Natural England Commissioned Report NECR322

# Monitoring grey seal (*Halichoerus grypus*) pupping sites in Cornwall 2019/2020

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# 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 Conservation of Seals Act 1970, the Natural Environment Research Council (NERC) has a duty to provide scientific advice to government on matters related to the management of seal populations. NERC has appointed the Special Committee on Seals (SCOS) to formulate this advice. Formal advice is given annually based on the latest scientific information on abundance and distribution provided to SCOS by the Sea Mammal Research Unit (SMRU). The annual SCOS report provides the basis for various reporting requirements (such as MSFD) as well as underpinning Environmental Impact Assessments.

Currently, no data from SW England is provided to SCOS, as the SMRU methodology for data collection (aerial survey) is not appropriate for the region. This means SW England is under represented in the data and therefore within the subsequent SCOS annual report. The objective of this project was to repeat and compare results from a previous survey undertaken in 2016 (NECR262). Specific aims were to a) estimate pup production, b) estimate land-based pup count of the Cornish coast from volunteer surveyors, and c) compare with previous 2016 results in terms of ability of boat and land-based data to provide a robust data set for inclusion in the SCOS annual report.

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**Further information**
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# Natural England Commissioned Report

Monitoring grey seal (*Halichoerus grypus*) pupping sites in Cornwall 2019/2020

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Cornwall Seal Group Research Trust and the University of Exeter

February 2020

www.naturalengland.org.uk

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Boat-based survey team:

| | | | |
|---|---|---|---|
| Adrian Langdon | David-John Millward | Kieran Reid | Sarah Millward |
| Annabelle Lowe | Emily Pollitt | Marion Beaulieu | Sue Sayer |
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| Chris Lowe | Jack Madden | Mike Taylor | Toby Neal |
| Craig Ashley | Katie Bellman | Rebecca Allen | Tom Wildblood |

Land-based survey data contributors:

Thank you to all 250 land-based contributors including CSGRT, BDMLR, Cornwall Wildlife Trust Marine Strandings Network, National Trust and local marine group member volunteers; members of the public; rehabilitation centre staff and local boat operators.

## Abstract

CSGRT provided data on grey seal pupping in Cornwall for the 2019-2020 season.

Complementary boat and land-based surveys recorded 153 unique grey seal pups at 47 different cave and cove locations across Cornwall. Of these, fifteen pups were found dead and sixteen pups were observed through to successful weaning.

The two most productive areas for pups were West Cornwall (n=61) and North Cornwall (n=48). These areas also demonstrated the highest rates of site fidelity and 'individual seal' site fidelity when comparing 2016 to 2019 data. Pupping sites within West Cornwall and North Cornwall coincide with Sites of Special Scientific Interest where seals are identified as features of special interest.

Land-based surveying was a reliable and non-intrusive method to monitor grey seal pup production in all but the most remote or inaccessible locations. All pups were recorded by land-based surveyors except for four: two at Lands End and two at the Lizard.

During boat-based surveying, disturbance was minimised by surveying larger caves over high tide. This reduced the distance of intertidal boulders the seals must cover to get to the sea; reducing the risk of injury to seals associated with stampedes without affecting the quality of gathered data. However, it remains challenging to balance the harm:benefit trade-off regards gaining information on seals, while not disturbing them by boat-based surveying at cove sites when larger numbers of seals are present.

Future surveys should consider:

- North Cornwall, West Cornwall and Other areas to be surveyed from the land only
- Lands End to be surveyed by boat at high tide only (requires a minimum of three days)
- Trial the implementation of remote cameras on larger cave entrances in the Lizard area, deploying these prior to the pupping season and to record data throughout. Combine this data with photo identification to improve an understanding of adult female grey seals accessing and exiting caves so to reveal further information on the numbers of pups in caves.

# Contents

# Aim and objectives

Aim

To provide data on grey seal breeding activity (termed "pupping") in Cornwall to inform the annual Special Committee on Seals (SCOS) report produced by the Sea Mammal Research Unit (SMRU). Grey seals can be subject to human disturbance, as such the exact locations of seal caves and other data revealing specific locations have been redacted from this report.

Objectives

1. Conduct eight days of boat-based surveys during the grey seal pupping season in 2019 to establish presence and absence of seal pups in caves at five areas known to support pupping on the north and south coasts of Cornwall, in particular: North Cornwall (NC), West Cornwall (WC), Lands End (LE), Lizard (LIZ) and Other (O).

2. Summarise Cornwall Seal Group Research Trust's (CSGRT) volunteer land-based surveys and *ad hoc* sightings to estimate pupping across Cornwall throughout the 2019 pupping season.

3. Assess the impact of disturbance and data contribution resulting from boat-based, cave survey work to the entire pupping dataset for the season.

# Method

### Boat-based pup surveys

Given available financial and logistical resources, survey priority was given to areas previously visited in 2016 and where prior knowledge suggested pupping activity occurred (Westcott, 1999 (LE); Westcott, 1999 (LE and WC); Westcott 2007 (NC); Steven, 1936; Summers, 1974 and Prime, 1985). Areas were surveyed in order of increasing difficulty with the first caves accessed being ones with which the survey team were most familiar and that were known to have relatively easy access. All caves surveyed in 2016 were re-visited in 2019 and additional caves were also surveyed in the region of the Lizard peninsula.

In 2016, Natural England provided CSGRT with maps of 54 cave systems drawn by Westcott (2005), which had been visited previously to ascertain the presence of seals. For surveying, these caves were grouped into the following five geographical areas: North Cornwall (NC), Other (O), West Cornwall (WC), Lands End (LE) and Lizard (L) (**Figure 1**).

To ensure safe operation when entering seal caves, organisations with experience of kayaking and coasteering, accredited to the national standards for observing wildlife (https://www.wisescheme.org/), were engaged to develop health and safety protocols and to act as expert guides during all boat-based surveying.

