# Calf of Man Seal Survey

*Autumn 2023*


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# Summary


**Pup Census:**

- A total of 96 seal pups were recorded and monitored on the Calf of Man during the survey period, marking the highest number since 2009.
- Pup numbers increased steadily over the years, reaching a new peak in 2023.
- The survey revealed the timing and distribution of pup births across the island, with certain sites being more productive than others.

**Pup Development and Mortality:**

- Out of the 96 pups observed, 82 were born on the Calf of Man, with 14 being wanderers.
- The mortality rate of pups during the survey period was 4.17%, lower than previous years.
- Factors contributing to pup mortality included stillbirth, infection, trauma, and adverse weather conditions.

**Site Fidelity:**

- Over half of the identifiable breeding cows (51.04%) were returning mothers, indicating a degree of site fidelity.
- Site fidelity analysis showed that 63% of returning mothers pupped at the same site as their last recorded pup, with an additional 10% pupping within the same sector.

**Birthdate Analysis:**

- 79% of mothers that pupped in 2022 pupped later in 2023.
- This suggests that factors influencing pupping dates are complex and may not solely be driven by rising temperatures.

**Use of Drone Technology (UAS):**

- Drone technology proved to be a valuable tool in monitoring seal populations, especially in inaccessible areas.
- Drones facilitated the identification of pups, monitoring of growth stages, and collection of high-definition images for individual identification.
- Elevation protocols were established to minimize disturbance to seals during drone operations.

**Additional Observations:**

- Instances of allosuckling, where a mother feeds a non-filial pup, were observed during the survey period.
- Disturbances caused by human activities, such as supply boat docking, were recorded, highlighting the need for minimizing human impacts on seal habitats.
- Three tagged seals were identified, providing insights into seal movements and research collaborations.

**Conclusion:** The research conducted on the Calf of Man Island has provided valuable insights into grey seal pup mortality, site fidelity of returning mothers, and the effectiveness of using drone technology for wildlife monitoring. The findings contribute to our understanding of seal population dynamics and habitat conservation efforts in the region. Efforts to minimize disturbances and mitigate human impacts on seal habitats are crucial for the continued conservation of grey seal populations on the Calf of Man Island.

# Introduction

Background

The British Isles is home two species of "true seal", grey seals (*Halichoerus grypus)* and harbour seals (*Phoca vitulina)*. These species were previously overexploited, being hunted for meat and gaining a bad reputation within fisheries. This led to noticeable declines in number (Mowat, 1984), with grey seal populations falling to only 500 in the early 20th century. Both are now protected under the 1976 Wildlife Act and the 1990 Manx Wildlife Act, with recovery in both populations being seen as a result of enforcements of these protections. The IUCN now recognises both species as 'Least Concern' in their assessment, with population numbers beginning to stabilise.

Grey seals are the predominant species of seal spotted around our coastlines with an estimated population of over 150,000 grey seals around the UK making up 95% of the European population. The British Isles are extremely important for grey seals with an estimated 37% of the global population breeding in the UK and Ireland. Whereas harbour seals, though widespread globally, are more of a rarity in British waters (Manx Wildlife Trust., 2020). Thus, grey seals are the focus of many marine mammal surveys and marine research within the UK. The highly mobile and pelagic nature of marine mammal species often makes them difficult to monitor (Gordon et al., 2003) however seals spend set periods of time on land for moulting, breeding and resting (Sayer et al., 2019). During these times, individuals 'haul out' in large numbers providing a perfect opportunity to gather data on population, size and fecundity acting which can acts as a good indicator of the local marine ecosystem health as a whole (Kaschner et al., 2001).

Here, breeding season is used as an opportune period to monitor population health, site fidelity and pup success due to the large aggregation of seals during this time. Female grey seals aggregate at specific locations during breeding season, giving birth to a single pup. Seal pups will suckle intensively for 15-21 days, during which the mums will stay with the pup and do not leave to feed (Fedak and Anderson, 1982; Pomeroy *et al.,* 1999). Females will leave their pups once they are weaned, with pups staying on land until they complete their moult. Pups will begin to lose their white lanugo coat post weaning revealing their adult pelage (Russell *et al.,* 2019), which can be used to identify individuals. This post-weaning period can last around 9-40 days (Baylis *et al.,* 2019), during which pups fast and can lose up to 25% of their body mass (Noren *et al.,* 2008) before fully moulting and entering the sea to learn to forage and feed (Russell *et al.,* 2019). First-year mortality

for grey seal pups is high, ranging from 38% for females to 80% for males (Hall *et al*., 2001). Thus, studying them at this stage is important to better understand population dynamics (Hall *et al.,* 2001).

In addition to monitoring pup success, breeding season provides a good opportunity to monitor site fidelity in not only breeding females but also in male seals. Grey seal cows are known to show significant site fidelity in pupping location (Pomeroy *et al.,* 1999) influenced by previous pupping success, familiarity with local conditions, predictability of habitat quality and experience level of the female (Weitzman *et al.,* 2017). On completion of weaning, the female seals mate with the male who has maintained dominance of that specific pupping location through repeated physical contests with rival males (Bubac et al., 2018). Due to the crossover between pupping and mating season, this period allows for study of population size of mature adults and their site fidelity. As early as post-weaning moult, grey seals are left with an individual pelage which can be used to identify them, much like human fingerprints. These unique patterns remain visible and stable throughout their lives (Sayer *et al.,* 2019) but do darken with age (Vincent *et al.,* 2001). Matching identification photographs from previous breeding seasons allows us to study the level of site-fidelity and number of returning individuals within the population.

Manx waters are particularly important for grey seal populations, with around 100-400 of the British population being observed around the Isle of Man at any given time (Howe and Parsons, 2017). The Isle of Man's abundant waters and rocky coastline provide the perfect habitat for grey seals with the Calf of Man, a small islet half a mile off the mainland, being recognised as significant site for Manx seals (Duck, 1996). The isolation and low level of human disturbance makes the Calf the ideal location to study seals with minimal influence from external factors. The Calf is the main breeding site for grey seals around the Isle of Man and has been monitored annually since 2009 by Manx Wildlife Trust through their seal pupping survey. Through the months of September to November, two dedicated seal pup volunteers reside on the Calf partaking in daily surveys. With the main objectives of surveys as follows;

<u>Objectives</u>

1. Collect photographic identification images of seals, to compare and match individuals to the catalogue database.

2. To monitor site fidelity, reproductive output and life history, predominantly of female seals.

3. Produce a seal pup census, recording the number of grey seals born during the pupping season at all known pupping sites around the Calf of Man.

4. To monitor the development of pups and determine survival rates of pups born on the island.

5. Determine the proportion of returning and new mothers pupping on the island.

# Methods

Study Area

The Calf of Man is a small largely uninhabited island located half a mile off the southwest coast of the Isle of Man. The Calf of Man has long been considered as an important site for grey seals within the Irish sea, due to its rocky inlets and beeches proving ideal habitat for seal birth site selection (Duck, 1996; Crow, 2013). Previous surveys of the seal pupping season have identified the 15 sites along the north and south coastlines utilised for pupping, which are now the pupping sites monitored throughout the survey season (Figure 1). These sites range in area from to 2,111m²-21,821m², with habitat consisting of gullies, rocky out crops and pebble beaches, providing haul out sites and possible shelter. The eastern and western coasts of the island lack suitable haul-out sites due to the sheer cliffs and therefore there has been a historical absence of pupping in these areas and so these areas are only surveyed during the island wide seal counts.

