0	0	0	0	0	1	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
Av	0.2	0.2	0	0	0	0	0	0	0.2	0	0	0	0

Table continued...

Survey months	Total (Max no. of seals seen)	Incl no. of seals hauled out	Including no. of seals in sea	Adult MALE	Adult FEMALE	Juvenile TOTAL	Weaners/Moulters	White coat pups	Unknown sex/age	Including no. net entangled	Number of seals disturbed into sea	Humans feeding seals (Tick if yes)	Strandings if any (Tick if any)
Island Eighteen SSSI													
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	2	0	2	1	0	1	0	0	0	0	0	0	0
Dec	2	0	2	0	0	2	0	0	0	0	0	0	0
Av	0.8	0	0.8	0.2	0	0.6	0	0	0	0	0	0	0
Island Fifty two SSSI													
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	1	0	1	1	0	0	0	0	0	0	0	0	0
Av	0.2	0	0.2	0.2	0	0	0	0	0	0	0	0	0
All areas													
Aug	331	252	79	132	101	84	0	2	12	5	33	0	0
Sep	358	269	89	123	114	107	0	10	4	4	46	0	0
Oct	495	424	71	167	174	134	0	9	11	4	68	0	0
Nov	587	491	96	247	178	122	8	11	24	5	71	0	0
Dec	763	654	109	308	234	210	1	1	9	4	39	0	0
Av	507	418	89	195	160	131	2	7	12	4	51	0	0
Stdev	177	166	15	80	54	48	3	5	7	1	17	0	0
%				39%	32%	26%	0%	1%	2%	1%	10%	0%	0%

Colours highlight age and sex classes

Boat-based seal counts: Islands

5.8 Seals were observed to frequent some islands more than others (Table 6), with 15 islands having a mean of 10 seals or more per survey. Of these, six islands had a mean of 10 to 20 seals observed, five islands had a mean of 20 to 50 seals observed and four had a mean of over 50 seals observed. These figures enable some prioritisation of seal habitat use within the Isles of Scilly, but it should be noted that considerable variability in numbers existed between surveys, even at the top four sites of Island Sixty seven, Island Sixty six, Island Five and Island Eleven.

Table 6 Island seal numbers observed from boat based counts

Area Code of island	Island	Mean (No. of seals seen)	Standard deviation (No. of seals seen)	Mean no. of seals hauled out	Mean no. of seals in sea	Mean Adult MALE	Mean Adult FEMALE	Mean Juvenile TOTAL	Mean Weaners/Moulters	Mean White coat pups	Mean Unknown sex/age	Mean no. net entangled	Mean of seals disturbed into sea
67	Island Sixty seven	85	23	76	9	26	16	39	1	0	2	2	7
66	Island Sixty six	58	45	52	6	13	16	27	0	0	3	1	10
5	Island Five	51	57	43	8	7	38	4	0	0	1	0	5
11	Island Eleven	51	49	42	8	34	10	2	1	3	0	0	2
6	Island Six	44	7	35	9	18	8	17	0	0	0	0	4
14	Island Fourteen	37	31	29	7	18	11	7	0	0	1	0	2
62	Island Sixty two	29	35	24	5	26	1	2	0	0	1	0	6
2	Island Two	27	11	20	7	5	17	4	0	0	1	0	4
1	Island One	21	23	18	3	9	9	2	0	0	0	0	5
7	Island Seven	19	10	14	5	7	5	7	0	0	1	0	1
9	Island Nine	19	19	16	3	7	3	8	0	0	0	0	2
3	Island Three	18	11	17	2	5	13	1	0	0	0	0	0
8	Island Twenty one	15	11	13	2	5	6	4	0	0	1	0	0
21	Island Eight	15	12	13	2	10	2	3	0	0	0	0	1
31	Island Thirty one	12	4	9	4	2	5	0	0	5	1	0	2
63	Island Sixty three	5	3	2	3	1	1	2	0	0	0	0	1
64	Island Sixty four	5	5	3	2	1	1	3	0	0	0	0	2
24	Island Twenty four	5	3	1	3	1	2	0	0	1	1	0	0
51	Island Sixty one	4	3	1	3	1	0	3	0	0	0	0	0
25	Island Twenty five	4	2	2	1	1	2	0	0	0	0	0	0
23	Island Twenty three	3	2	3	1	3	0	0	0	0	0	0	0
22	Island Twenty two	3	1	2	0	0	2	0	0	0	0	0	1
58	Island Fifty eight	3	2	0	3	1	1	0	0	0	0	0	0
65	Island Sixty five	3	2	2	1	1	0	2	0	0	0	0	0
59	Island Fifty nine	2	N/A	0	2	1	1	0	0	0	0	0	0
18	Island Eighteen	2	0	0	2	1	0	2	0	0	0	0	0
60	Island Sixty	2	1	1	1	1	0	1	0	0	0	0	0
35	Island Thirty five	1	N/A	0	1	0	0	1	0	0	0	0	0
16	Island Sixteen	1	N/A	1	0	0	0	0	0	0	1	0	0
52	Island Fifty two	1	N/A	0	1	1	0	0	0	0	0	0	0
	Grand Mean	23	31	19	4	9	7	6	0	0	1	0	2

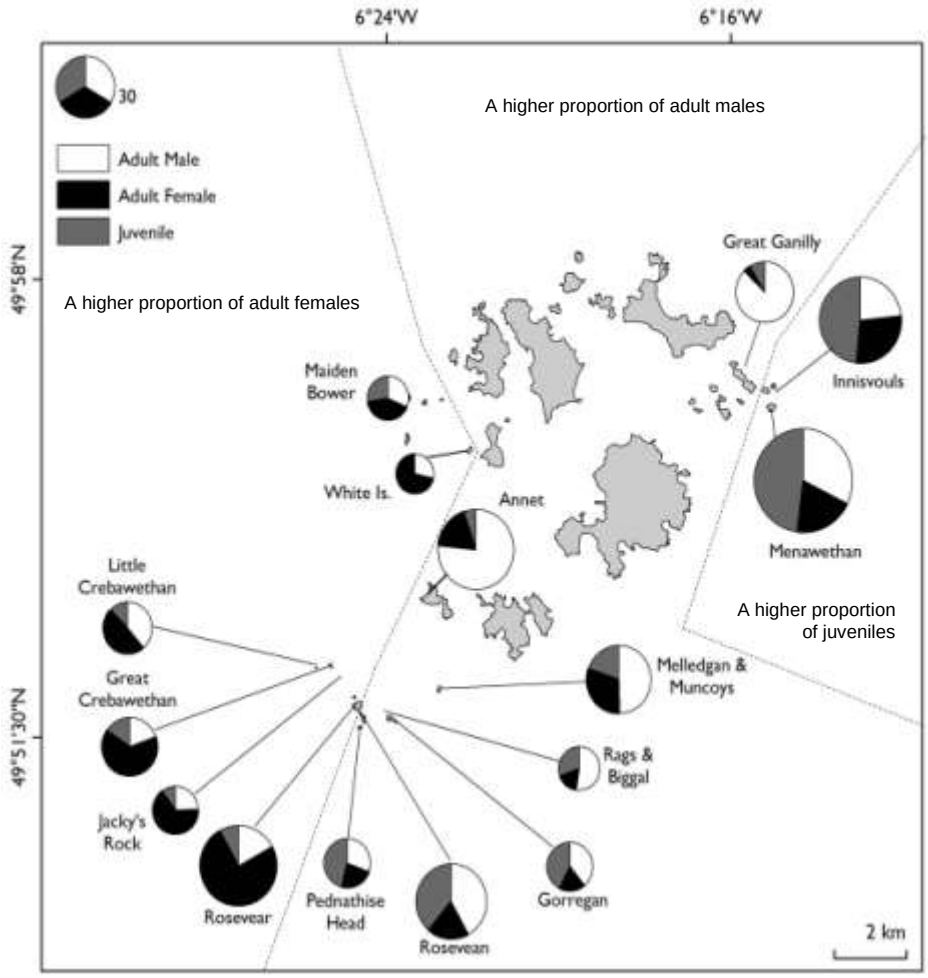

Figure 5 Map of top 15 seal sites showing mean seal numbers and age / sex ratios

5.9 A pattern was observed in the spatial distribution of seal age and sex ratios during the pupping season (Figure 5). Island Eleven, Island Fourteen, Island Sixty two and Island Eight were adult male dominated, whilst Island Five, Islands One, Island Two, Island Three, Island Twenty one and Island Thirty one had a greater proportion of adult females (Plate 4). Overall, the northern and western islands in the Western Rocks SSSI and Norrards SSSI had greater female sex ratios, whilst the inner islands of the Western Rocks SSSI had higher proportions of males. The two islands with the greatest proportions of juveniles were in the Eastern Isles SSSI. One exception was Island Seven, which had a high proportion of juveniles.

Plate 4 Photo of two adult females hauled out, one net entangled

Land based pup counts

5.10 During the five surveys, 85 unique alive and dead pups were observed on the four islands surveyed by landings (landings were not possible on Island Eleven and Island Thirty one in August, but this did not greatly affect pup production estimates, this being at the start of the pupping season.) The total number of unique pups was calculated by subtracting the total number of fully moulted pups (red) from the total number of pups observed. Moulted pups can remain at their natal site for differing periods of time and up to 29 days (Fedak and Anderson 1982) before leaving to embark on their post weaning dispersal. This explains why the number of fully moulted pups one month is less than the number of white coated pups the previous month (Table 7).