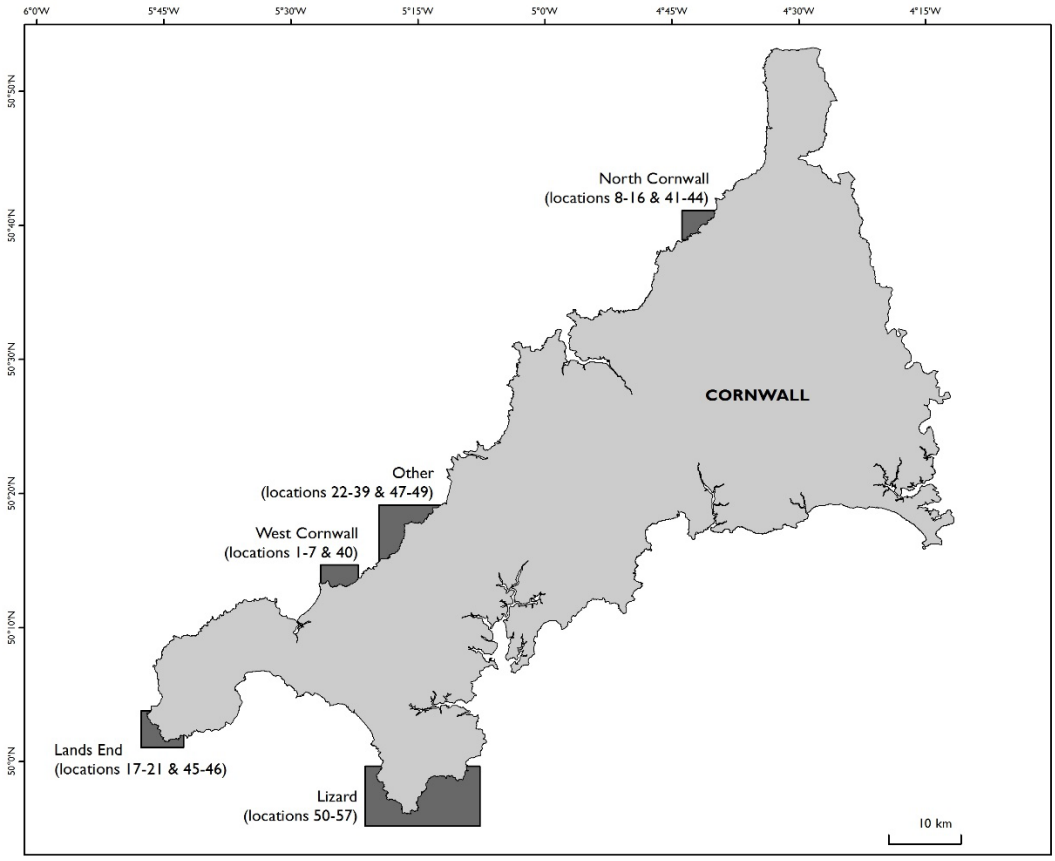


**Figure 1**. Boat-based survey areas for grey seal pups in coves and caves along the Cornwall coast.

*Survey frequency*

Cave and cove surveys were determined by tide, sea and weather conditions. Caves were surveyed according to survey area (**Figure 1**). Survey areas were maintained to ensure consistency with previous survey effort in 2016. Additional sites were surveyed outside the existing survey areas and these are reported to the survey area 'Elsewhere'. Caves at West Cornwall, North Cornwall and some sites at Other were accessible at mid to low tide whilst larger caves at Lands End, Lizard, and remaining sites at Other were surveyed close to high tide. Sites were surveyed at a higher state of tide where possible to minimise the impact of disturbance on seals. Prior to 2016, the peak pupping month for Cornwall was October (Sayer 2015) and in 2016, this had moved to September (Sayer and Witt 2016a). All caves were surveyed over the shortest possible survey period (23 days) from late September and through October to ensure that the majority of pups born during peak pupping months would be recorded.

*Safe access to shore*

Coves and caves were accessed by two pairs of kayakers and each pair included an experienced kayak guide and a seal surveyor. Guides determined whether landing outside caves, or entering caves by kayak, was the most suitable method for each site to ensure safety of survey teams. Despite attempts on a variety of survey days, some coves and caves could not be accessed. A further single person kayak was available on the main survey vessel for emergency support.

*Pup recording*

A FLIR Scout handheld water resistant thermal infra-red camera was used in the deepest caves to reveal the presence of seals in poor light conditions. This improved the chances of seal detection at the earliest opportunity and ensured surveyors entering caves were prepared to minimise the impact of seals leaving caves at speed, representing a welfare issue to seals and a health and safety hazard to surveyors. Each encountered pup was assigned: (i) a sequential unique number, (ii) a developmental code (**Figure 2**) according to Radford (1978) and (iii) was photographed. A GPS waypoint (latitude, longitude; decimal degrees, WGS84) was gathered at the entrance of each cave surveyed. Dead pups were recorded but not assigned a development code.


**Figure 2**. Examples of seal pup developmental stages according to Radford (1978).

**Land-based pup surveys**

Counts of seals along the coast of Cornwall by volunteers of Cornwall Seal Group Research Trust commenced in 2000, focusing on West Cornwall. From 2008, systematic boat-based marine life coastal transect surveys by this charitable organisation have revealed that seals are not observed along the entire coast of Cornwall, but sightings form multiple areas of high relative abundance. This pattern of distribution indicates land-based monitoring at key seal sites along the coast can provide meaningful data on pup production.

White coated pups have been identified along Cornwall's coast in every calendar month; yet most are born between 1st September and 31st December, with the annual peak in September and October (Sayer 2012; Sayer 2015; Sayer and Witt 2016a; Sayer and Witt 2016b).

From 2014, records of pup sightings were collected for other locations (in addition to West Cornwall) to develop a catalogue of pupping sites. By 2015, CSGRT had developed a working knowledge of Cornwall's pupping sites and the majority of these locations have been surveyed systematically since. By 2016, CSGRT were able to provide basic estimates of seal pup production at these sites and this work has continued to the present date.

Each pup identified during land-based surveys was assigned a unique alphanumeric code and the following information was recorded:

- Date of first sighting
- Location
- Recorder
- Status (i.e. alive, dead or rescued)
- Estimated age
- Estimated date of birth
- Developmental stage (according to Radford; **Figure 2**)
- Mothers identification (where possible)
- Re-sightings dates
- Likelihood of successful weaning (fully transitioned from dependency on mothers' milk to be a self-sustaining individual)
- Photographic evidence (where possible)

CSGRT revisited pup locations during the lactation period and re-assessed pups from photos to avoid repeat counting.

*Survey frequency*

CSGRT volunteers undertook surveys at varying frequencies for each site. Ideally pup surveys are conducted at the optimum minimum of once every 17 to 21 days.

**Combined boat and land-based surveys**

Photographs from pupping sites enabled the number of pups recorded both on boat and land-based surveys to be determined.

A minimum estimate for pup production for 2019 was calculated by combining numbers of grey seal pups from both boat and land-based surveys and subtracting duplicated records and stage five and weaned moulted pups that could have begun their post weaning dispersal (indicating they could have originated from elsewhere and create a multiple count).