Map showing survey locations.

| Code | Location |
|---|---|
| CL | The Cletts |
| GH | Grant's Harbour |
| CH | Cow Harbour |
| WC | West of Cow |
| GI | Gibdale |
| BF | Bay Fine |
| AM | Amulty |
| BO | Bay yn Ow |
| GL | Ghaw Lang |
| SC | Smugglers Cave |
| CP | Caigher Point |
| LE | The Leodan |
| MG | Mill Giau |
| PU | The Puddle |
| SH | South Harbour |

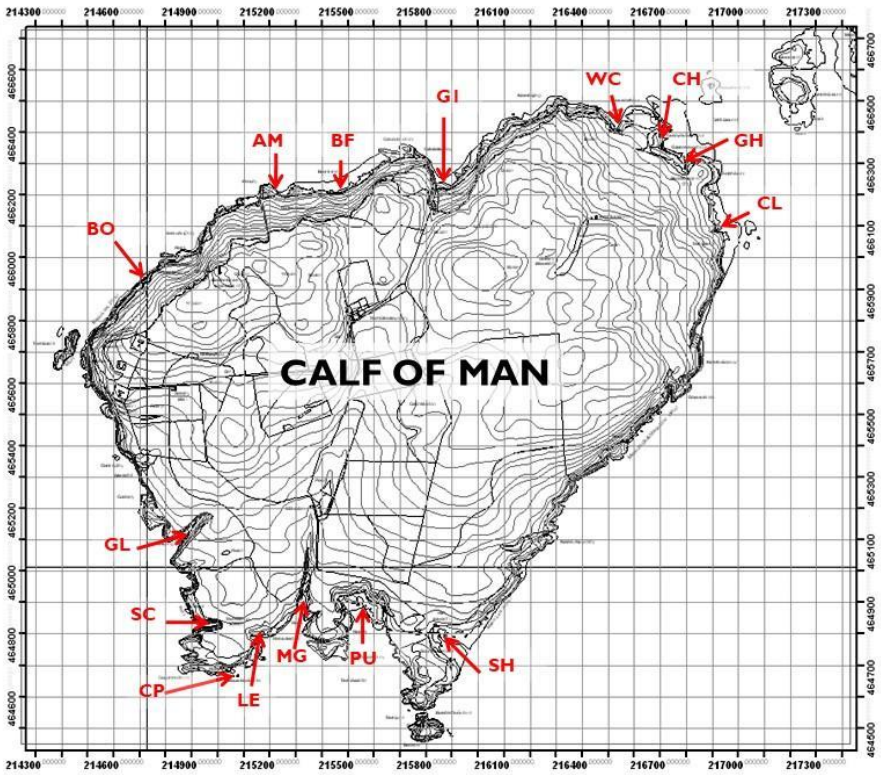


*Figure 1 Map of Calf of Man showing the 15 different grey seal pupping locations used for surveys. Table provides full names of sites and corresponding codes.*

Data Collection

The breeding season on the Calf of Man occurs between September and November (Stones *et al.,* 2013), so data collection is carried out during this period, which this year was from 5th September to 3rd November by volunteers Duncan Kenny and Bethany-Paige Begbie, with guidance from Manx Wildlife Trust Marine Officer Dr Lara Howe. Of the 15 sites, two survey routes of seven sites were formed, consisting of North sites (BO-CL) and South sites (GL-SH) (Figure 1). To be able to accurately track pupping on the island, but with the aim to also reduce the impact of human disturbance, survey routes were carried out on alternate days. All seals and pups present at a site, both hauled-out and in the water, were counted at each visit. Island wide surveys were completed on three occasions by foot: 25/09/2023 (174 seals), 22/10/2023 (294 seals), 02/11/2023 (223 seals). These consisted of a whole island count of adult seals and pups along the coast of the island in addition to pupping sites.

The surveys consist of two parts, firstly to carry out a pup census of the island and secondly to count and photograph adult seals to carry out photo identification for population estimates. Upon reaching each site, the number of pups present were noted, including if there had been any births since the previous visit, as well as classifying the age of each pup. During pup observations, behaviours that confirmed filial relationships, such as suckling, were photographed and recorded. On occasions when insufficient data was collected during the initial site visit, a return visit was carried out later that day, sometimes requiring the surveyor to sit out-of-sight until the necessary photographs could be taken to match pups to mothers by witnessing suckling.

In addition to this, the number of adults were counted and photographed using a Nikon Coolpix P100 digital camera with a 24-3000mm lens and a Canon EOS 77D DSLR camera fitted with a 150-600mm lens. In order to carry out photo identification, images were taken of seals that showed clear natural pelage markings, with where possible of both left and right sides of the seal preferably of both the head and flank of each side. Using high-quality photographs of individuals increases chances of re-identify from previously identified individuals in the catalogue, and reduces the chance of false rejections, whereby one individual is duplicated (Hiby *et al.,* 2013). Priority of photographs were given to mothers and pregnant females, to aid the tracking of pups and so we were able monitor mothers for analysis on site fidelity.

Poor visibility at some site observation posts makes it hard to identify the presence of seals and pups due to geographical restrictions such as cliffs, rocky outcrops, and sea level caves. Four sites in particular Smugglers Cave, Bay Fine, Amulty and Bay yn Ow being notorious for this.
This year two additional photographic methods were utilised to try and overcome the visibility limitations at these sites;

1. a Pulsar Helion 2 XP50 Thermal Imaging Spotter Scope Camera. The thermal imager assists as it detects temperature differences between the seals and the surrounding, and thus highlight seals in red and yellow, being warmer than the surrounding rocks. With a core average body temperature of 38.9°c (Worthy, 1991), thermal imaging cameras are an ideal tool for confirming seal pup presence when visibility is low, as seen in Figure 2.

2. A DJI Mavic 2 Zoom UAS (Unmanned Aircraft System [drone]). The UAS assists as the camera can be positioned at a safe distance utilising the zoom feature minimising risk of disturbance and maximising appropriate angle for observation of seals in remote or hidden areas, as seen in Figure 3.

Through this we were able to accurately count the number of seals and pups even when we were unable to see them ourselves from the observation posts.

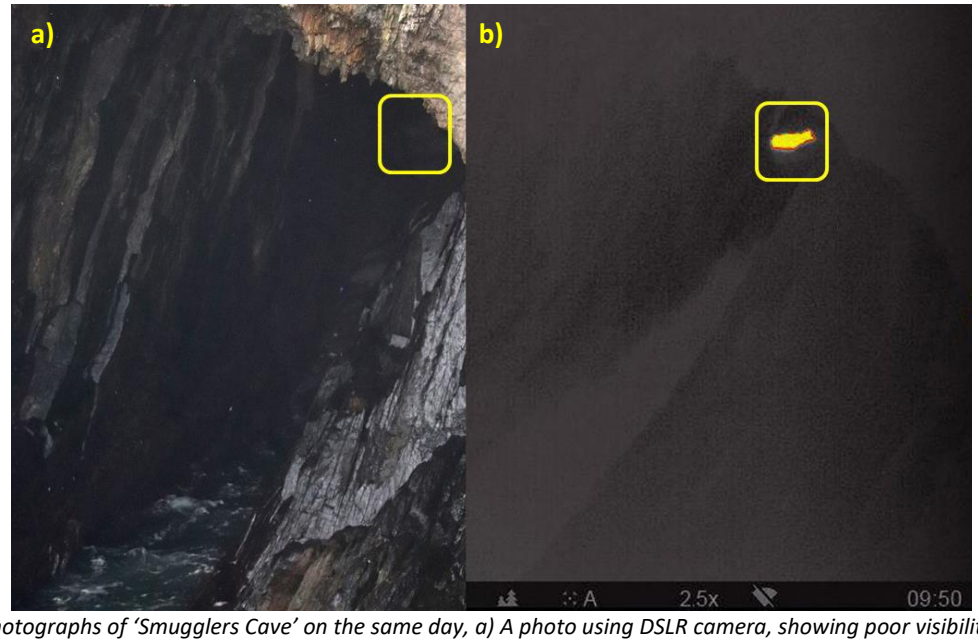


*Figure 2 Photographs of 'Smugglers Cave' on the same day, a) A photo using DSLR camera, showing poor visibility to see pup (highlighted in the yellow box) compared to b) using the thermal imager confirms presence of pup in the cave.*


*Figure 3 Photographs of 'Bay Fine' on the same day, a) A photo using DSLR camera, showing poor visibility to see pup and adult seals beside large stone block (highlighted by the yellow arrow) compared to b) using the UAS confirms presence of pup (1), mother (2) and additional pregnant cow (3).*

Pup Development Stages

The photographs of the pups through their developmental stages were assessed using a system of classification into five stages (see Appendix A), whereby their physical appearance and behaviour can be related to pup age (Kovacs and Lavigne, 1986; Radford *et al.,* 1978; Russell *et al*., 2019). The stages are separated by characteristics including percentage of lanugo coat vs moulted and body shape. The appearance of fresh afterbirth, umbilical cord and lanugo coat stained yellow along with blood around the mother also was used to indicate a pup was recently born. Tracking the developmental stages allowed the team to monitor the growth of seal pups (Figure 4), and the success rate of pups born, all of whom were named beginning with a single letter of the alphabet (the letter 'A') as per the ongoing system on the Calf of Man.