Table 7 Pup numbers observed from landings

	27&28 Aug	17&18 Sep	16&17 Oct	23&24 Nov	10, 11&12 Dec	Total
Total pups observed	2	25	51	28	15	121
Fully moulted pups	0	2	13	12	9	36
Total unique pups alive/dead observed (not including moulters)	2	23	38	16	6	85
Dead pups	1	3	1	1	0	6*
Total unique pups alive observed (not including moulted pups)	1	20	37	15	6	79

Extent of the pupping season

5.11 Based on data collected, the pupping season extended from at least August until December with the peak months being October, followed by September and November (Figure 6). Most pups were observed on Island Eleven and least on Island Twenty four (Figure 7). Island Twenty four was the only island where pups were observed during all five surveys with Island Eleven and Island Five being used for pupping for four months between September and December and Island Thirty one only being used for two months in September and October (Figure 8). All four islands provided important habitat for pupping.

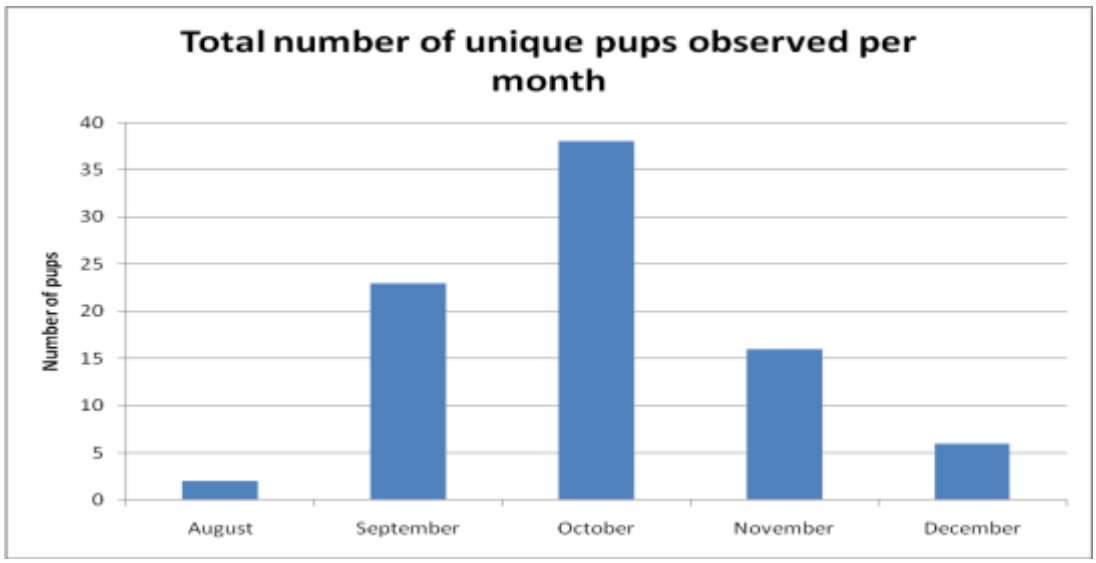

Figure 6 Graph showing the monthly distribution of unique seal pups counted from landings

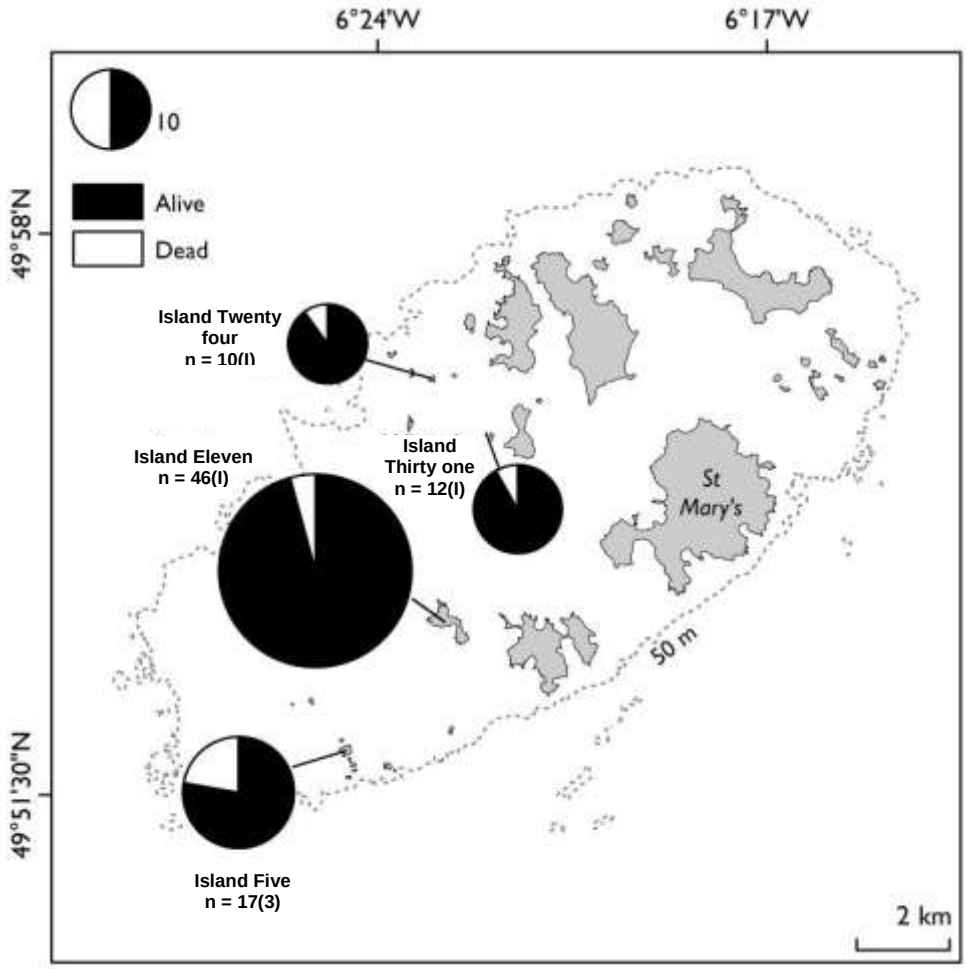

Figure 7 Map showing number of unique alive/dead seal pups observed from landings

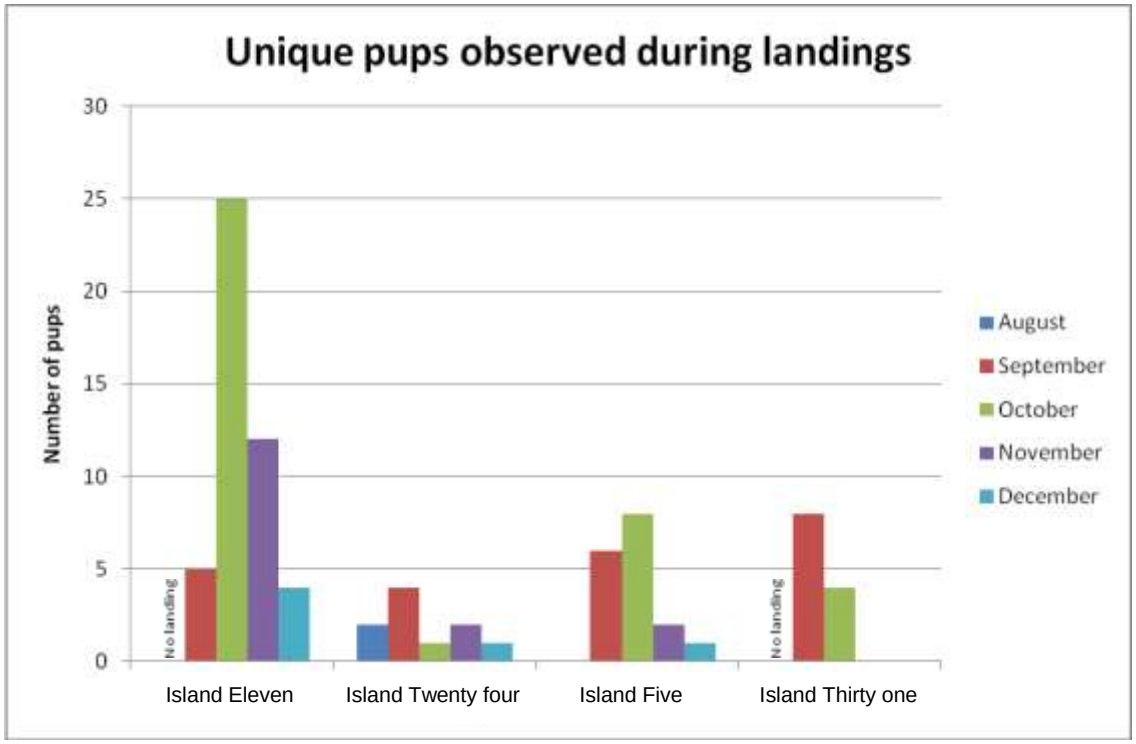

Figure 8 Graph showing the monthly distribution of unique seal pups seen per island

Pup mortality rates during lactation

5.12 In total, eight dead pups were counted, but two of these seen in December (one on Island Eleven and one on Island Five) had been counted during previous surveys. So only six* (Table 7) unique dead pups were observed, representing a mortality rate of 7%. Mortality rates varied across the islands, being highest on Island Five and lowest on Island Eleven (Figure 9). Please see Appendix 5 for data table.