A relationship between the number of grey seal pups counted from boat-based cave visits versus the number of pups visible from geographically linked land-based surveys (i.e. nearby cliff tops) was determined for the period of boat-based surveys. This relationship offers a correction factor, such that the number of grey seal pups in caves could be estimated from cliff top counts alone.

The site fidelity of adult female grey seals to pupping caves and coves was established using boat and land-based photo-identification conducted during the 2016 and 2019 surveys.

# Results

### Boat-based pup surveys

Eight days of boat-based seal cave surveying were completed between 30/09/19 and 23/10/19 (**Table 1**). One hundred sites, representing 80 caves and 20 coves across 42 locations were surveyed (**Table 1**). Five additional locations were unsafe to survey: one in West Cornwall and four in Other (O).

**Table 1**. Survey dates and locations. All Location/site numbers are consistent with those used in 2016.

| Survey | Date | Area | Location |
|---|---|---|---|
| 1 | 30/09/19 | West Cornwall | 1-3, 5 & 40 |
| 2 | 12/10/19 | North Cornwall | 9 & 12 |
| 3 | 14/10/19 | North Cornwall | 8, 10-11, 41-44 |
| 4 | 15/10/19 | Other | 29, 31 & 35 |
| 5 | 20/10/19 | Lands End | 17-18, 21, 45-46 |
| 6 | 21/10/19 | Lizard East and West | 50-57 |
| 7 | 22/10/19 | Other | 24, 27-30, 34, 47-48 |
| 8 | 23/10/19 | Other | 37-38 & 49 |

Thirty-eight grey seal pups were counted at 24 (24%) sites (**Table 2**; **Figure 3**). Twenty-nine pups (76%) were white coated and nine (24%) had moulted. Six (15.8%) pups were classified as stage 1, six at stage 2 and 24 (63%) pups were estimated to be three weeks old (seals in stages 3, 4 and 5). Two pups were not assigned a developmental stage as they appeared severely underweight for their state of moult. Four detected pups were dead (two stage 1 emaciated white coat pups, one at stage 3 and one at stage 4). Most pups were observed in West Cornwall (n=17; 45%), followed by North Cornwall (n=9; 24%), Other (n=7; 18%), Lands End (n=3; 8%) and Lizard (n=2; 5%).

Thirteen pups (34%) were found in caves (ten hauled and three in the sea), 24 (63%) in open coves (one on the water's edge) and one (3%) was in the open sea (dead).

Other grey seals (adults and juveniles, n=173) were hauled out at 25 sites (**Table 2**; **Figure 4**). These were a combination of adult male, adult female and juveniles. Sixty percent (n=60) of surveyed sites within the 42 locations (**Table 1**) had no hauled seals present.

**Table 2.** Sites with seals observed during boat-based surveys.
North Cornwall (NC), West Cornwall (WC), Lizard East and West (LIZ), Lands End (LE), Other (O).
Ordered by area and survey site alphabetically.
Location numbers (shared from Table 1) that appear multiple times indicate complex topographic sites with multiple caves, coves or rock systems but share a common geographic place name.

| Survey sites with pups | Area | Number of pups |
|---|---|---|
| 45 | LE | 2 |
| 17 & 18 | LE | 1 |
| 53 | LIZ | 1 |
| 54 | LIZ | 1 |
| 42 | NC | 1 |
| 8 | NC | 3 |
| 9-11 | NC | 2 |
| 9-11 | NC | 1 |
| 38 | O | 2 |
| 29 | O | 1 |
| 29 | O | 3 |
| 30 | O | 1 |
| 1 | WC | 2 |
| 40 | WC | 2 |
| 3 | WC | 3 |
| 3 | WC | 1 |
| 2 | WC | 1 |
| 2 | WC | 2 |
| 2 | WC | 2 |
| 2 | WC | 1 |
| 5 | WC | 1 |
| 5 | WC | 1 |
| 5 | WC | 1 |
| 14 | WC | 2 |
| | | |

| Survey sites with other hauled seals | Area | Number of seals |
|---|---|---|
| 17 | LE | 2 |
| 21 | LE | 1 |
| 17 | LE | 7 |
| 53 | LIZ | 2 |
| 54 | LIZ | 2 |
| 42 | NC | 2 |
| 42 | NC | 3 |
| 42 | NC | 1 |
| 8 | NC | 1 |
| 8 | NC | 93 |
| 12 | NC | 1 |
| 9-11 | NC | 29 |
| 9-11 | NC | 8 |
| 9-11 | NC | 2 |
| 9-11 | NC | 2 |
| 9-11 | NC | 1 |
| 9-11 | NC | 1 |
| 9-11 | NC | 1 |
| 38 | O | 1 |
| 7 | O | 1 |
| 1 | WC | 1 |
| 3 | WC | 2 |
| 3 | WC | 1 |
| 2 | WC | 4 |
| 5 | WC | 4 |


**Figure 3**. Numbers of pups observed during boat-based surveys. Sites with no pups are not marked on the maps.


**Figure 4**. Numbers of seals observed during boat-based surveys. Sites with no seals are not marked on the maps.

*Disturbance*

Two hundred and eight seals were hauled out at surveyed sites during eight days of boat-based surveying. Of all hauled seals, 152 (73%) were disturbed into the sea. Seals remaining on land were 16% pups (n=33), 11% adults and juveniles (n=22) and 0.5% were dead (n=1).

At location eight, 94 of the 97 recorded seals were disturbed into the sea. The three remaining seals were pups. We observed multiple blood trails resulting from the stampeding seals sustaining injuries whilst rushing over rocks towards the sea (**Figure 5**).