This year it was decided to take on an assessment of pup condition as used by researchers on Skomer Island undertaking a similar project. An assessment of pup condition was made at last sighting of pup, classified on a five-point scale:

| | |
|---|---|
| 1. Very small | Assumed not to have survived long after moult |
| 2. Small but healthy | In good condition, would have a reasonable chance of survival |
| 3. Good size | Most should survive |
| 4. Very good size | All should survive |
| 5. Super-moulter | An exceptional sized pup |

Seal pups were considered successful if they survived until the beginning of moult, unless they were in poor condition (Hewer, 1974). If a pup disappeared before the beginning of moult an individual assessment was made on its likelihood to have survived based on the above criteria. Pups ≥ size 3 were assumed successful, whereas pups smaller than size 3 were assumed unsuccessful.


*Figure 4 Photographs of Pup 13 'Apple' a) on the day she was born at stage 1 (22/09/2023), and b) at full wean stage 5 (13/10/2023), illustrating the significant development changes.*

Wanderers

Fourteen pups were recorded as wanderers. Wanderers are pups which turn up unaccompanied by a cow, either stage 3 or stage 4 development, and where their natal beach is unknown. Large wandering pups usually finish moult once they have established themselves on a beach, whereas the smaller ones (presumably abandoned or separated) usually disappear within days.

The appearance of wandering (unknown) pups is most likely linked with storm and spring tide events.

Photo Identification

Photographs of adult seals taken at the pupping sites were compared with a catalogue of individuals recorded previously on the Calf of Man, consisting of 626 females and 61 males before the 2023 season. There is a particular focus on identifying breeding females who were photographed with pups, allowing for continued analysis of the levels of site fidelity shown by returning females. Seals that were photographed and did not match any images in the catalogue were added as 'new seals' and assigned a number and a catalogue folder, establishing a record of their individualised pelage patterns and noting the dates and locations in which they were observed.

Camera Trapping

Camera traps are relatively inexpensive as well as non-invasive and a relatively inexpensive tool to monitor wildlife, (Brassine & Parker, 2015), allowing to observe animal behaviour without human disturbance (Di Cerbo & Biancardi, 2012). Commonly used across terrestrial habitats, in recent years they have been introduced to study hauled-out pinnipeds (Gucu 2009; Koivuniemi *et al*., 2016). For the purpose of this study, camera traps were used to monitor disturbance recovery by mothers at key pupping sites subjected to occasional risk of disturbance. Additional monitoring of some sites was achieved by camera placement at a safe distance from the immediate pupping area. The camera trap allowed us to continually monitor seals and pups without disturbance. A total of two camera traps were deployed at two locations: one at South Harbour and one at The Puddle (beach 4). The camera at The Puddle was placed ten metres from the pupping site before breeding season begun and the camera at South Harbour was placed 40 m from the pupping site 2 hours prior to known arrival of supply boat into the harbour (Figure 5). Both cameras were set on time lapse, for one photo to be taken every 30 minutes, with photos taken between daylight hours of 6:00 – 20:00. Using these settings allowed reduced memory storage and battery drainage, which reduced the number of times cameras had to be checked, thus minimising potential human disturbance to seals.


*Figure 5 Photo showing camera trap view at site SH at the time of supply boat arrival and docking. Positions marked in yellow indicate location of pups (1-3) and cow (4) present.*

Boat Survey

A limitation that had been identified previous years was the possibility that pups were born at locations that were not visible during land surveys. This would potentially mean that there was a under reporting number of pups born on the island. In 2023 the use of a UAS (drone) was deployed to minimise this limitation. In addition to the UAS, this season we undertook a boat survey on 15/10/2023 along the north section of island after the peak of the pupping season, with the route taken seen in Figure 6. The date was decided on due to boat availability and appropriate weather conditions. This trip had the aim of checking established pupping sites and identifying potential pupping activity in caves which we were unable to enter using the UAV. We used the Thermal imaging camera handheld from within the boat to ensure a safe distance was maintained to minimise risk of disturbance. There were 4 additional pups identified (1 BF, 3 AM) that were out of view during land surveys. Starting at CH the boat travelled West to BO then returned to CH rechecking all site along the route.

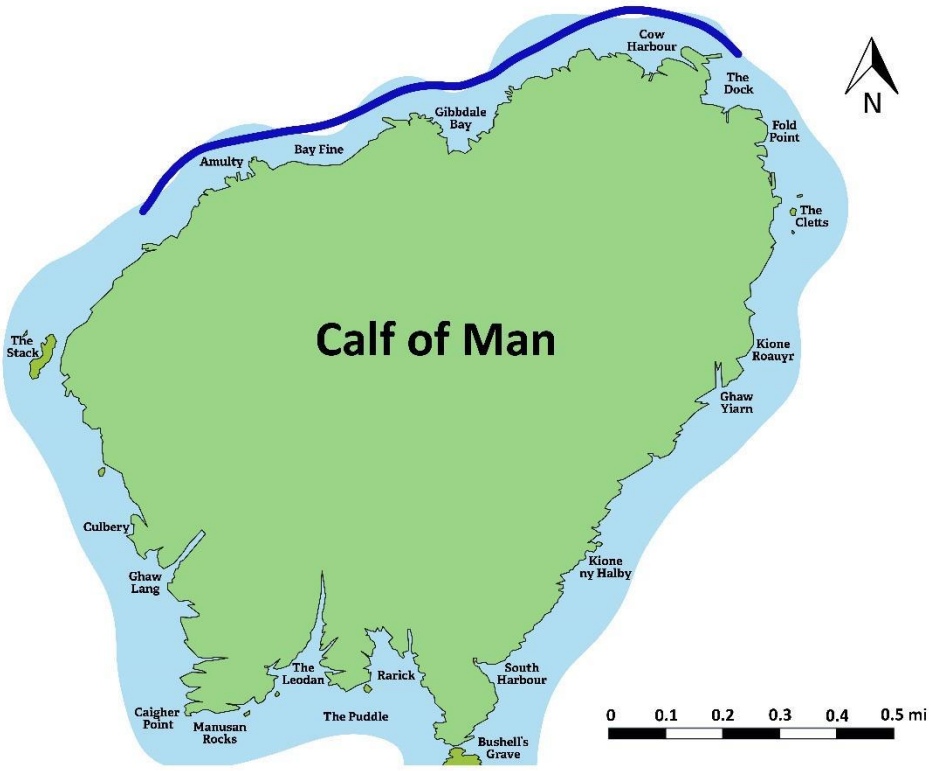


*Figure 6 A Map showing the boat journey taken around the Island on the 15/10/23*

Data Analysis

The program Microsoft Excel 2017 was used to analyse results for pup and female analyses. This program was also used to produce graphs comparing this year's data compared to previous years as well as calculating levels of site fidelity and success rates of pups.

# Results

Pup Census

A total of 96 pups were recorded and monitored on the Calf of Man over the survey period this year. This is the highest number of pups recorded on the Calf since surveys began in 2009, it should be noted that this year extra data was collected with help of UAS. Figure 7 illustrates the number of pups born each year overall. Pup numbers increased steadily from 2009 (n=29), reaching a previous peak pup number of 84 in 2016. After 2016 the annual pup number plateaued, remaining at an average of 64.6 pups until this year with a new peak being reached of 96 pups.