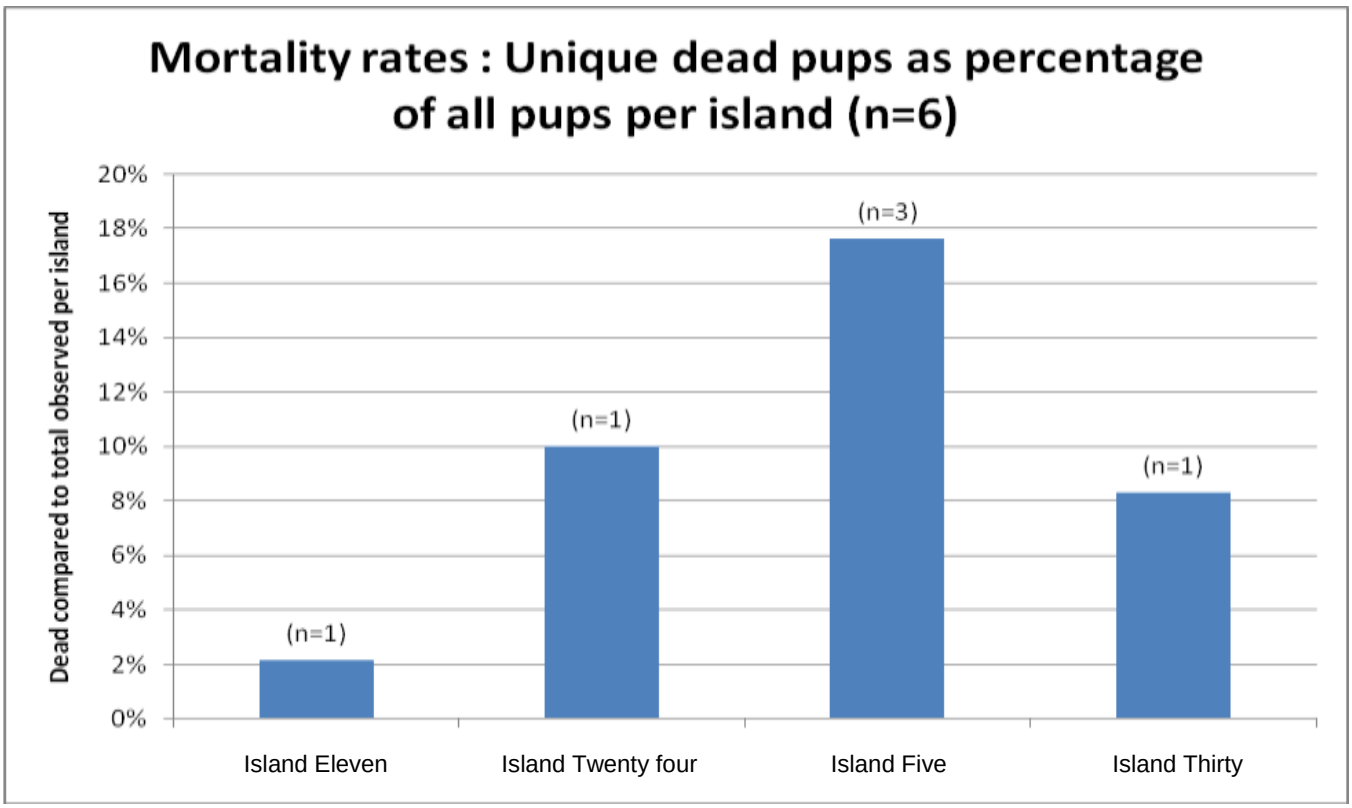

Figure 9 Graph showing pup mortality rates during lactation period

Pup stages and ages

5.13 All 115 alive and six dead (85 unique and 36 moulted) pups observed were classified according to their stage, week and best fit code (Plates 5 to 8; Tables 8 to 11). To identify only unique pups, all 36 stage five or week 3c pups were discounted as they were fully moulted and could have been present during previous surveys. Pups at all stages and weeks of development were observed from new born pups, lying adjacent to probable birthing stones, up to very fat, fully moulted and weaned pups.

Plate 5 Photos illustrating different stage codes for pups

Table 8 Pup stage codes observed from landings

Stage	Aug	Sep	Oct	Nov	Dec	Total
1	1	13	6	0	1	**21**
2	0	6	14	3	0	**23**
3	0	1	6	11	3	**21**
4	0	0	11	1	2	**14**
5	0	2	13	12	9	**36**
Total	**1**	**22**	**50**	**27**	**15**	**115**

Plate 6 Photos illustrating the different week codes for pups

Table 9 Different pup week codes observed from landings

Week	Aug	Sep	Oct	Nov	Dec	Total
1a	0	6	5	0	1	**12**
1b	1	5	4	0	0	**10**
2	0	8	11	3	0	**22**
3a	0	1	6	11	3	**21**
3b	0	0	11	1	2	**14**
3c	0	2	13	12	9	**36**
Total	**1**	**22**	**50**	**27**	**15**	**115**

Plate 7 Photos illustrating the different best fit codes for pups

Table 10 Different pup best fit codes observed from landings

Best fit	Aug	Sep	Oct	Nov	Dec	Total
Week 1	1	13	9	0	1	**24**
Week 2	0	6	11	3	0	**20**
Week 3	0	3	30	24	14	**71**
Total	**1**	**22**	**50**	**27**	**15**	**115**

Plate 8 Photos illustrating the different dead pup codes

Table 11 Different dead pup codes observed during landings

Dead	Aug	Sep	Oct	Nov	Dec	Total
Week 1	1	0	1	1	0	**3**
Week 2	0	3	0	0	0	**3**
Week 3	0	0	0	0	0	**0**
Total	**1**	**3**	**1**	**1**	**0**	**6**

No 'Dead week 3' pups were observed

Pup locations

5.14 The location of each pup was recorded using a hand-held GPS receiver or marked on a map by hand and later transformed into WGS84 latitude, longitude coordinates and maps generated. On Island Eleven and Island Thirty one, most seal pups were found on the north and east sides, corresponding with the most shelter from prevailing weather (Figures 10 and 11). On Island Twenty four and Island Five, pups in August and September were found on the island margins and with progressing time (October to December), pups were found in increasingly more central locations (Figures 12 and 13). Most pups were found at unique sites that hadn't been used by pups in previous months and whilst there was a little overlap in popular island areas, the pup space-use appeared to be on an infilling basis rather than a re-use of the same site within the pupping season.