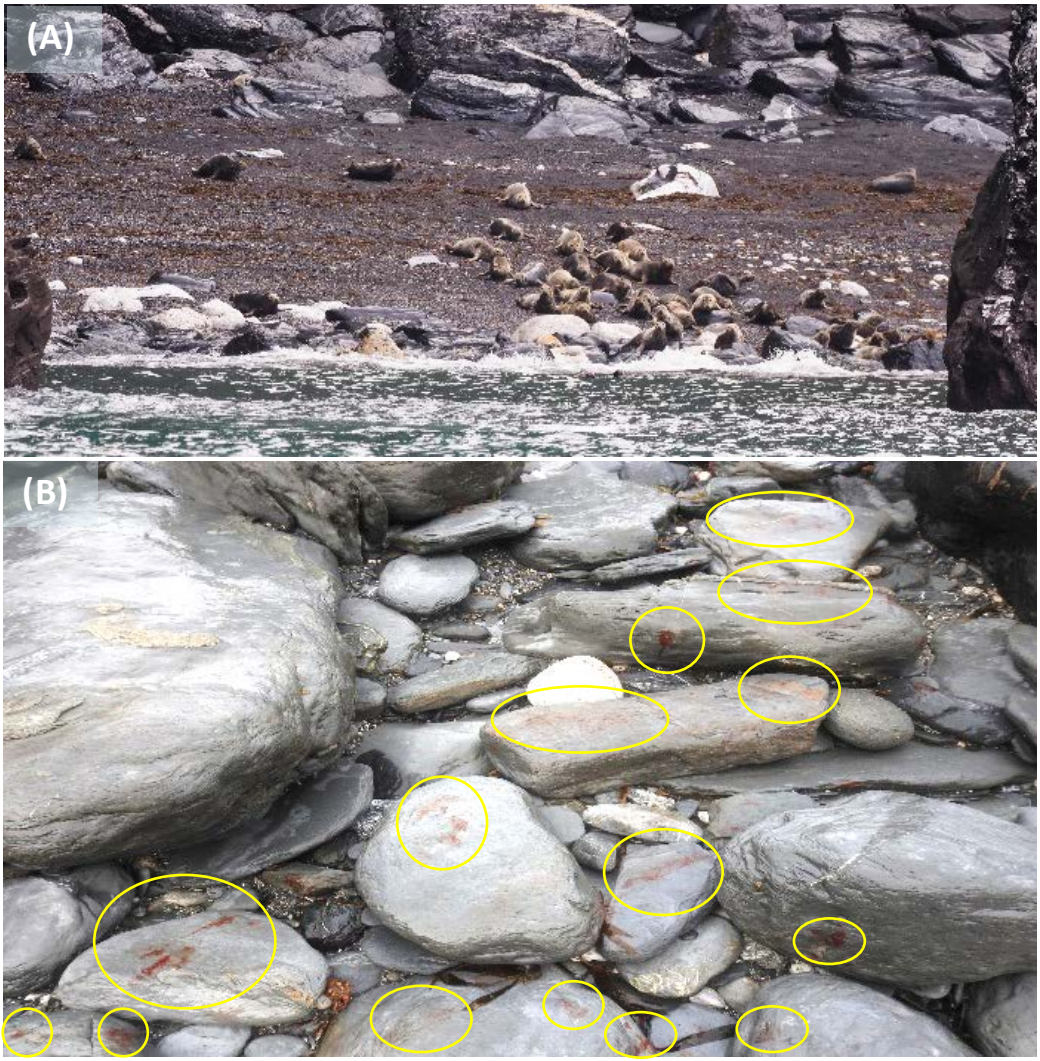


**Figure 5**. (A) Numbers of seals disturbed and those remaining on land. (B) Blood trails resulting from stampeding seals returning to the sea.

**Land-based pup surveys**

A total of 2120 surveys were completed between 01/07/19 and 31/01/20 by CSGRT volunteers covering 174 different locations including previously identified pupping sites (**Figure 6**). Of these, 1852 (87%) were in mainland Cornwall with 91 sites (52%) surveyed multiple times including 66 sites (38%) that were surveyed at least once a month up to a maximum of once per day.

White coated grey seal pups were recorded at 35 previously established pupping sites. During the peak pupping months of August to November, 22 of these sites were surveyed more frequently than the optimal 21-day interval; the duration from birth to weaning is between 17 and 23 days (**Table 3**).

Two hundred and fifty different individual volunteer contributors provided data, as well as information from a range of organisations with forty-seven of these volunteers recording white coated seal pups.

A total of 149 grey seal pups were recorded between July 2019 and January 2020 across Cornwall using land-based surveys. The first pup was recorded on 12th July 2019 with an estimated date of birth 9th July; this pup was dead. The last recorded white coated pup occurred on 5th January 2020; this pup was also dead. Most grey seal pups (n=101; 68%) were identified at 14 systematically surveyed locations (**Figure 7**; **Table 3**). Most pups were observed in West Cornwall (n=61; 41%), followed by North Cornwall (n=48; 32%), Other (n=18; 12%), Elsewhere in Cornwall (n=9; 6%), Roseland (n=6; 4%), the Lizard (n=5; 3%) and Lands End (n=2; 1%).

At systematically surveyed sites most pups were observed during September followed by October, then August (**Table 3; Figure 7**). Coves and their associated caves (where they exist) were occupied by mothers and pups for varying durations. Four surveyed locations were used for pupping for three months; eight locations were used for two months and thirty-five locations for one month (**Table 3**).

All 149 pups observed on land-based surveys were white coated in stages one to four of development (stage one n=60; stage two n=55; stage three n=13; stage four n=7; and fourteen were dead). Moulted stage five pups were not included as their post-weaning dispersal meant they could have originated from elsewhere.

**Table 3**. Systematic and *ad hoc* sites of land-based surveys for grey seal pups. Ordered by area and survey site. Areas: Lands End (LE), North Cornwall (NC), Roseland (R), West Cornwall (WC), Other (O), Elsewhere (E). Survey frequency: Daily (D), Twice/week (2W), Weekly (W), Fortnightly (F), Monthly (M), Occasional or *ad hoc* (O).