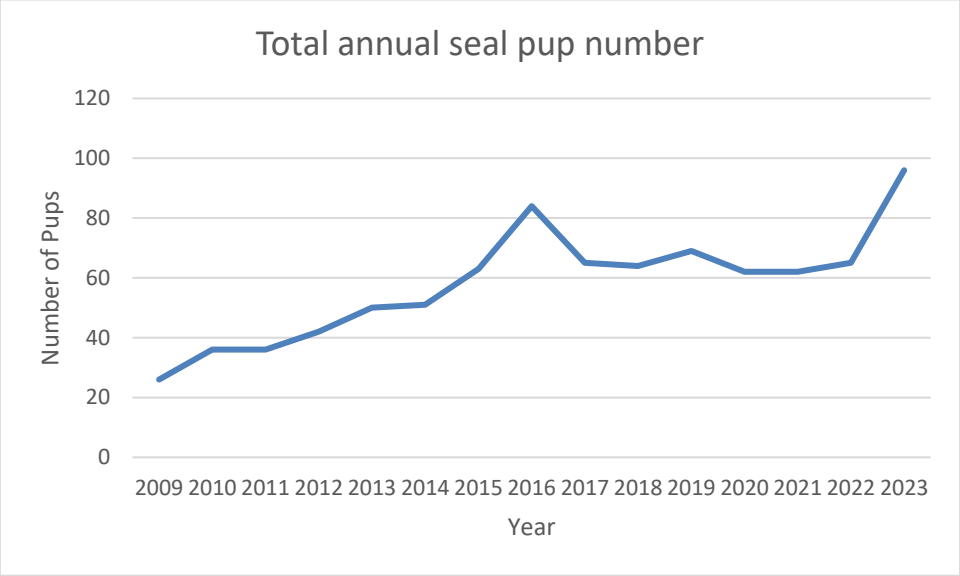


*Figure 7 A graph showing the annual total pup number since 2009*

The number of pups observed each week during the survey period is displayed in Figure 8, showing the spread of pupping dates across the season and a comparison of the previous year's pupping dates. This years survey started the same week as the 2022 survey but ended around 10 days earlier due to bad weather risking boat trips off island. The peak pupping period remained the same this year as in previous survey periods, 29/09/2023-05/10/2023, however this year saw 7 extra pups being born in this week compared to last year (n=18). This year we saw a more consistent increase in pup numbers through the first 5 weeks of the survey and a second peak during the penultimate week which was not seen in 2022.

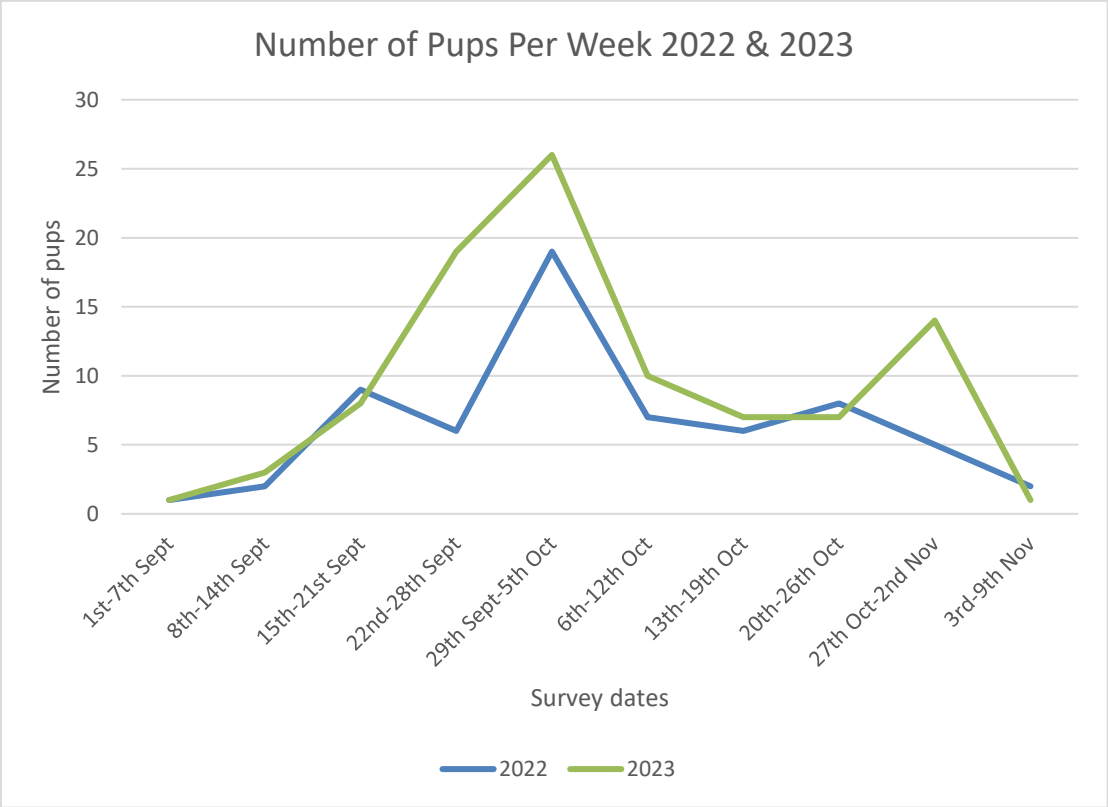


*Figure 8 Graph showing the spread of pupping dates during 2023 survey period compared to 2022.*

Figure 9 shows a comparison between this year's pupping dates with the previous average for the survey and for the 2016 season (the previous highest pupping season). The graph illustrates how pupping season has moved forward in recent years with above average pup numbers being seen in the beginning weeks of this year's survey. In both the 2016 and 2023 survey we can see a second smaller peak in pupping toward the end of the season, which has not seen throughout previous surveys, perhaps responsible for the high numbers of pups seen in both these years. The second peak in 2016 was seen a week earlier than 2023 and at numbers similar to the peak week (2016 peak week n=21, second peak n=19). For 2023 the second peak (n=14) was considerably lower than the week 5 peak (n=26). Although peak week remains the same the average birthdate is creeping forward as seen in Table 1, showing pupping season is becoming earlier.

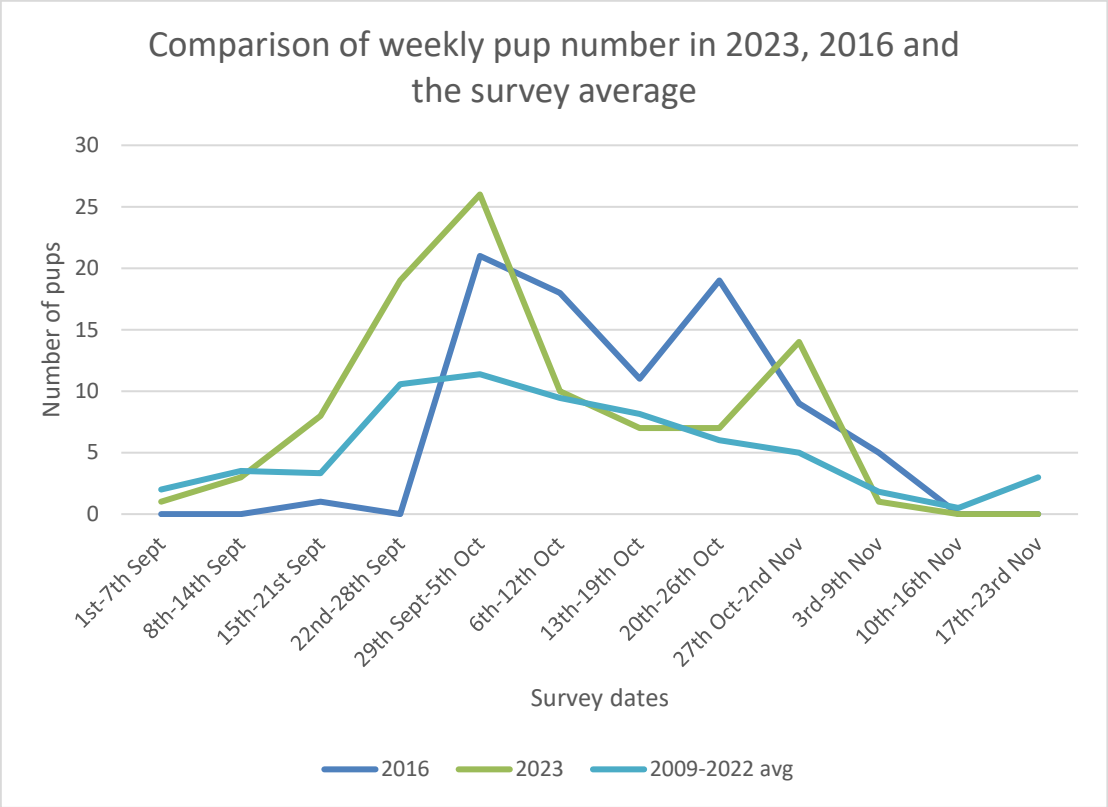


*Figure 9 Graph showing the spread of pupping dates over the 2023 season compared with both the 2016 season alone and the survey average from 2009-2022.*