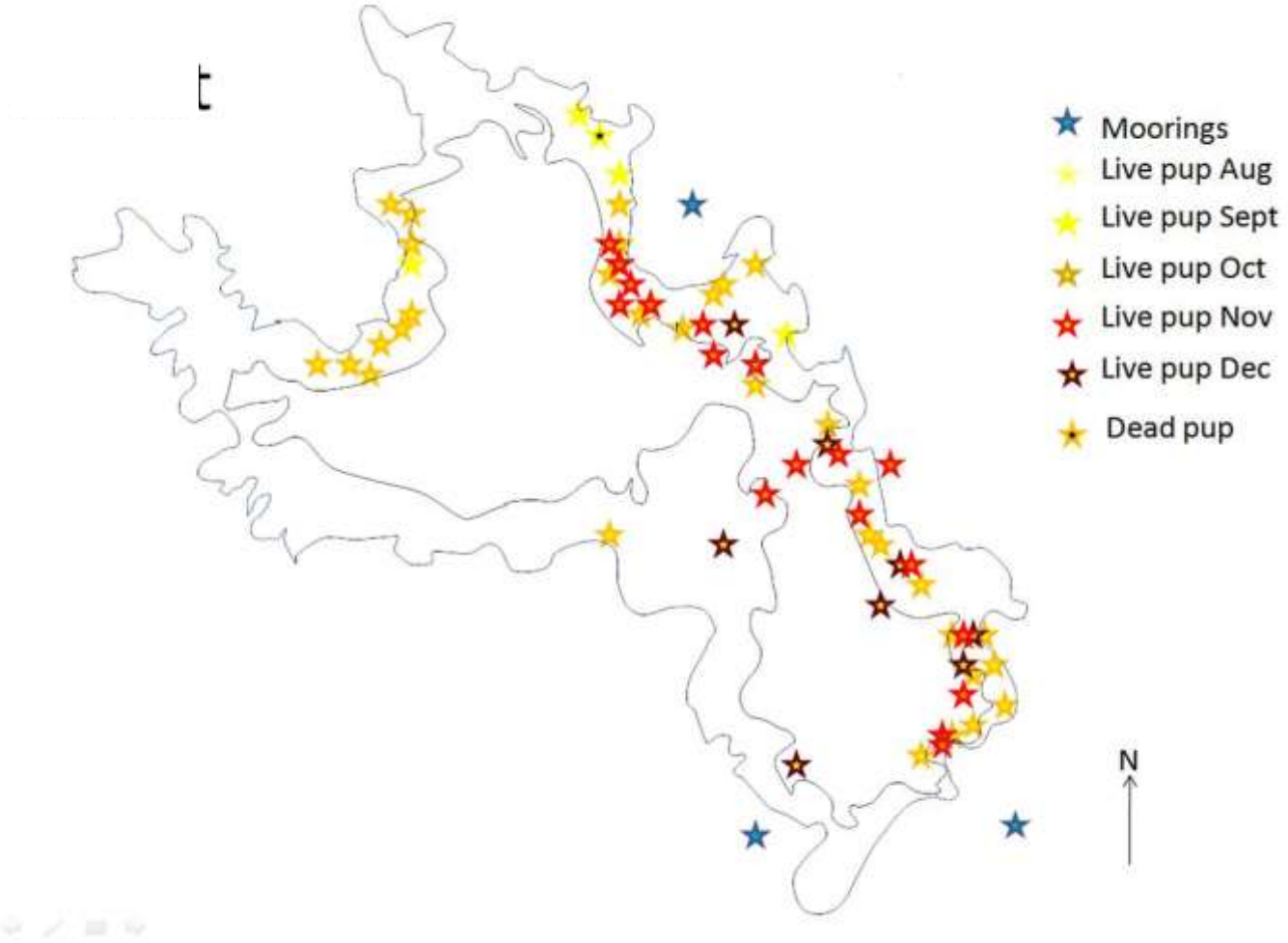

Figure 10 Map of Island Eleven showing pup locations

Figure 11 Map of Island Twenty four showing pup locations

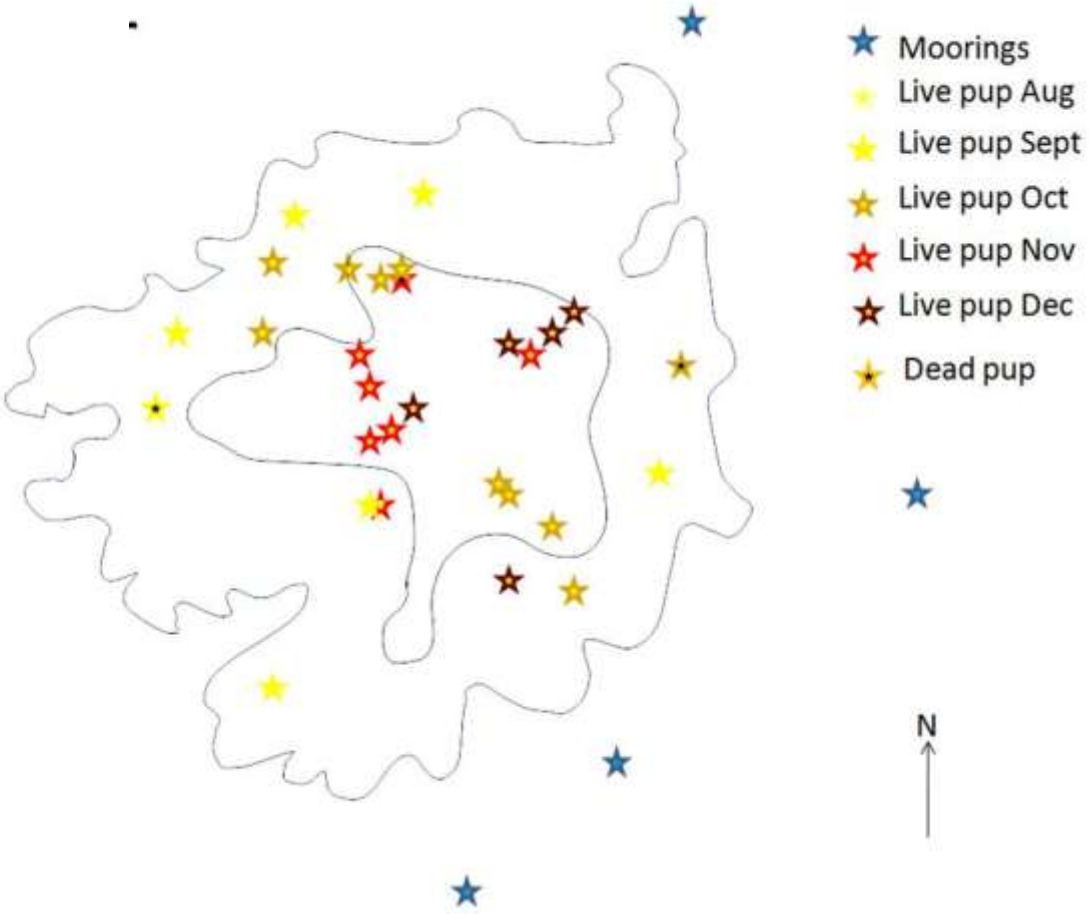

Figure 12 Map of Island Five showing pup locations

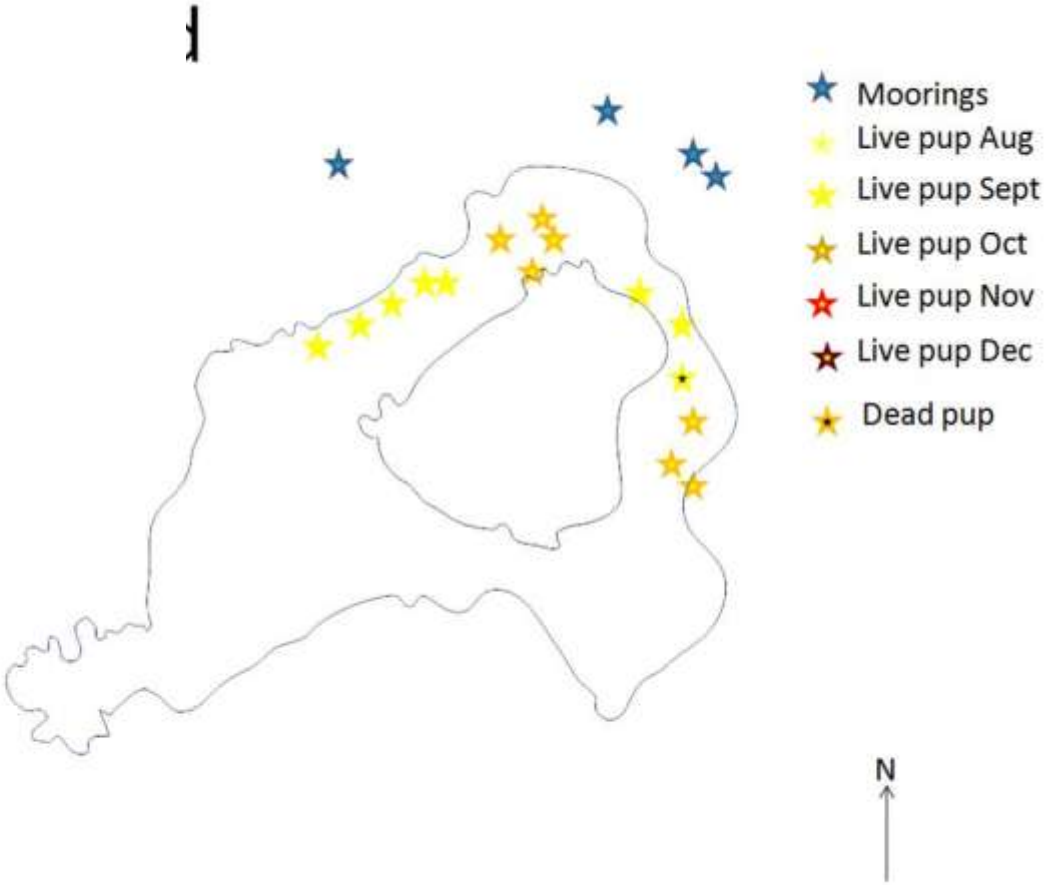

Figure 13 Map of Island Thirty one showing pup locations

On the maps above, the two contours represent the highest astronomical tide and the mean low water springs

Photo identification of individual seals

Isles of Scilly photo identification catalogue

5.15 Since July 2007, a photo identification catalogue of pelage (lifelong fur) patterns has been collected by CSG for seals observed on the Isles of Scilly with seals classified as male, female, net entangled and common seals (*Phoca vitulina*). A total of 24 different seals (eight females, one male, 13 net entangled and two common seals) have been re-sighted on the Isles of Scilly (Table 12 and Plates 9 to 12). During these five surveys, 14 different seals were re-identified from the Isles of Scilly seal photo identification catalogue (four adult females, eight net entangled seals and two common seals with one of the net entangled seals – N13 – being re-identified twice). Photo identification has revealed seals move between different SSSI areas on the Isles of Scilly – for example N13 was first observed on the Western Rocks, but was seen in the Eastern Isles during these surveys.

Cornwall photo identification catalogue

5.16 One female seal (S311) was identified – she was last seen at Godrevy on 21/06/10 and was re-sighted on Island Sixty six on 24/11/10 (Table 12 and Plate 12).

Skomer (Pembrokeshire Islands SAC) photo identification catalogue (Boyle, D 2010)

5.17 One female seal (F12) was identified from Skomer – she was last seen on Island Sixty six on 26/06/10 and re-sighted on Skomer on 13/09/10* looking heavily pregnant (Table 12 and Plate 10).

Table 12 Summary of seal photo identifications

	IDs from IoS SAC	IDs from Cornwall	IDs from Skomer SAC	Females	Net Entangled	Commons
Aug	2	0	0		N13	C6
Sept	6	0	1*	F39 (Mum), F61, F12*	N1, N2, N5, N22	
Oct	2	0	0		N1, N3 (Mum)	
Nov	5	1*	0	F45, F60, S311	N10, N32	C3
Dec	0	0	0			
Total	15	1	1*	6	9 (8 different)	2

5.18 S311, the seal linked to Godrevy brings the total number of seals observed both on the Isles of Scilly and Godrevy to 22 different individuals – nine of which were male and 13 of which were female. One seal observed in the Isles of Scilly (S163) left to travel east to have her pup at Godrevy in Cornwall, whilst F12 left the Isles of Scilly and was seen heavily pregnant on Skomer, part of the Pembrokeshire Islands SAC in Wales. An additional link was discovered during these surveys as a satellite tagged seal from Brittany visited the Isles of Scilly and remained there between 15/07/10 and 04/09/10 (Vincent 2010 Unpub). This information demonstrates the position of the Isles of Scilly at the hub of the Celtic Sea population of seals.

Plate 9 Seal photo identifications during August


F29 18/09/10


F29 ID photo


F61 18/09/10

F61 ID photo


N1 17/09/10

N1 ID photo


N22 17/09/10

N22 ID photo


N5 17/09/10

N5 ID photo

Plate 10 Seal photo identifications in September

Plate 11 Seal photo identifications in October


F60 24/11/10
F60 ID photo


S311 24/11/10
S311 ID photo


N32 24/11/10


N32 ID photo

Plate 12 Seal photo identifications in November (grey and common seals)

5.19 There were no identifications in December 2010.

6 Discussion

Survey frequency

6.1 The restrictions and limitations surrounding survey logistics, such as the tide, sea conditions, wind conditions, island carrier, accommodation, boat and survey team availability make conducting surveys at the optimum interval exceptionally challenging. Surveys one (August) & two (September) and four (November) & five (December) were within the optimal inter-survey duration of 17 to 23 days, whereas surveys two (September) & three (October) and also surveys three (October) & four (November) were further apart than the ideal required. This may have resulted in some pups being missed, so adjustment calculations were needed for the pup production estimates (refer to Appendix 11).