| Site | Area | Survey freq. Aug-Nov | Survey freq. Jul-Jan | Number of pups | Jul. 2019 | Aug. 2019 | Sep. 2019 | Oct. 2019 | Nov. 2019 | Dec. 2019 | Jan. 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | WC | W | F | 2 | | | 2 | | | | |
| OR-25 | WC | O | O | 1 | | | | 1 | | | |
| OR-10 | WC | F | M | 2 | | | 2 | | | | |
| B | WC | 2W | W | 13 | | 1 | 10 | 2 | | | |
| C | WC | 2W | W | 13 | | | 13 | | | | |
| D | WC | 2W | W | 7 | | | 7 | | | | |
| P | WC | 2W | W | 2 | | | 2 | | | | |
| Q | WC | 2W | W | 5 | | | 4 | 1 | | | |
| F | WC | 2W | W | 15 | | | 6 | 8 | 1 | | |
| OR-13 | WC | O | O | 1 | | | | 1 | | | |
| R | NC | O | O | 1 | | | | 1 | | | |
| OR-5 | NC | O | O | 1 | | | | 1 | | | |
| G | NC | 2W | W | 16 | | 2 | 10 | 4 | | | |
| OR-26 | NC | O | O | 2 | | | 1 | 1 | | | |
| K | NC | F | F | 8 | | | 5 | 3 | | | |
| H | NC | F | M | 3 | | | 3 | | | | |
| I | NC | 2W | W | 6 | | | 4 | 2 | | | |
| J | NC | W | W | 9 | | | 8 | 1 | | | |
| S | NC | O | O | 1 | | | | 1 | | | |
| OR-7 | NC | O | O | 1 | | | | 1 | | | |
| OR-27 | O | M | O | 1 | | | 1 | | | | |
| OR-28 | O | O | O | 1 | | | 1 | | | | |
| OR-29 | O | O | O | 2 | 1 | | 1 | | | | |
| L | O | 2W | W | 4 | | | 2 | 1 | | | 1 |
| OR-8 | O | O | O | 2 | | | | 2 | | | |
| M | O | F | F | 7 | | | 4 | 3 | | | |
| OR-30 | O | F | M | 1 | | 1 | | | | | |
| OR-31 | LIZ | O | O | 1 | | | | 1 | | | |
| T | LIZ | D | D | 1 | | | | 1 | | | |
| OR-14 | LIZ | O | O | 1 | | | | | 1 | | |
| E | LIZ | D | D | 1 | | | | 1 | | | |
| N | LIZ | F | M | 1 | | | 1 | | | | |
| U | R | F | F | 3 | | | 1 | 2 | | | |
| OR-32 | R | O | O | 1 | | | 1 | | | | |
| OR-33 | R | O | O | 1 | | | | 1 | | | |
| V | R | F | F | 1 | | | | 1 | | | |
| OR-34 | LE | O | O | 1 | | | | 1 | | | |
| OR-35 | LE | F | M | 1 | | | | 1 | | | |
| OR-36 | E | O | O | 1 | | | | 1 | | | |
| OR-37 | E | O | O | 1 | | | | 1 | | | |
| OR-38 | E | O | O | 1 | | | | 1 | | | |
| OR-39 | E | O | O | 1 | | | | 1 | | | |
| OR-40 | E | O | O | 1 | | | | 1 | | | |
| OR-41 | E | O | O | 1 | | | 1 | | | | |
| OR-42 | E | O | O | 1 | | | | 1 | | | |
| OR-43 | E | O | O | 1 | | | | 1 | | | |
| OR-44 | E | O | O | 1 | | | | 1 | | | |

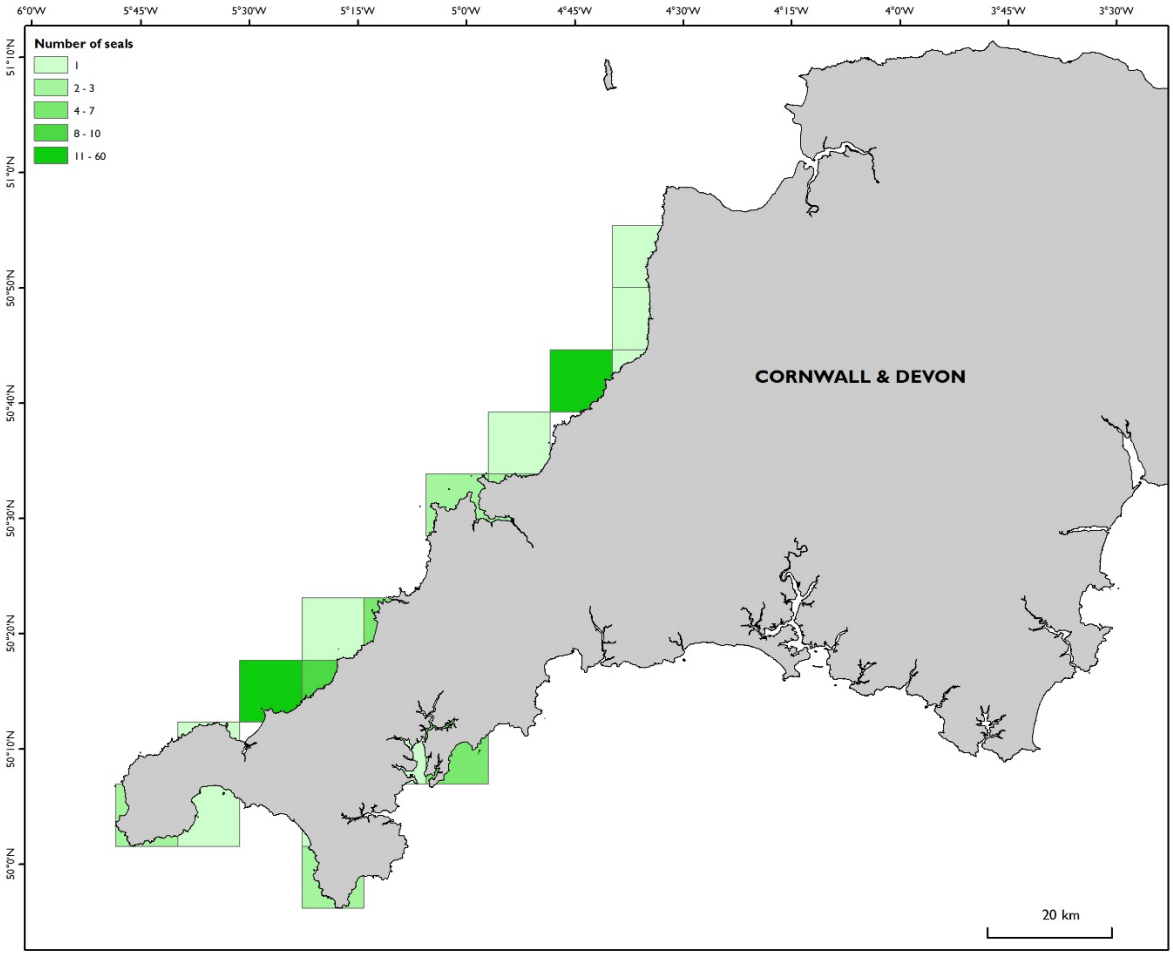


**Figure 6.** Locations of observed grey seal pups in Cornwall and from land-based surveys (systematic and *ad hoc*) shown using a 10 km x 10 km grid.