*Table 1 Table of average birthdate in 2023 compared to previous years.*

| AVERAGE BIRTHDATE DATE 2023 | AVERAGE BIRTHDATE PRE-2022 |
|---|---|
| 6th October | 9th October |

Of 96 pups observed on the calf, 82 were born on the calf with 14 wanderers. Of all these pups 4 were confirmed deceased during the survey period, making up 4.17% of the pup population. This is lower than the pre-2023 average (5.53%) and lower than the proportion of deceased pups seen in the 2022 survey (4.62%). A total of 44 pups were observed all the way to stage 5 of development (45.83% of pups), 8.33% higher than the survey average.

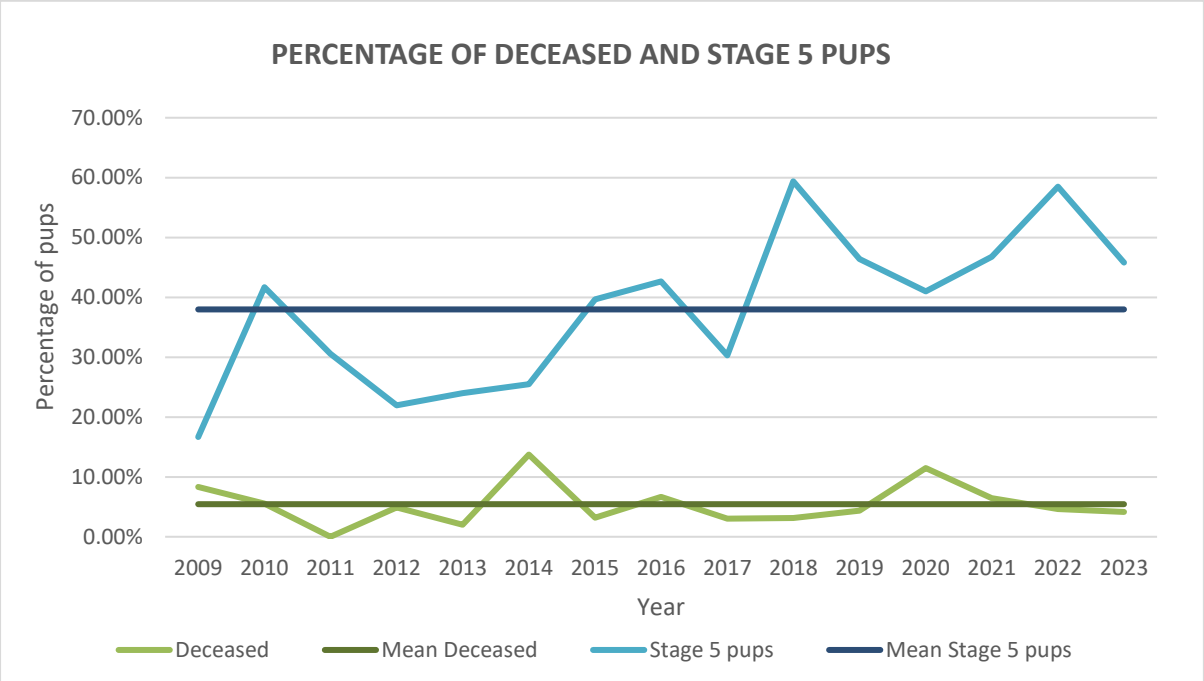


*Figure 10 Percentage of pups confirmed as deceased each year, compared to the mean between 2009-2022, as well as the percentage of pups successfully tracked through to stage 5 of development each year and the mean of previous years.*

*Table 2 Table showing number of pups deceased and stage 5 pups each year as well as the corresponding percentage for each survey year. Information used in graph in Figure 7.*

| YEAR | TOTAL PUPS | DECEASED PUPS | *PERCENTAGE OF DECEASED PUPS* | STAGE 5 PUPS | *PERCENTAGE OF STAGE 5 PUPS* |
|---|---|---|---|---|---|
| 2009 | 24 | 2 | 8.33% | 4 | 16.67% |
| 2010 | 36 | 2 | 5.56% | 15 | 41.67% |
| 2011 | 36 | 0 | 0.00% | 11 | 30.56% |
| 2012 | 41 | 2 | 4.88% | 9 | 21.95% |
| 2013 | 50 | 1 | 2.00% | 12 | 24.00% |
| 2014 | 51 | 7 | 13.73% | 13 | 25.49% |
| 2015 | 63 | 2 | 3.17% | 25 | 39.68% |
| 2016 | 75 | 5 | 6.67% | 32 | 42.67% |
| 2017 | 66 | 2 | 3.03% | 20 | 30.30% |
| 2018 | 64 | 2 | 3.13% | 38 | 59.38% |
| 2019 | 69 | 3 | 4.35% | 32 | 46.38% |
| 2020 | 61 | 7 | 11.48% | 25 | 40.98% |
| 2021 | 62 | 4 | 6.45% | 29 | 46.77% |
| 2022 | 65 | 3 | 4.62% | 38 | 58.46% |
| ***Average pre-2023*** | ***54.50*** | ***3.00*** | ***5.53%*** | ***21.64*** | ***37.50%*** |
| **2023** | **96** | **4** | **4.17%** | **44** | **45.83%** |

Pup Distribution

96 pups were recorded in total this year across 14 pupping sites (Figure 11). Pup abundance was highest at GH (n=15) and CH (n=15), each contributing to 15.78% of the total pup number. Coming in close second was PU with 14 pups (14.73%). Historically GH, CH and PU have produced the highest number of pups, with this season following the same trends. Together these 3 highly productive sites account for 46.29% of all pups, almost half the islands pup population for 2023. The lowest pup numbers were seen at Gibdale with only 2 pups born here this season.

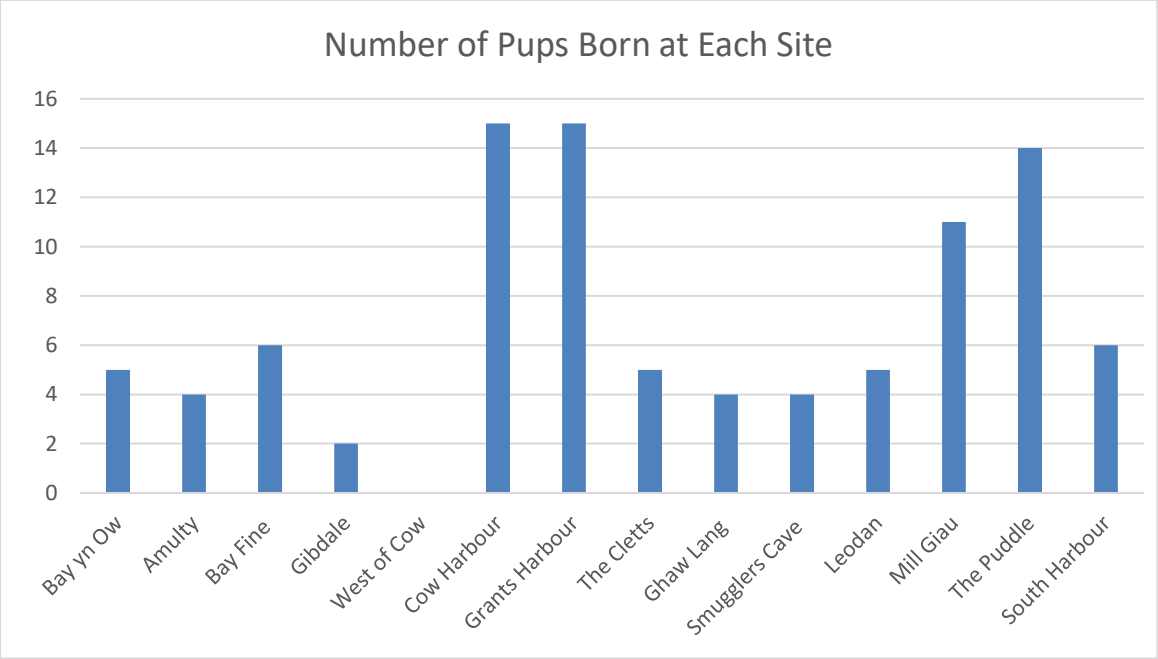


*Figure 11 A bar graph showing the number of pups born at each site around the Calf of Man*