Survey planning

6.2 A high degree of commitment, organisation and flexibility was required from all participants to enable surveys to take place at very short notice. Once tide and weather conditions became optimal, other issues, such as the lack of an island carrier availability on a Sunday and fully booked flights and accommodation during peak periods, added to the difficulties posed by the inevitable changes in weather conditions from those forecast. Completing five of the six possible surveys fully (apart from two landings in August) was challenging and was a great credit to CSG and volunteer surveyors.

Boat-based seal counts

6.3 The approach of counting seal numbers, in and out of the sea and by age/sex classes ensured a robust mechanism for seal recording. Seal numbers on the Isles of Scilly varied considerably between and within months for different years, reaching a peak in the winter and a minima in the summer (Sayer *et al* 2011). Any surveys covering less than a 12 month period need to be set within the context of this seasonal distribution. The increase in seal numbers observed across the surveys (August to December 2010) was most likely to be the result of seasonality in seal behaviour, with individuals potentially using offshore habitat during the summer months and inshore habitat during the winter months. It could also be a result of dispersed migration across the Celtic Sea during the summer and migration into the Isles of Scilly during the winter from other regions of the Celtic Sea. Both theories imply that the Isles of Scilly seal population and habitat are not isolated, but are part of an open system linked to seal habitat in other areas. The seal sex ratio in the Isles of Scilly appeared to be male dominated, except during October, the peak month of the breeding season. This is consistent with the sex ratio, dominated by male numbers, observed at Godrevy in Cornwall (CSG Annual Reports, 2004 to 2008 and Sayer, 2010 Unpub.). Only the adult female age/sex class of seals increased monotonically across all five surveys. Adult male numbers decreased between August and September, whilst juvenile numbers decreased between October and November.

6.4 The numbers of seals disturbed into the sea during surveying increased steadily between August and November and then declined in December, which was surprising as this was when most seals were observed and also the time when seals experienced the least boat activity and so would be least ‘acclimatised’ to the boat traffic. Throughout the surveys, more seals were disturbed into the sea at places with big congregations of seals, as it only took one ‘spooked’ seal to set up a domino effect of seals moving seawards. The reduction in seals being disturbed into the sea in December may well be linked to the start of the moulting season, with seals being more reluctant to enter the sea at this time, despite being in greater numbers and potentially less used to boat activity.

6.5 Seals most likely require undisturbed and 'quiet' areas of land to haul out to rest, give birth and moult (Davies, J. *et al* 2001) hence terrestrial haul out habitat is essential year round. The Isles of Scilly archipelago represents a complex network of potentially favourable seal haul out habitat, with different islands serving different purposes for seals in different seasons and conditions and for different individuals or classes of seals. The intricate web of seal activity on the Isles of Scilly is difficult to describe without further research. During the pupping season, there did appear to be an overall progression of sex ratios from west to east with higher proportions of females in the northwest, higher proportions of males on the inner Western Rocks and Island Sixty two and higher proportions of juveniles in the more easterly Islands, where conditions were generally more sheltered from prevailing weather / sea conditions. Considerably more survey work throughout future pupping seasons will be needed to establish any inter-annual variation to this observed sex ratio distribution, as well as during the moulting and summer seasons.

6.6 Several SSSI areas encompassed habitat utilised by seals during the pupping season and each SSSI area appeared to be preferentially (though not exclusively) used by particular age/sex classes of seals - adult males (Island Eleven), adult females (the Western Rocks, the Norrards and Island Thirty five) and juveniles (The Eastern Isles). As the Western Rocks, Eastern Isles and Norrards SSSIs are groups of islands themselves, more fine scale analysis was helpful to clarify the contributions made by individual islands to seal habitat. Island Five, Island Six, Island Fourteen, Island Two, Island One, Island Seven, Island Nine, Island Three and Island Eight were the islands most well used by seals on the Western Rocks SSSI. Island Sixty seven, Island Sixty six and Island Sixty two had the highest seal counts on the Eastern isles, whilst most seals in the Norrards were observed at Island Twenty one and Island Thirty one. A mean of less than ten seals were seen at another 15 other island locations.

Land based pup counts

6.7 There was a considerable difference between the number of pups observed during boat-based and landing counts, highlighting the importance of undertaking landings to make accurate pup counts. The first grey seal pup observed was born on Island Twenty four on 22/08/10 and the last pup observed on 11/12/10 was thought to have been born on Island Twenty four that day, as it was very small with rolls of skin, had a bright red umbilicus, blood on its long white pelage and it was lying adjacent to rocks still covered with fresh blood. The peak month for pupping on the four main pupping islands was October, followed by September and November, with a smaller number of pups born in August and December. It is entirely possible that pups may be born outside of this pupping season, but these pups are not expected to make a significant contribution to overall production in any one year. This pattern is consistent with the results obtained from the north coast pupping area from Godrevy to Deadman's Cove in Cornwall for beach based pups 2000 to 2010, where numbers peaked in October, followed by September and November and with a small number of pups scattered across all remaining months of the calendar year (Sayer, 2010 Unpub) The most important seal pupping habitat on the Isles of Scilly during these surveys was Island Eleven SSSI, followed by Island Five within the Western Rocks SSSI, Island Thirty one in the Island Thirty five SSSI and Island Twenty four in the Norrards SSSI.

6.8 The pup mortality rate recorded in the five surveys was 7% (n=6) and is consistent with pup mortality during lactation, which can be as much as 15% (Davies, J. *et al* 2001). The number of dead pups was a minimum estimate, as carcasses may have been washed out to sea during heavy seas between surveys. Pup mortality was highest on Island Five (18%; n=3) perhaps because of this island's more exposed location on the Western Rocks and because of the island's terrain, being collections of large boulders beneath which some pups were seen to be trapped, either partially or completely. The lowest mortality rate was observed on Island Eleven (2%; n=1), a large and therefore relatively sheltered island with numerous small coves with easy access in places to expansive areas of grass. Here pups were observed well above the highest astronomical tide level, where one mother was found sleeping amongst the tussocky grass next to her pup (Plate 13).

Plate 13 Photo of mother (lying next to her pup) above the highest astronomical tide

6.9 Three systems of coding pups into age classes were used, which along with photographing the majority of pups ensured accurate recordings were made. The system of stages adapted from Radford (1978) was the most objective, but gives little indication of a pup's likely age. The system of week codes developed by CSG combines the more objective stage codes with an indicator numeral linking the code to the age of the pup. The third coding system is a simplification of the previous two methods, using a CSG best fit approach that codes pups as week 1, 2 or 3. All three systems were easy to use and each revealed a greater proportion of younger pups in the August and September surveys and a greater proportion of older pups towards December. Assignments of pup coding were allocated contemporaneously and then retrospectively evaluated using photographs taken and a small proportion (n=2) were re-assigned based on this post-hoc validation. It is hoped that these pup codes will form a useful baseline against which future survey data can be compared. None of the coding systems would have worked well for pups that were separated from their mothers, as they were unable to feed and develop at the standard rate assumed by the coding systems.

6.10 The apparent preferred use of the east and north sides of Island Eleven and Island Thirty one by seal mothers corresponds with these islands more sheltered sides, both having greater fetches (distances of exposed sea) on their southwest sides, the direction of the prevailing winds and seas. Island Twenty four and Island Five could be described as being centrally located between other islands, which shelter them from all four main compass directions. This may partly explain the position of pups all around these islands, with first pups being born and able to survive at peripheral locations on the islands with easy access to the sea in August and September when seas were less wild, followed by more central, higher locations being utilised later in the season, when stormy seas were more likely. Island Thirty one's low lying profile may make it too exposed for use as a pupping site after October.

Comparison of boat and land pup counts

6.11 From boat-based counts, 33 unique live and dead white coated pups were counted as opposed to the 79 unique live white coated pups recorded during landings. Only 42% of pups counted on land were visible from the sea (Table 13).

Table 13 Comparison of unique alive pup counts from landings and the boat-based counts

Unique alive pup counts – landing / boat	Aug	Sep	Oct	Nov	Dec	Total	%
Island Eleven SSSI	0 / 0	4 / 2	25 / 4	12 / 10	4 / 1	45 / 17	38%
Island Twenty four (Norrards SSSI)	1 / 2*	4 / 1	1 / 0	2 / 1	1 / 0	9 / 2	22%
Island Five (Western Rocks SSSI)	0 / 0	5 / 0	7 / 0	1 / 0	1 / 0	14 / 0	0%
Island Thirty one (Island Thirty five SSSI)	0 / 0	7 / 6	4 / 3	0 / 0	0 / 0	11 / 9	82%
Sub total	2 / 0	23 / 9	38 / 7	16 / 11	6 / 1	79 / 28	
Island Twenty five (Norrards SSSI)			0 / 2			0 / 2	
Island Fourteen (Western Rocks SSSI)		0 / 1				0 / 1	
Total	2 / 2	23 / 10	38 / 9	16 / 11	6 / 1	79 / 33	42%

* 1 of these pups was dead

6.12 None of the 14 pups observed on landings on Island Five were visible from the boat-based surveys. This was probably a result of the geographical profile and undulating boulder beaches of Island Five. On Island Twenty four, pups on the south east boulder ramp and east side were visible during boat-based surveys, but not those found elsewhere on the island. A slightly higher proportion of pups were visible during boat-based surveys on Island Eleven compared to landings, whilst the majority of pups observed on landing on Island Thirty one were also visible from the boat-based counts. It should be noted that a total of three pups were observed during boat-based counts on two islands where landings were not done.