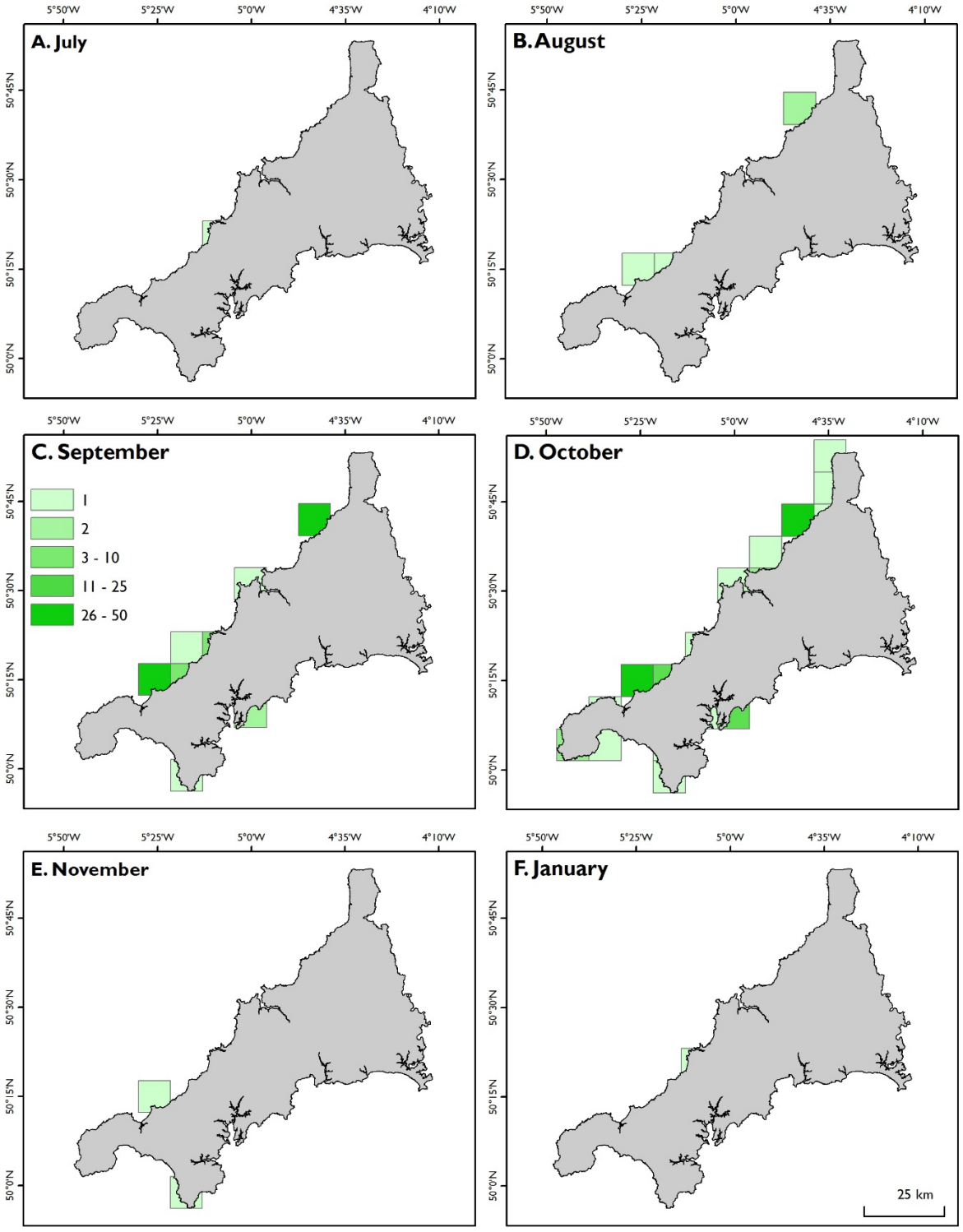


**Figure 7.** Monthly pattern of grey seal pups in Cornwall from land-based surveys shown using a 10 km x 10 km grid. December not included as no pups were recorded.

**Combined boat and land-based surveys**

The numbers of grey seal pups observed during boat and land-based surveys were combined to produce a minimum estimate for pup production for 2019 (**Table 4**).

Twenty two of the 38 pups observed on boat-based surveys had previously been observed from land prior to boat-based surveying and 16 were new records. Eight of these new records were subsequently observed from land. To eliminate the possibility of duplication, four of the new records were not included in the final dataset of 153 pups. These pups were all developmental stage five; they were weaned and moulted pups and could have already begun their post-weaning dispersal and could therefore have been previously recorded by CSGRT volunteers on land.

Four pups (3%) were observed only via the boat-based surveys; three of which were in caves and one in a cove, located at Lands End and the Lizard. Three of these pups were at developmental stage 3; the other was dead (in the sea, in a cave at the Lizard).

*Pup mortality rates during lactation*

Ten percent of the pups observed (n=16) were tracked to successful weaning for over 17 days or were considered sufficiently well fed to survive at the completion of weaning. Twenty four percent of pups were not successfully weaned. The minimum estimated mortality rate during the first three weeks was 14%.

**Table 4**. Counts of grey seal pups from boat and land-based surveys.

| **Survey type** | **Pups** |
|---|---|
| Boat-based counts | 38 |
| Land-based cove counts | 149 |
| Maximum number of pups visible from boat and land (subtraction) | -30 |
| Duplicate records error margin (subtraction) | -4 |
| **Minimum number of pups observed from boat and land surveys** | **153** |

*Site fidelity for both 'individual seals' and 'sites'*

Adult female grey seals observed in close proximity to or feeding pups (confirmed mothers) were photographed in both 2016 (n=28) and 2019 (n=65), (**Table 7c**). Dominant adult male grey seals ("Beach masters") observed on surveyed beaches, caves and coves were additionally photographed in 2019 (n=7). Seven seal pup mothers were identified as having pupped in both 2016 and 2019 at four sites, all in North Cornwall and West Cornwall. Six of these female adult seals pupped at the same sites in both 2016 and 2019. One adult female grey seal pupped at two sites 75 km apart in 2016 and 2019 (West Cornwall and North Cornwall respectively). Twenty-two locations were used for pupping in both 2016 and 2019 (**Table 5; Table 6**).