Cow Harbour saw a new record number of pups this year (n=15), with the previous highest number being seen in 2019 (n=14). Leodan also had a new record of 5 pups this year, with the previous record of 4 being set in 2014. Bay yn Ow was a new pupping site this year with 5 pups observed across the season, additionally Amulty had 4 pups this season with the only previous record being one pup seen in 2016.

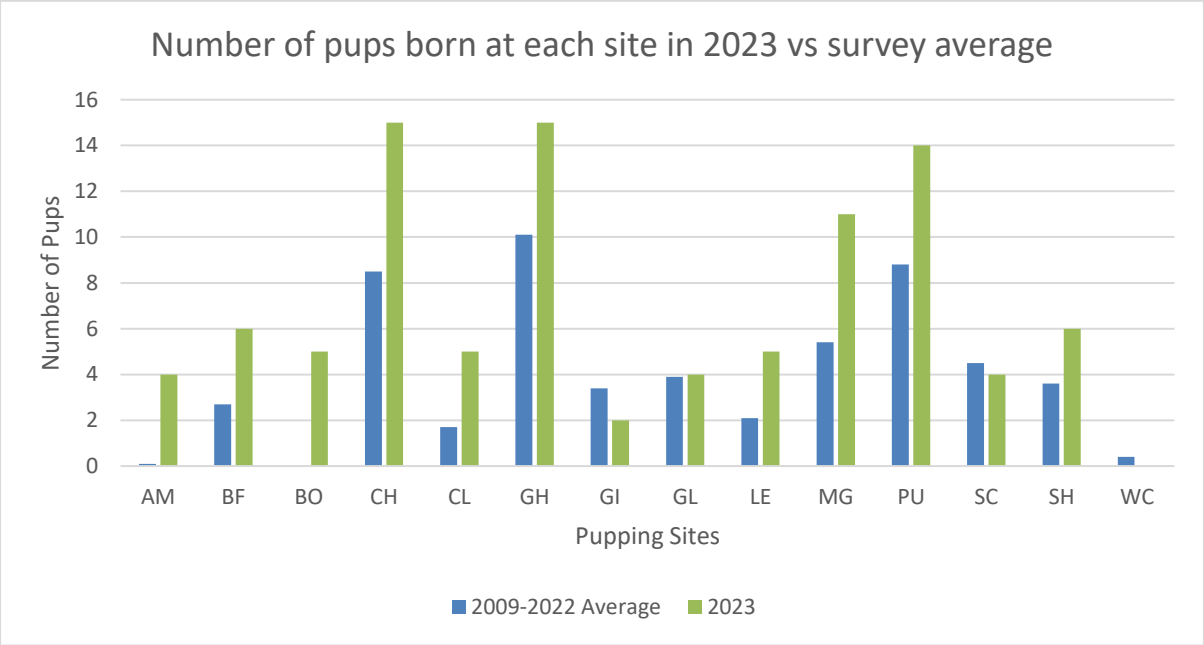


*Figure 12 Graph showing the number of pups at each site in 2023, compared to the mean of previous surveys.*

Photo Identification

**Mothers**

In total 72 females were able to be identified this season as either returners or new mums to the Calf, with 23 females unable to be identified due to lack of observation (Figure 13). Out of these mothers 51% were returning cows and had pupped on the Calf in previous years.

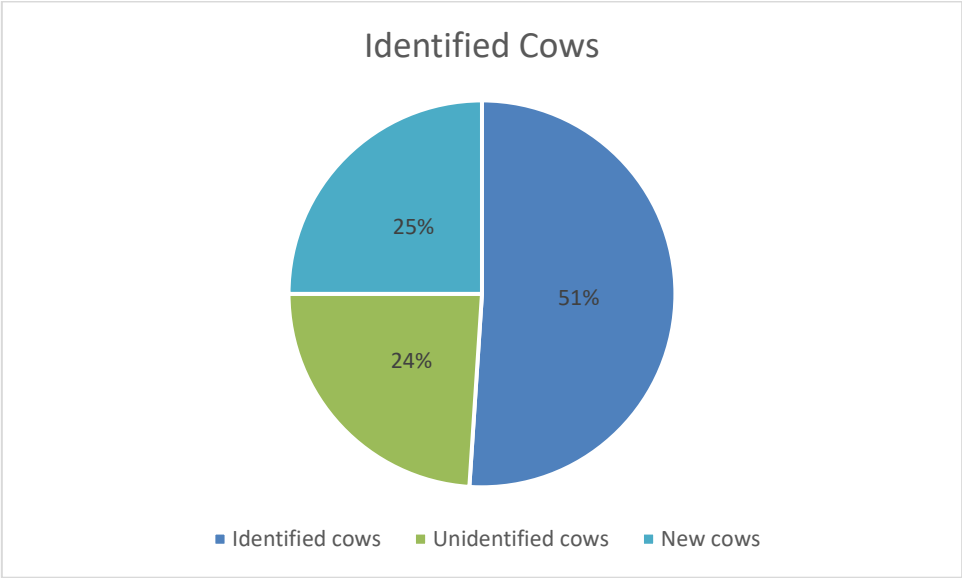


*Figure 13 A pie chart representing the proportion of mothers which were identified, unidentified or new during the 2023 season.*

**Non-pupping females**

This season non-pupping females were not recorded.

Site Fidelity

**Returning cows**

Of the 96 grey seal pups recorded on the Calf of Man in 2023, 51.04% (n=49) of identifiable breeding cows were returning cows. Subsequently, 23.96% (n=23) of pupped cows were unable to be identified or recorded, either not observed or photographed, marked as unknown. 25% (n=26) of pupped cows were new mothers and added to the Female Seal ID 2023 catalogue.

The oldest breeding female was ID:004 who pupped for the fourteenth time on the Calf of Man in 2023. The first time she was recorded she pupped at CH in 2009. Since then, she has been recorded as successfully pupping every year except for 2012, where no data for her was recorded.

**Site Fidelity**

Site fidelity was worked out by looking at a females' pupping site this season (2023) compared to the site used when they had their last pup. Out of the 46 returning mothers 63% pupped in 2023 at the same site as their last recorded pup with 10% pupping at a site within the same sector (Figure 15).

Sites in close proximity were grouped into sectors (Figure 14), where there was little distinction or separation between the pupping sites.