Pup production estimate

6.13 In addition to the 85 unique (alive and dead) pups that were observed from land based counts in 2010, three pups (one on Island Fourteen on 18/09/10 and two from Island Twenty five on 16/10/10) were observed from boat-based counts and a further three pups were rescued from Island Eighteen by British Divers Marine Life Rescue on 15/09/10 Boo; 10/10/10 Roz and 19/10/10 Dug (Jarvis, D. 2010). These pups could have been born on Island Eighteen, although it is entirely possible that two of these pups could have washed in from other islands – most likely Island Thirty one (pups of comparable ages had been observed on Island Thirty one on the previous survey) so these two pups were discounted. This brings the total of unique pups to 89.

6.14 An unknown number of pups were missed during boat-based counts on the other islands and more would have been missed for the two survey intervals that were longer than 17 to 23 days. It should, however, be noted that with an interval less than 23 days, it is possible for a small number (potentially between 3 and 5 pups) of barrel shaped white coated or partially moulted pups to have been over-counted. Appendix 11 outlines the two methods that were employed for calculating the estimated number of pups missed as a result of variations in seal pup weaning and moulting parameters and variations from the average optimal survey interval in order to produce approximations for a pup production estimate for the 2010 pupping season. These calculations suggested that the pup production estimate for 2010 lies between the 89 unique pups observed from landings, and other sources, up to the median estimate of 134 pups generated by the two methods. Whilst this estimate of between 89 and 134 pups has been generated with a moderate level of reliability (JNCC 2007), these figures do not reflect the actual recruitment figure of pups into year one, as mortality rates of between 40 to 60% occur within 12 to 18 months (Davies, J *et al* 2001). As such, recruitment at year one is likely to be between 36 (number of live pups from landings and other sources with 60% mortality) and 92 (maximum pup production estimate with 40% mortality) juvenile seals, given reported mortality rates at their age class.

Celtic Sea seal links – photo identification and satellite tags

6.15 Taking photographs of seals at distance from a moving boat is challenging even in good light conditions. Added to this is the time pressure during a boat-based count to keep moving in order to complete the survey within the available six hour tide window during daylight hours. A single pass of a group of seals frequently means, with stationary seals, that photos of only one side of the seal is possible. Seals often turn to face the boat and head-on shots were not good for photo identification, ideally side-on profiles were best. As a result, photo identification possibilities were considerably reduced by this combination of circumstances. Despite these challenges, 16 (15 different) seals were re-identified during the five surveys, 15 from the Isles of Scilly catalogue, one from Cornwall and one seal from Isles of Scilly catalogue was identified on Skomer, part of the Pembrokeshire Islands SAC. 15 were grey seals and two were common seals (a Cornwall and UK BAP species.) The photo identification results and the satellite tag link confirm the open nature of the Isles of Scilly seal population and its connection to at least three of the four nations of the Celtic Sea – England, Wales and France. The fourth nation, Eire, was connected too by a small seal named 'SMRU' rescued and taken to the National Seal Sanctuary in December 2009, as she had swum from south east Ireland to the Isles of Scilly (NSS 2009 weblink).

Comparable results from 2010 with pup counts from 2005 (Westcott, 2008)

6.16 In 2005, monitoring for grey seals was completed by Stephen Westcott commissioned by Natural England. The partial nature of the 2005 survey makes full comparison of the results of these two surveys challenging, although tentative comparisons can be made. In both surveys landings were done in August on 2 islands (Island Twenty four and Island Five) and in September on 3 islands (Island Eleven, Island Twenty four and Island Five).

Table 14 Comparable pup counts from 2005 and 2010

	2005 SW	Incl dead	2010 CSG	Incl dead
Island Five (Western Rocks SSSI)	14	1	6	1
Island Eleven SSSI	1	0	5	1
Island Twenty four (Norrards SSSI)	5	1	6	1
Total pups	20	2	17	3
% mortality		10%		18%

6.17 For these two months, pup numbers in 2010 were slightly lower than in 2005 with fewer pups born on Island Five, more on Island Eleven and comparable numbers born on Island Twenty four in both years, but the numbers were too small to confidently infer a trend, although it is probably stable (Table 14). One more dead pup was observed in 2010 compared with 2005, but numbers were very small. Consistencies exist in the sex ratios of seals at some island sites between 2005 and 2010, with Island Six and Island Eight having proportionally more males and Island One and Island Three having proportionally more females. In 2005, Westcott coded pups using the 5-stage categorisation proposed by Radford *et al* (1978). In 2005, Westcott compiled a photo identification catalogue of 20 mothers and 7 attendant males. In 2010, CSG created a catalogue of identification images for 59 different females, assumed to be mothers, and 10 males, assumed to be beachmasters or dominant attendant males (refer to Appendix 9).

6.18 Based on the partial pup production survey of 2005 by Westcott, a tentative estimate for seal births was likely to total between 55 and 70 pups. From 17/08/05 to the 26/09/05, 35 pups were actually counted during land based surveys. As this survey covered a total of 39 (33%) days of a potential 120 days (17/08/05 to 17/12/05), possibly missing the peak of the pupping season, it

seems likely that the observed number of pups represents under a third of the likely pup numbers, so a revised pup production estimate for 2005, based on a longer pupping season with an October peak, would be at least 108 pups. Based on the 2010 boat-based survey of the Isles of Scilly and landings on 4 key pupping islands, an estimate was reached with a moderate level of reliability (JNCC 2007) that the number of grey seal pups born on the Isles of Scilly during the 2010 pupping season was likely to be between 89 and 134 (refer to Appendix 11).

6.19 It was not possible to use method one from Appendix 11 to calculate a revised pup production estimate for 2005, due to the partial nature of the survey data.

7 Conclusions

7.1 The results from the 2010 survey of grey seals on the Isles of Scilly enable the following conclusions to be drawn in relation to the grey seal monitoring attributes (numbered one to seven):

1) Pup production: Most weight should be given to the conclusion drawn about trends in pupping (probably stable) made using directly comparable results during the months of August and September 2005 and 2010, as both were gathered with close to 100% accuracy. In 2005 a pup production estimate of 55 to 70 pups was described as tentative by Westcott (2008) and has been previously assessed with low confidence in the condition review completed by Natural England staff in 2008. A revised estimate based on a longer pupping season, peaking in October would be at least 108 pups. In 2010, a pup production estimate of 89 to 134 pups (observed and median of estimates) was generated with moderate levels of reliability. (JNCC 2007). These figures cannot be used to reliably describe any trend (decreasing or increasing) as the estimates were not directly comparable.

   The number of breeding females: 160 ± 54; mean ± 1 s.d. adult females (not necessarily breeding) were counted per month August and December 2010. No comparable count was made in 2005.

   Mortality in the breeding colonies: the likelihood of dead pups being washed from islands between surveys added uncertainty to dead pup counts. Comparable mortality at the start of the pupping season were - 2005 (10%) and 2010 (18%); the number of dead pups observed was small, so it is not possible to infer a trend from these figures. Mortality can be described during the weaning period with a further mortality rate occurring within 12 to 18 months. Rates are affected by a range of environmental and anthropogenic factors.

2) The distribution of grey seal pups: in 2005, pups were observed on 6 islands in the Western Rocks SSSI, Norrards SSSI and on Island Eleven SSSI, compared with 6 islands in 2010 in the Western Rocks SSSI, Norrards SSSI, Island Eleven SSSI and Island Thirty one (Island Thirty five SSSI).

3) Accessibility of SAC sites for breeding: stable - no access issues were observed in 2005 or 2010. Habitat quality and extent: more investigation is required to comment on this.

7.2 Two additional attributes were monitored for grey seals on the Isles of Scilly (Table 15):

4) Disturbance, using reduction or displacement seal numbers during surveys: data on disturbance in 2005 was qualitative, so no comparable assessment is possible. In 2010, 10% ± 3% (mean ± 1 s.d.) of seals were disturbed into the sea whilst the survey boat was in the vicinity, with the highest level occurring in October and the lowest levels in December 2010.

5) Extent of breeding, moulting and haul out sites measured in terms of total area: Breeding: in 2005, pups were observed at Island Eleven, Island Nine, Island Two, Island Twenty four, Island Twenty five and Island Five. In 2010 from the boat-based surveys and landings, pups were observed on Island Eleven, Island Twenty four, Island Twenty five and Island Five, as well as Island Fourteen (not studied in 2005) and Island Thirty one (not reported on in 2005).There is evidence that seals previously pupped on the Eastern Isles (Sayer *et al* 2011) but no pups were observed there in 2005 or 2010. Haul out: A full survey of haul out sites was not possible in 2005. In 2010, seals were observed hauled out at 30 different island sites – 10 in the Eastern Isles SSSI, 9 in the Western Rocks SSSI, five in the Norrards SSSI, two in the Island Thirty five SSSI, one in each of the following SSSIs – Island Eleven, Island Sixteen, Island Fifty two, Island Eighteen. There were no surveys of the moulting sites in 2005 or 2010.

7.3 Two further attributes are noteworthy (Table 15):

6) Extent of the breeding season: probably stable, as this was thought to be between July and December from previous experience in 2005 and was observed to be between at least August and December 2010, although experience from the Godrevy to Deadman's Cove pupping area suggests that a small number of pups (less than one per month per year) could be born during any other month of the year (Sayer 2010).

7) Net entanglement observed on live seals: a mean of 1% ± 0% (mean ± 1 s.d.) of seals were observed with some evidence of net entanglement with rates decreasing from 1.5% to 0.5% between August and December 2010. No assessment possible as no comparable 2005 data.