**Table 5**. Locations pups were observed on boat-based surveys in both 2016 and 2019.

| Location | Area | Number of pups 2016 | Number of pups 2019 |
|---|---|---|---|
| 17 & 18 | LE | 3 | 1 |
| 8 | NC | 6 | 3 |
| 9-11 | NC | 7 | 3 |
| 29 | O | 1 | 1 |
| 29 | O | 3 | 3 |
| 1 | WC | 2 | 2 |
| 3 | WC | 3 | 4 |
| 2 | WC | 2 | 6 |
| 5 | WC | 2 | 3 |
| 14 | WC | 6 | 2 |
| **Total pups (sites used 2016 and 2019)** | | **35** | **28** |
| **Total pups at all sites** | | **44** | **38** |

**Table 6**. Locations where pups were observed on land-based surveys in both 2016 and 2019.

| Location | Area | Number of pups 2016 | Number of pups 2019 |
|---|---|---|---|
| A | WC | 2 | 2 |
| OR-10 | WC | 1 | 2 |
| B | WC | 9 | 13 |
| C | WC | 3 | 13 |
| D | WC | 13 | 7 |
| F | WC | 5 | 15 |
| OR-13 | WC | 1 | 1 |
| OR-5 | NC | 2 | 1 |
| G | NC | 11 | 16 |
| K | NC | 2 | 8 |
| H | NC | 2 | 3 |
| I | NC | 4 | 6 |
| J | NC | 2 | 9 |
| OR-7 | NC | 2 | 1 |
| L | O | 1 | 4 |
| OR-8 | O | 2 | 2 |
| M | O | 2 | 7 |
| OR-14 | LIZ | 1 | 1 |
| E | LIZ | 2 | 1 |
| N | LIZ | 5 | 1 |
| **Total pups (sites used 2016 and 2019)** | | **72** | **113** |
| **Total pups at all sites** | | **90** | **149** |

**Comparison of 2016 and 2019 surveys**

Survey efforts increased in 2019 from those in 2016 in both boat and land-based surveys. An additional geographical area (Lizard) was surveyed by boat in 2019. More sites and locations were surveyed in 2019 using both survey techniques: twice as many sites were surveyed by boat (2016 n=50, 2019 n=100) and more than five times as many were surveyed from land (2016 n=34, 2019 n=174) than in 2016. The number of voluntary contributors and individual land-based surveys also increased in 2019 (**Table 7a-b**). There was a decrease in the number of pups observed in caves (2016 n=25, 2019 n=13) despite a higher number of caves surveyed in 2019 (2016 n=32, 2019 n=80) (**Table 7a**). Pups were recorded over a longer season in 2019 (July- January) than in 2016 (Sept-November). The peak pupping month of September is consistent in years 2016 – 2019. Fluctuations in pup numbers persists across several years. The pup counts for each area taken as a percentage of the total pups and the minimum estimated pup mortality rate in 2019 are consistent with results from 2016 (**Table 7b-c**).

**Table 7a-c**. Comparative survey data for years 2016 – 2019 in Cornwall.

| **a) Boat-based surveys** | **2016** | **2019** |
|---|---|---|
| Days surveying | 8 | 8 |
| Geographical areas surveyed | 5 | 6 |
| Total sites surveyed | 50 | 100 |
| Cave sites surveyed | 32 | 80 |
| Cove sites surveyed | 18 | 20 |
| Total pups counted | 44 | 38 |
| Pups in caves | 25 | 13 |
| Pups in coves | 19 | 24 |
| Pups in caves and coves not observed from land-based surveys | 26 | 4 |
| Other hauled seals (adults and juveniles) | 34 | 175 |
| Disturbance of other hauled seals | 94% | 86% |

| **b) Land-based surveys** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|
| Total surveys | | 1952 | | | 2120 |
| Voluntary contributors | | 92 | | | 250 |
| Total sites surveyed | | 34 | | | 174 |
| Total pups counted | 90 | 90 | 135 | 79 | 149 |
| Pups not observed during boat-based surveys | | 80 | | | 119 |
| First recorded pup | | Sept. | | | July |
| Last recorded pup | | Nov. | | | Jan. |

| **c) Combined boat and land-based surveys** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|
| Total pups | 90 | 124 | 135 | 79 | 153 |
| Total locations surveyed | | 39 | | | 47 |
| Pups by area: Lands End | | 6% | | | 3% |
| Pups by area: Lizard | | 9% | | | 5% |
| Pups by area: North Cornwall | | 34% | | | 31% |
| Pups by area: Other | | 6% | | | 11% |
| Pups by area: Roseland | | 0% | | | 4% |
| Pups by area: West Cornwall | | 39% | | | 40% |
| Pups by area: Elsewhere | | 6% | | | 6% |
| Minimum estimated pup mortality rate (first three weeks) | | 16% | | | 14% |
| Peak pupping month | | Sept. | Sept. | Sept. | Sept. |
| Confirmed seal mothers photo identified | | 28 | | | 65 |

# Discussion

**Boat-based surveys**

*Survey frequency*

Caves were surveyed from late September and throughout October to ensure survey effort overlapped with the assumed peak period of pupping to enable the maximum number of grey seal pups to be recorded. Eighty caves and twenty coves across 42 locations were surveyed within this timeframe. Survey effort was sufficient to provide simple presence and absence data in caves at a single point in time within the pupping season. However, the method cannot provide a more complete pup production estimate for the season. This could be achieved with more frequent surveys but would result in more disturbance.

*Pup counts*

Most pups were recorded at West Cornwall sites, contributing almost twice as many as North Cornwall; followed by caves in Other, Land's End and the Lizard. Thirteen of the thirty-eight pups were recorded in caves. Only four pups were seen that had not been previously or were subsequently recorded from the land.

*Disturbance*

Many of the hauled seals encountered (n=152, 73%) were disturbed during the boat-based surveys, this mostly occurred in North Cornwall where seal survey sites coincided with greater numbers of seals initially concealed from view during surveyor approach. There are few examples of the direct impact of disturbance on seals from disturbance and so the longer-term effects of disturbance from surveying are unknown. Photographic evidence of bleeding from injuries, collected during these surveys provides a valuable resource to share with the public illustrating why best practice is needed to minimise seal stampedes or tombstoning (diving off land from a height onto rocks or into water).

*Thermal Infra-red technology*

The use of a FLIR Scout thermal IR camera provided a useful technique for detecting seals prior to them being seen under poor lighting conditions in caves. Detecting the seals with this technology ensured the survey team had additional time to more effectively plan safe exit routes for seals enabling better disturbance management. In all cases seals were visible to the FLIR Scout and pups could be separated from adults and counted in most cases. The use of a handheld flood light and waterproof wrist mounted torches ensured the survey team was always visible to the seals.

**Land-based surveys**

Land-based surveying of seal pups provided comprehensive coverage of most seal pupping sites except for Lands End and remote parts of the Lizard. This exception reflects the inaccessibility of coast and steep cliffs in this area that reduce pup visibility to coastal path walkers.

A total of 149 pups were observed at 47 sites across Cornwall. The peak pupping month of September, followed by October, was one month earlier than that for Cornwall in years 2000 to 2013. Although

this pattern is consistent with more recent years 2016 – 2018 (Sayer, 2015, 2017 and 2018 unpublished raw data; Sayer and Witt 2016 Natural England Commissioned Report).