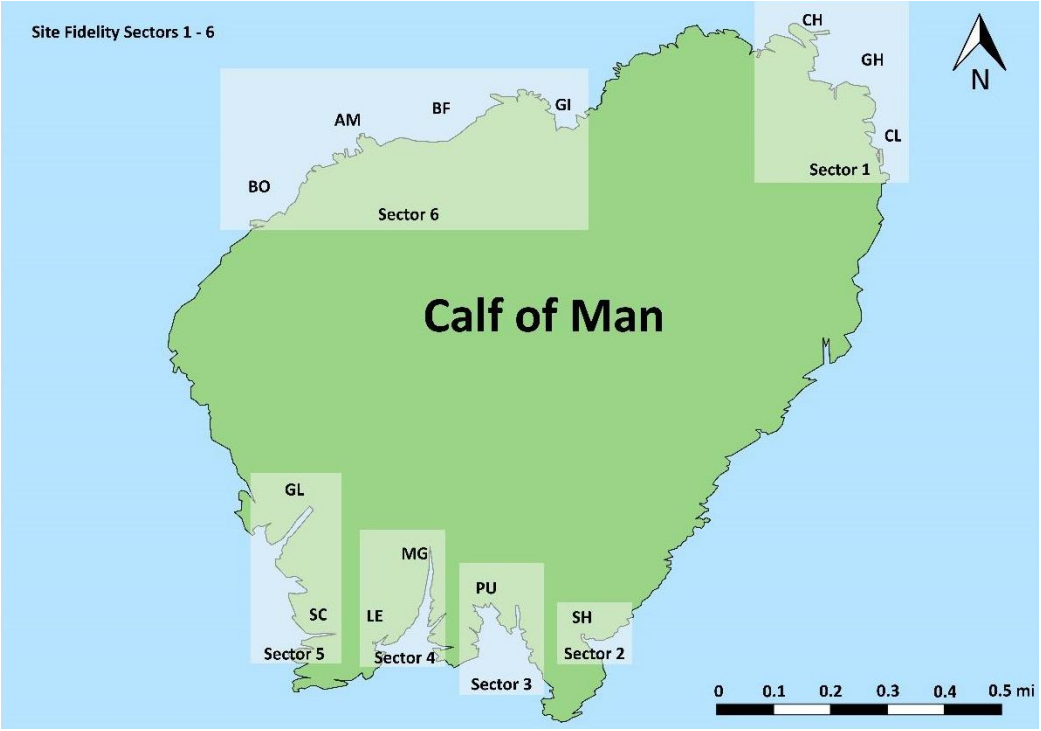


*Figure 14 A map of the calf showing the grouped sites into 6 sectors*

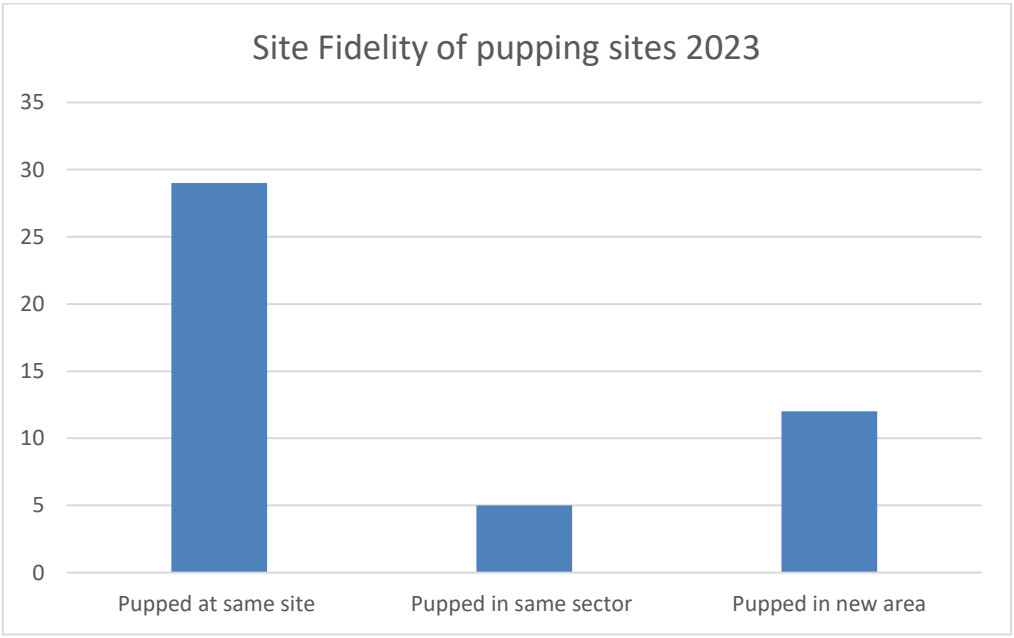


*Figure 15 A bar graph showing site fidelity to pupping sites on the Calf. The graph shows the number of individuals that pupped at the same site, in the same sector or in a completely new area compared to the last time the female pupped.*

Birthdate

Data collected over previous years can be used to analyse changes in pupping date. Of the mothers which pupped on the Calf in 2022 and returned this season, 79% pupped at a later date than 2022 (Figure 16).

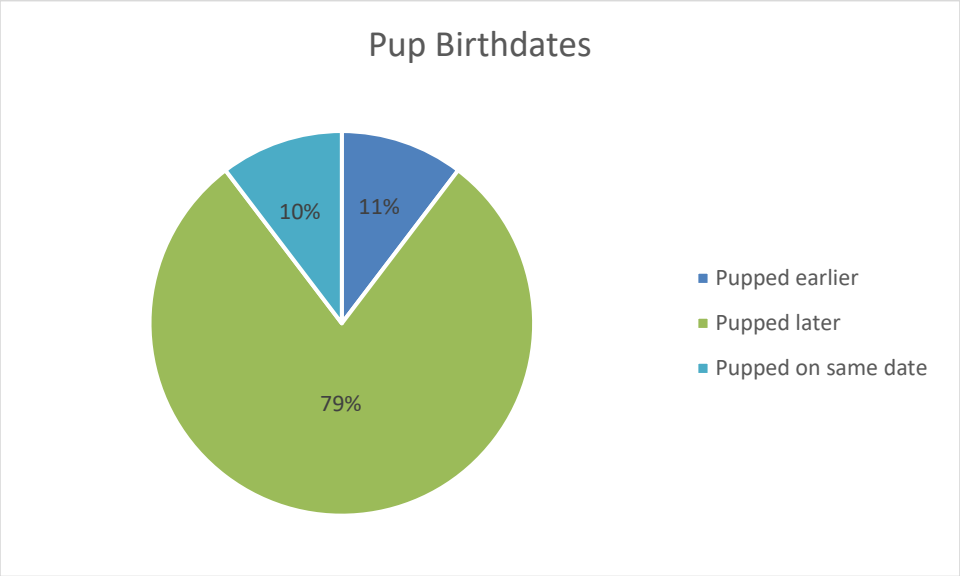


*Figure 16 A Pie chart showing the percentage of pups which pupped earlier, later or the same date in 2023 as 2022.*

# Discussion

Pup Numbers

The total number of pups recorded on the Calf of Man this season was 96, being the highest ever pupping season seen on the Calf. It was previously believed the Island had reached carrying capacity with pup numbers remaining within the 60s for the 6 prior seasons, and a peak of 75 in 2016. This followed previous research that showed growth of seal populations in areas besides the central and southern North Sea, have dropped below 1% compared to 6% in the 1980s (Russell *et al.,* 2019; Thomas *et al*., 2019). From the first survey year in 2009 up until 2015 pup numbers increased annually, most likely as a result of increased survey periods and improved methods. Pup numbers then reached a peak of 75 in 2016, before levelling out and staying in the 60s for the following survey years. Similar trends were seen in seal pupping populations in the Outer and Inner Hebrides, and on Orkney (Thomas *et al.,* 2019) where pup production increased until overshooting carrying capacity and then levelling out. However, breeding populations in the North Sea are continuing to grow exponentially (Thomas *et al.,* 2019).

The increase in pups seen this season can somewhat be attributed to the use of the drone during surveys. There were multiple occasions whereby the drone located seals which could not be seen by the volunteers looking from the observation points. This was especially true for sites on the north sites of the island where there are many caves and insets which cannot be seen from the top of the steep cliff faces. This year saw pups recorded at Bay yn Ow for the first time due to the lack of safe observation points into the two inlets in the cliff face here. Without use of the drone the 5 pups which were recorded here this season would not have been seen.

This year seal volunteers left the island on the 3rd of November due to weather, 10 days earlier than the 2022 season. When heading to get on the boat on the 3rd the volunteers were met by a new born pup at South Harbour, signalling that potentially that the pupping season was not over just yet. However, in 2022 staying those 10 extra days only saw 2 additional pups born showing there may be little benefit to extending the survey season any further.