Table 15 Comparison of attribute data from 2005 and 2010

Attribute	2005	2010	Trend and comment
Pup counts August & September	21	17	Probably stable. Highest levels of reliability with close to 100% accuracy.
Pup production estimates	55 to 70 (Revised to at least 108)	89 to 134	Not possible to determine. Results are NOT directly comparable and the figure in 2005 had low reliability, being a tentative estimate from a partial survey.
Number of breeding females		160 ± 54 (adult females)	Not possible to determine. Adult females were not necessarily breeding females.
Pup mortality during the lactation period	10%	18%	Not possible to determine as sample sizes were small.
Spatial distribution of pups	Six island	Six islands	Not possible to determine.
Accessibility of SAC site for seals	No issues	No issues	Stable
Disturbance		10% ± 3%	Not possible to determine, as data was qualitative in 2005.
Extent of breeding, moulting and haul out sites		30 different haul out islands	Not possible to determine as a full survey of haul out sites was not possible in 2005.
Extent of the breeding season	Thought to be July to December	At least August to December	Probably stable.
Net entanglement		1%	Not possible to determine.

8 Recommendations

Surveys

- Additional monthly surveys would be required to further investigate the spatial and temporal variation in the habitats used by seals on an intra annual basis.
- Additional pupping season counts to be carried out during the 2011 pupping season to establish levels of site fidelity used by breeding males and females from the photo identification catalogue and establish inter annual variation.
- Pup counts to be done on a more frequent basis than the minimum of once every six years to enable the resulting data to have sufficient power to detect trends in pup production (Sayer *et al*, 2011).
- From the practical landing experience gained from this survey, island landing decisions made based on health and safety grounds could now be reassessed. Landings should be considered essential on Island Eleven, Island Twenty four, Island Five and Island Thirty one and the feasibility of landing on Island Nine, Island Two, Island Six (Westcott, 2008), Island Twenty five (Westcott, 2008 and 2010 boat-based surveys) and Island Fourteen (from 2010 boat-based observations of white coated pups) could be re-evaluated prior to the start of future monitoring.
- Intensive and focussed effort based photo identification work during each of the three seal seasons (pupping, moulting and summer) over a period of several days, will enable an assessment to be made of the variability in habitat use over short periods of time and to investigate how different habitats are interlinked by seal use during each of the three different seal seasons.
- A quantitative investigation into the levels of disturbance experienced by seals during the peak tourist season, along with other potential threats to seals at this key habitat at the hub of the Celtic sea population, such as climate change and other anthropogenic effects.
- A survey of moulting season sites is needed to fully assess the extent of moulting season sites used by seals, one of the key assessment attributes.

Method

- The survey team should employ the use of a boatman experienced in Isles of Scilly waters and in approaching seals.
- Survey teams to contain a minimum of at least 3 experienced and trained people, one as a spotter/photographer, one as a counter/age and sexer and one as a data recorder.
- Adding an additional day to the survey framework would enable additional sites to be explored for pups by landing, such as Island Fourteen and Island Twenty five, where pups were observed from boat-based counts and Island Nine, Island Two and Island Six identified as nursery sites by Westcott in 2005, which were the only three he identified that were difficult to assess for pups by boat. It should be noted that surveyors were required to work from dawn until dusk on two of the survey days just to complete a boat-based survey and landings on four islands. Surveyors worked a mean of 16 working hours per survey.
- Landings were essential for accurate pup counts to be obtained and a minimum of two landing personnel should make up each landing team (more per team on Island Eleven).
- Pup codes should be amended to take account of pups separated from their mothers.
- Allowances should be made in funding for surveys aborted due to conditions changing from those forecast. The weather was very variable even over short periods of time (Plate 14). Contingency funds would increase the chance of surveys closer to the optimum interval, shorter working days and increased health / safety in what were already hazardous situations.

Plate 14 Photo showing rapid change in weather conditions on Island Eleven, foreground sun, background squall (seal mother and pup - middle left side of photo)

- Exact GPS locations for each pup to be recorded for every pup to investigate pup space-use.
- During boat surveys around pupping islands, the number of adult females offshore should be counted, as this is thought to be a useful surrogate value for the number of seal pups found ashore.
- The limitations imposed by unequal intervals between surveys emphasised the importance of surveys being conducted as close to the optimum of 17 to 23 days to avoid the majority of white coat pups being missed.
- Survey teams undertaking future monitoring should be highly experienced in the field of pinniped surveys. Despite 11 years of study, focussed solely on seals, the lead surveyor was surprised at the level of challenge posed in assessing the age and sex ratios of seals hauled out in large groups, made more difficult over the distances involved and from a moving platform. Specialist field experience with breeding seals enables the location of even well hidden pups to be detected, increasing the accuracy of pup counts and minimising mother and pup disturbance.
- Satellite tags can be used to research seals, but their deployment has been demonstrated to have a detrimental effect on the study animals (Hazelcamp *et al* 2010). Decisions about research using satellite tags on seals in the Isles of Scilly should demonstrate the novel value in the potential findings and include an evaluation of the ethics involved in highly invasive tag deployment prior to their use. Photo identification techniques based upon non invasive observation of a seal's unique fur pattern yield lifelong information, whilst a satellite tag is shed along with fur during a seal's annual moult. The challenging terrain and seas of the Isles of Scilly mean that currently, satellite tagging of seals cannot be recommended.

SSSI designations

- The results of this survey may be used to inform Natural England's review of SSSI coverage for grey seals in England through the SSSI Notification Strategy, and particularly the reviews of existing SSSIs in the Isles of Scilly.

Attributes (for assessing Favourable Conservation Status)

- The seal attribute of net entanglement be added to the future condition assessment for grey seals in the Isles of Scilly.
- The wording of the existing attribute 'the extent of breeding, moulting and haul out sites' could be amended to ensure spatial and temporal coverage and to aid clarity:

1. The extent (geographical range) of grey seal pups across the islands
2. The extent (temporally) of the pupping season in days/months
3. The extent (geographical range) of haul out and moulting sites across the islands
4. The extent (temporally) of haul out and moulting site use in days/months.

Future WiSe (Wildlife safe) training

- Local people are most able to influence anthropogenic impacts on seals using Isles of Scilly habitat. WiSe training carried out in March 2010, could be supplemented by a specialist unit on seals, provided for boatmen on the islands, to increase levels of knowledge about the lifestyles and habitat of seals and associated conservation issues.

9 References

BOYLE, D. 2010. Skomer seal photo identification catalogue. Wildlife Trust of South and West Wales. Unpublished raw data.

DAVIES, J. *et al*. 2001. Marine Monitoring Handbook, JNCC.

FEDAK, M.A. and ANDERSON, S.S. 1982. The energetics of lactation: accurate measurements from a large wild mammal, the grey seal. Journal of Zoology, London 198: 473-479.

HAZELCAMP, AAH. 2010. Flow simulation along a seal, the impact of an external device. European Journal of Wildlife Research 56:131-140.

JARVIS, D. 2010 British Divers Marine Life Rescue pup rescues 2010. Unpublished raw data.

JNCC, 2005. Common Standards Monitoring Guidance for Marine Mammals – version May 2005.

ISSN 1743 8160. JNCC. URL: **www.jncc.gov.uk/pdf/CSM_marine_mammals.pdf** [Accessed September 2012].

JNCC. 2007. Second Report by the UK under Article 17 on the implementation of the Habitats.

Directive from January 2001 to December 2006. JNCC Peterborough. **www.jncc.gov.uk/article17** [Accessed September 2012].

NATIONAL SEAL SANCTUARY (NSS). 2009. **www.sealsanctuary.co.uk/smru09g.html** [Accessed September 2012].

RADFORD P.J. *et al* 1978. A statistical procedure for estimating grey seal pup production from a single census. Mammal Review 1978, Volume 8, Nos. 1 and 2, 35-42.

SAYER, S. *et al*. 2004 to 2008 Cornwall Seal Group Annual Reports. Unpublished manuscripts.

SAYER, S. 2010. Grey seal pup numbers between Godrevy and Deadman's Cove on the north Cornish coast 2000 to 2010. Unpublished raw data.

SAYER, S. 2010. Highlights of the grey seal year at Godrevy, 2010. Unpublished raw data.

SAYER S., HOCKLEY K., WITT M.J. 2011. Meta analysis and summative report of all existing Isles of Scilly seal data. Isles of Scilly Area of Outstanding Natural Beauty Partnership. Manuscript in preparation.

SPECIAL COMMITTEE ON SEALS (SCOS). 2009. Scientific advice on matters related to the management of seal populations. Seal Mammal Research Unit.

WESTCOTT, S.M. 2008. Procedural guidelines for studying grey seals in southwest England, 2006. ISSN 1754 1956. NERR017 Natural England.

VINCENT, C. 2010. Seal tagging in the Marine Park of the Iroise Sea. Unpublished raw data.