Several factors affect pup production including the environmental conditions of their habitat such as extreme weather events, sea conditions and human impacts such as disturbance as well as breeding success in the previous year. As a result, fluctuations in pup production are expected to occur and this is reflected in CSGRT's unpublished raw data for intervening years (2017 n=135 pups; and 2018 n=79 pups).

**Combined boat and land-based surveys**

A total of 153 unique grey seal pups were recorded from boat and land-based surveys including 15 dead and 16 rescued pups. Two areas, West Cornwall (n=61 pups) and North Cornwall (n=48 pups), were the most productive for grey seal pupping. The boat and land-based surveys produced complementary results that are consistent with data obtained using the same survey methods as 2016's Sea Cave Research Project.

*Correction factor*

Given the challenging nature of conducting boat-based surveys and the disturbance that can result, a correction factor was developed using data gathered for seal caves and coves that could be both viewed from cliff tops and direct accessed by the boat-based survey team. The comparison was conducted using data for the period 30/09/19 to 23/10/19 only (the duration of the boat surveys). Of the 57 seal pups recorded during this period, 7% (n=4) were sighted only as a result of boat-based surveys; these were in remote locations at Lands End and the Lizard inaccessible to land-based surveyors. As such, counts of grey seal pups made from cliff tops could be divided by 0.93 to produce a conservative estimate of the number of seal pups likely to exist.

*Mortality*

Direct observations of four dead pups (of 38 pups) on boat-based surveys suggests a possible minimum mortality rate of 11%. This figure increases to a minimum of 14% when all 153 seal pups from both boat and land-based surveys are taken into consideration. This is consistent with the mean rate of mortality prior to weaning of 15% (Davies 2001) and data obtained in 2016 (16%). It should be noted however that it was not possible to assess the likelihood of successful weaning for the majority of pups observed (n=100).

*Site fidelity*

Twenty-two pupping locations were used by adult female grey seals in both 2016 and 2019. Seven seal pup mothers were identified as pupping in both 2016 and 2019. Of these, six pupped at the same cave or cove site.

# Conclusion

It has taken 20 years for CSGRT to build knowledge of Cornwall's grey seal pupping sites and to recruit the extensive network of volunteers able to conduct the intensive surveys across Cornwall that we have today.

Most grey seal pups were recorded at the sites in West Cornwall and North Cornwall (n=109, 71%); this is consistent with data obtained in 2016 (73%). Adult female grey seal fidelity to a site for pupping was determined using photo identification, six of seven seal mothers who pupped in both survey years did so at the same sites; these were all at West Cornwall and North Cornwall, but notably the seventh adult female pupped at two locations 75 km apart. Most pupping locations used both in 2016 and 2019 (by all seals, identified or not) were also in West Cornwall and North Cornwall (63.3%). These factors combined consolidate the evidence that these are the two most important grey seal pupping regions in mainland Cornwall (the Isles of Scilly and Lundy being important offshore pupping sites and Special Areas of Conservation not included in this report). Seals in both the West Cornwall and North Cornwall areas are included as features of interest in the designations of their respective Sites of Special Scientific Interest (SSSI).

Boat-based surveys contributed four grey seal pups that were not seen from land providing a factor of 7%. This is much lower than the corresponding data from 2016 (26%). This may be attributed to the increase in survey effort improving the spatial and temporal coverage of the land-based data. Only two pups at the West Cornwall and North Cornwall sites went unobserved via land-based surveys in 2016, both pups were in a cave at location two. All pups recorded at West Cornwall and North Cornwall were observed on land-based surveys in 2019. Land-based surveying would be the preferred technique deployed in future surveys at these sites.

Land-based surveys recorded a further 119 pups across the region that were not seen during boat surveys which had covered smaller spatial areas and shorter temporal scales. Thirty pups were recorded on both boat and land-based surveys. Boat and land-based surveys provided complementary results, with the boat surveys providing data from caves and land-based surveys providing wider spatial and temporal coverage of the pupping season. Land-based surveys were conducted at optimal frequency throughout the pupping season without any disturbance of seals.

## Recommendations

Land-based surveying by volunteers is the most sustainable option and likely to produce the most accurate data with the best spatial and temporal coverage.

A total of 153 pups were recorded during the seven-month period; only four of these pups were not visible from land-based surveys. Looking only at sites that were surveyed by both boat and land, all pups recorded were seen from land. This suggests that where possible, land-based surveying is highly effective and because of its minimal potential impact land-based surveying is the recommended method for sites visible from land. This is particularly the case for sites supporting high numbers of seals as land-based approaches avoid disturbance hence limiting stampedes that can be trigged by boat-based surveys.

For sites that are not visible from land and with caves readily accessible by kayak, such as Lands End, boat surveying remains the most suitable option. Larger caves are better accessed over high water (where headroom enables safe access) when pups remain ashore relatively undisturbed by survey teams and mothers have short and easier access routes to the sea. This minimises the potential for injury to seals arising from long egress routes across boulder beaches. Surveying at a higher tide also ensures surveyors have less challenging ground to cover to find pups that are typically located towards the back of the cave or cove.

We recommend trialling the implementation of remote camera systems on the entrances of larger caves that are not visible from land nor easily accessible by kayak such as those at the Lizard. To minimise disturbance, this would need to be done prior to the pupping season and then to record data throughout the season. As remote cameras in caves cannot easily cope with the darkness, remoteness, moisture and pressure; cameras on some of the larger cave entrances could quantify the adult females accessing and exiting caves. This coupled with photo identification would reveal more about the numbers of pups in caves. CSGRT have previously noted that the number of adult females just on and offshore at a pupping site closely corresponds to the number of pups present onshore (Sayer and Witt 2016b). Pregnant females arrive shortly before giving birth and leave suddenly at weaning to feed. This pattern was also observed during the current surveys as the number of females present on land, then disturbed into sea and remaining just offshore was typically the same as the number of pups present onshore. This solution would improve the accuracy of data by providing greater temporal coverage than that achieved by boat-based surveying.

These three methods in combination would ensure that disturbance caused is minimised, as the consequences of disturbance could affect pup production due to the short and intense weaning period of grey seal pups.

The Cornwall Wildlife Trust's Marine Strandings Network hold data on dead seal pups. An analysis of dead white coated pups from 2019 would increase understanding about grey seal pup mortality rates in comparison to pup production summarised in this report.

The two most productive areas for pups coincide with Sites of Special Scientific Interest (SSSI) where seals are listed as a special interest feature. It is recommended that awareness of this should be raised through public signage, including enforcement action for disturbances to wildlife or for destroying any features of interest.

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