Appendix 1 Surveyors

(Numbers in parenthesis refer to codes used in Table 1 on page 9)

Boatman: Dave McBride, Tiburon Boating / Dive Scilly

Lead surveyor: Sue Sayer, Cornwall Seal Group (1)

Recorders: Bex Allen (3), Kate Hockley (2), Annabelle Lowe (6)

Spotters and photographer: Caroline Curtis (4), Chris Lowe (7), Dr Matthew Witt (5)

Plate A Photos of seal survey team members

Appendix 2 Equipment list

Survey equipment

Binoculars

Mobile phone and charger

Laptop and charger

Canon SX1 camera with 22 times optical zoom and charger with rechargeable batteries / lens cloth / spare memory card (have two cameras if possible)

USB card reader

8 spare batteries

Dry bags

Recording box and clip / elastic bands

Forms – 25 and pencils – 5

GPS (and download cable)

OS Map divided into numbered sites

Weather sheet

Tide tables

Maps of islands

Pup codes sheets

Pup recording sheets

Strandings – forms, labels and gloves

Health and Safety

First Aid kit

Risk assessment and emergency forms – 2

Emergency blanket

Bottle of water

Sun cream – high protection

Toilet paper

Wet wipes or anti bacterial handwash

Freezer bags

Bin bags

2 way radios

Appendix 3 Survey sheets

Isles of Scilly SAC Condition Assessment Monitoring for Seals

Surveyors					Recorder			(Circle sea & wind force below)									
Date		Start time			End time			Low tide time									
Sea: Stormy:Very Rough:Rough:Choppy:Calm					Wind force: Gale:Very Windy:Windy:Breeze:Still								Wind direction:				
1		2	3		4								5	6	7	8	9
Area Code of Location	Waypoint	Total (Max number of seals seen)	Incl number of seals hauled out	Including number of seals in sea	ADULT MALE	ADULT FEMALE	JUVENILE	WEANERS / MOULTERS	WHITE COAT PUPS (Number of pups as well as stage/s AND week/s of pup/s)	UNKNOWN AGE/SEX	Including no. net entangled	Number of seals disturbed into sea	Humans feeding seals (Tick if yes)	Strandings if any (Tick if any)	Other comments / observations		

Figure 14 Survey sheet used for boat-based counts

Island name : _____

Pup No.	Pup Ref.	GPS waypoint or lat/long	Stage	Week	Best Fit	Comment

Figure 15 Survey sheet used for pup counts during landings

Appendix 4 JNCC mandatory attributes & reliability levels

Mandatory attributes: UK Marine Mammal Common Standards Guidance (JNCC, 2005)

UK guidance on conservation objectives for monitoring designated sites Interest feature: Grey seal *Halichoerus grypus*

Reporting category: Mammals

NB: All attributes listed are mandatory

Table A Mandatory grey seal attributes

Attribute	Targets	Method of assessment	Comments
Pup production in the SAC/SSSI/ASSI.	A stable or increasing number of breeding female grey seals in the SAC/SSSI/ASSI.	Pup counts from aerial photography and extrapolation: direct counts from boat or shore.	Pup counts standardised and extrapolated to give an annual estimate of production. Extrapolation to be based on work in SAC/SSSI/ASSI where possible. Counts once every three years, ideally more often.
Distribution of grey seal pups within the SAC/SSSI/ASSI.	A stable or increasing area of usage within the SAC/SSSI/ASSI.	Aerial photography or direct mapping from boat or shore.	Can be carried out at same time as above.
Accessibility of SAC/SSSI/ASSI for breeding.	An accessible breeding site.	Aerial photography or direct mapping from boat or shore.	Can be carried out at same time as above.

Reliability of judgements (JNCC, 2007)

High : Expert opinion is that the concluding judgement accurately reflects the current situation based on professional understanding of the species. For range, population and habitat, quality of data used to establish current estimate has been identified as good. The data used to inform trends is comprehensive and is up to date.

Moderate : A greater understanding of the feature, or factors affecting it, is required before a confident concluding judgement can be made by experts. For ranges, pup and habitat, the current estimate and/or trend is based on recent but incomplete or limited survey data, or alternatively a comprehensive, but outdated period.

Low : Judgements and comprising estimates are based predominantly on expert opinion.

Appendix 5 Data tables

Table B Monthly distribution of unique seal pups observed per island

Totals unique alive / dead pups	Aug	Sep	Oct	Nov	Dec	Total
Island Eleven SSSI	0	5	25	12	4	46
Island Twenty four (Norrards SSSI)	2	4	1	2	1	10
Island Five (Western Rocks SSSI)	0	6	8	2	1	17
Island Thirty one (Island Thirty five SSSI)	0	8	4	0	0	12
Total	2	23	38	16	6	85

Table C Mortality rates observed during the weaning period

Dead pups only	Aug	Sep	Oct	Nov	Dec	Total	Mortality %
Island Eleven SSSI		1			0	1	2%
Island Twenty four (Norrards SSSI)	1					1	10%
Island Five (Western Rocks SSSI)		1	1	1	0	3	18%
Island Thirty one (Island Thirty five SSSI)		1				1	8%
Total	1	3	1	1	0	6	7%

Appendix 6 Site references

Table D Island code numbers and locations used during surveys

Island No.	Island name	SSSIs relevant to seals
1	Island One	Western Rocks
2	Island Two	Western Rocks
3	Island Three	Western Rocks
4	Island Four	Western Rocks
5	Island Five	Western Rocks
6	Island Six	Western Rocks
7	Island Seven	Western Rocks
8	Island Eight	Western Rocks
9	Island Nine	Western Rocks
10	Island Ten	Western Rocks
11	Island Eleven	Island Eleven
12	Island Twelve	Western Rocks
13	Island Thirteen	Western Rocks
14	Island Fourteen	Western Rocks
15	Island Fifteen	
16	Island Sixteen	
17	Island Seventeen	
18	Island Eighteen	
19	Island Nineteen	Norrards
20	Island Twenty	Norrards
21	Island Twenty one	Norrards
22	Island Twenty two	Norrards
23	Island Twenty three	Norrards
24	Island Twenty four	Norrards
25	Island Twenty five	Norrards
26	Island Twenty six	Norrards
27	Island Twenty seven	Norrards
28	Island Twenty eight	Norrards
29	Island Twenty nine	Norrards
30	Island Thirty	
31	Island Thirty one	Island Thirty five
32	Island Thirty two	Island Thirty five

Table continued...

Island No.	Island name	SSSIs relevant to seals
33	Island Thirty three	Island Thirty five
34	Island Thirty four	Island Thirty five
35	Island Thirty five	Island Thirty five
36	Island Thirty six	
37	Island Thirty seven	
38	Island Thirty eight	
39	Island Thirty nine	
40	Island Forty	
41	Island Forty one	
42	Island Forty two	
43	Island Forty three	
44	Island Forty four	
45	Island Forty five	
46	Island Forty six	
47	Island Forty seven	
48	Island Forty eight	
49	Island Forty nine	
50	Island Fifty	
51	Island Fifty one	
52	Island Fifty two	
53	Island Fifty three	
54	Island Fifty four	
55	Island Fifty five	
56	Island Fifty six	
57	Island Fifty seven	Eastern Isles
58	Island Fifty eight	Eastern Isles
59	Island Fifty nine	Eastern Isles
60	Island Sixty	Eastern Isles
61	Island Sixty one	Eastern Isles
62	Island Sixty two	Eastern Isles
63	Island Sixty three	Eastern Isles
64	Island Sixty four	Eastern Isles
65	Island Sixty five	Eastern Isles
66	Island Sixty six	Eastern Isles
67	Island Sixty seven	Eastern Isles

Appendices 7 to 10

Available on CD by contacting the Natural England Marine Advisor for the Isles of Scilly **www.naturalengland.org.uk**.

Appendix 7 Photos of locations

Appendix 8 Google Earth KML file of pup locations

Appendix 9 Photos of Mothers and Beachmasters

Appendix 10 Photos of pups, including moulted weaners

Appendix 11 Pup production estimate calculation methods

Method one

1) The number of pups occurring at each of four monitoring sites was counted at intervals during the reproductive season (2010; August to December), including the beginning, middle and end of the pupping season. The planned interval between counts (21 days) was optimised based on knowledge of grey seal reproductive biology. This interval is the approximate average reported duration between birth and fully moulted status, where pups, with white coats with fresh umbilicus, progress to being moulted juveniles with darker pelts and are independent and leave the vicinity of the pupping site.

2) The actual interval between surveys varied during the reproductive season (17 and 38 days), due to weather constraints (as well as other factors such as boat availability). It was therefore necessary to estimate the total number of pups born across the four monitoring sites using a simple modelling approach. The resulting estimates are to be considered alongside the total of observed counts to assist an assessment of likely total productivity for the season.

3) A normal (Gaussian) distribution was first fitted to the observed pup counts against cumulative day of the survey season. The tails of this curve were extrapolated until daily estimates (y) reach 1 pup per day. The model had a fit of 0.96 (R^2).

4) From this distribution it was then possible to calculate the total number of pups born by summing the daily estimates. The total number of estimated pups born was then divided by the approximate pup development duration (birth to fully moulted; for example 21 days). Given this period is variable, most likely influenced by genetic and environmental factors, several estimates of total pup production were derived using durations between 17 and 23 days. Final estimates of total pup production (median, 25^{th} and 75^{th} percentile) were derived from the seven estimates of production.

5) This method of estimation assumes that the peak of the pupping season (occurring in October) was surveyed and that the distribution of pup births followed a normal distribution. Furthermore it was assumed that pups fully moulted and dispersed between 17 and 23 days.

Table E Pup production estimate using Methodology 1

moulting duration	est. pup count*
17d	153
18d	145
19d	137
20d	130
21d	124
22d	118
23d	113

5th percentile	115
25th percentile	121
Median estimate	130
75th percentile	141
95th percentile	150

md. Moulting duration (days between birth and leaving birth site)

*estimated seasonal distribution is estimated to start on:	7th Aug
*estimated seasonal distribution is estimated to finish on:	29th Dec
*first survey:	28th Aug
*final survey:	11th Dec

Method two

The total figure of 89 unique alive and dead pups observed between August and December 2010 was calculated by removing all fully moulted pups observed during surveys two (September) to five (December). As the survey intervals between surveys two (September) and three (October) and surveys three (October) and four (November) were over the optimal survey interval, it is likely that pups were missed. For this method of calculating the pup production estimate, the number of moulted pups observed during October and November has been added to the total number of unique pups observed.

Table F Pup production estimate using Methodology 2

Unique pups (alive and dead)	89
Fully moulted pups observed in October	13
Fully moulted pups observed in November	12
Total (i.e. pup production estimate)	114

Median of estimate methods

Table G Pup production estimate using the median range of estimate methods

	Lowest estimate	Highest estimate
Unique pups observed (alive and dead)	89	
Method 1	113	153
Method 2		114
Median range of pups born during pupping season 2010	101	134