Pup trends

**Weekly Trends**

The pupping season this year started with the first pup born on the 5th of September, lasting just over 9 weeks with the last pup recorded as volunteers left the Calf on the 3rd of November. The first pup of the season was born just a day earlier than 2022 but this date is creeping forward slowly with this season's first pup being 4 days earlier than 2020 (9th of September). The peak pupping week remained consistent with the 2022 season, but an additional 7 pups were born within this week for a total of 26 pups for the busiest Calf week.

**Mortality**

Pup mortality was recorded only when the remains of a deceased pup was visible to surveyors. Four pups were recorded as deceased this season, representing 4.21% of the pups born on the Calf of Man in 2023, less than the average and for the past two years. This year there were three named storms occurrences on the island during survey period. Namely, Storm Agnes (27/09/2023), Storm Babet (18/10/2023) and Storm Ciaran (01/11/2023). Bad weather conditions increase morality rate (Baker and Baker, 1988), in 2017 on the Calf for example almost half the pups went missing, due to Hurricane Ophelia. Pups can potentially survive periods when violent seas are running on to the sites where they are being nursed (Westcott and Stringell, 2003). Of the 95 pups, 7 (7.36%) were classed as 'missing' during the survey, so it is possible that some missing pups were, in fact, deceased.

With the case of missing pups, an assessment was made of the condition of each pup when last seen, classified on a five-point scale:

| | |
|---|---|
| 1. Very small | Assumed not to have survived long after moult |
| 2. Small but healthy | In good condition, would have a reasonable chance of survival |
| 3. Good size | Most should survive |
| 4. Very good size | All should survive |
| 5. Super-moulter | An exceptional sized pup |

Seal pups were considered successful if they survived until the beginning of moult, unless they were in poor condition (Hewer, 1974). If a pup disappeared before the beginning of moult an individual assessment was made on its likelihood to have survived based on the above criteria. Pups ≥ size 3 were assumed successful, whereas pups smaller than size 3 were assumed unsuccessful.

The main causes of mortality in grey seal pups are starvation, infection, septicaemia, stillbirth, and trauma (Baily, 2014). Of the four pups confirmed as deceased, one Pup, '81', was stillborn. The pup was larger and passed during birthing, the birth was prolonged lasting for approximately 15 minutes from first sight of pup head. The pup was measured after the mother left the site and measured 960mm (nose to hind flipper phalange). Both pups 'PU2' and '54' were at stage 2 development when found recently deceased at PU (beach 3) on 08/10/2023 and GH on 19/10/2023 respectively. Pup '88' was at stage 3 development and late-stage decomposition when found deceased at PU (beach 3) on 30/10/2023.

Pup Distribution

As seen throughout survey years the area of Cow and Grants Harbour were the most popular pupping sites in the 2023 season with the Puddle coming in a close second. Sites on the north of the island and in this sector 1 area (Figure 14) are considerably less affected by weather events than the south of the island. This makes these areas much safer pupping sites as shown by a higher number of pups being born in the North of the island and sector 1 being the pupping site of 36% of all the pups born on the Calf in 2023. Females are believed to select pupping sites based on the habitat (Twiss *et al*., 2000) with habitat features such as low gradient shores, tidal pool presence, sea access and decreased tidal and storm-surge influences providing the optimal pupping location (Anderson *et al.,* 1979; Twiss *et al.,* 2001; Weitzman *et al.,* 2017). Studies indicate that females are less likely to choose sites subject to flooding and storm surges (Allen, Bowen & den Hyer, 2022). Cow Harbour, Grants Harbour, Mill Giau and the Puddle all saw pup numbers over 10 this season and we can see these optimum habitat features exhibited in all of these sites with their low gradients, tidal-pools and easy access to the sea.

Some variants from previous survey data compared to the 2023 survey regarding pup distribution are due to improved observational methods at BO and BF. BO holds no previous recorded pup data, however this year due to deployment of the UAS, we were then able to regularly observe the site (weather permitting). This site is set back from a large cliff and settled in a raised cave area concealed by overhanging cliffs. No observations are possible from cliff tops observation points, therefore previously only observable by boat. Due to the rocky area seaward of the site, this would only allow a limited viewpoint (Figure 3).

Site Fidelity

The average percentage of returning cows from the previous ten years (2012-2022) is 45% and annual variation is possibly the result of a combination of factors such as unknown dynamics in the seal population, developments in and access to photographic equipment and methods, observer skill, time availability and weather conditions. In previous years looking at site fidelity on the Calf has focused on the number of different sites a female has used and the number of returning mothers at a specific site. This season we decided to look at site fidelity in a different way, comparing whether returning mothers were using the same site or sector as their last pupping season. Over half of the 46 returning mothers used the exact same site as their last pupping season showing high levels of site fidelity across the Calf. Sites were also grouped into sectors under the belief there would be higher number of returning mothers within a sector than to a specific site due to little distinction or separation to the site from the sea. This grouping of sites has been seen in other site fidelity studies on seal species (Baker *et al.,* 1995). However, we saw a higher number of specific site fidelity which was not expected with a higher percentage of returning mums pupping in a completely new area than pupping within the same site. Site fidelity and choice in grey seals is not very well understood and there are conflicting theories to explain this behaviour (Giuggioli and Bartumeus, 2012)

Birthday Analysis

There has been concern that pupping season is moving forward as global temperatures shift, with previous survey results showing individual mothers pupping earlier each year. A trend seen in a number of species, with these shifts recognised as an impact of climate change (Root *et al.,* 2003). Studies have found advancements in pupping season of up to seven days in response to a temperature increases of 2˚C (Bull *et al.,* 2021). Conversely, this year we saw 79% of the mothers that had pupped in 2022 pupped later in 2023.

Drone - Unmanned Aircraft System (UAS)

The use of drones in wildlife conservation has been a game-changer for conservationists and researchers. Drones provide a quick, easy, and cost-effective way to monitor wildlife from a distance. They can be used to track animal movement and behaviour, observe species in hard-to-reach areas, and identify illegal hunting and poaching. Additionally, drones are being used to monitor the health and condition of wildlife, as well as to count and identify individual animals. Drones are also being used to assess habitat health, monitor environmental conditions, and detect changes in the environment. We utilised drone technology during the 2023 season with the aim to access additional areas of the island's coastline which have previously had limited or no observation opportunities due to geographical constraints. We found that drone deployments proved to be an effective method which led to:

1. 14 seal pups identified and monitored in areas inaccessible by land or boat survey observations,
2. 2 additional seals monitored for growth stage development in areas where land or boat surveys would cause disturbance,
3. High-definition images obtained of mother seals which led to pelage identification in areas where land or boat surveys would cause disturbance,
4. Additional data collected which led to accurate seal counts at established pupping sites where multiple seals utilise the intertidal zone and exhibit high sensitivity to disturbance,
5. Creation of site aerial maps to log precise birthing locations for each pup born during the 2023 season at each pupping site. This is beneficial for improving site fidelity analysis in future surveys (Figure 17)

Prior to deploying the drone at pupping sites for the purpose of data collection, we carried out test flights at regular haul out sites around the island. The take-off and landing areas were identified at a greater distance away from the seals in comparison to the usual observation points for land surveys.

We manoeuvred the drone directly above the haul-out sites at an elevation exceeding 75 metres above sea level (ASL). No responses to the drone by the seals was detected and accurate images were obtained of the numbers of seals haul out in that area. We reduce the elevation to 50 metres (ASL), no response to the drone was detected in the behaviour of the seals. We reduced the elevation further to 40 metres (ASL), occasional but minimal head movements were observed which

indicated that the drone may be within audible range of the hauled-out seal(s). Images for individual seal pelage identification were obtained at this altitude with the addition of identifying injuries relating to welfare and health assessments. We reduced the elevation further to 30 metres (ASL), distinct head movements looking around for the source of the sound were observed and on two occasions the drone was looked at directly by an individual seal. At this time, we increased aircraft elevation and returned the drone to the take off point, with no further flights that day. No flights directly above the hauled-out seals resulted in shuffling at the resting spot by seals. No flushing (movement away from threat into the water) was observed.
When further testing was carried out at pupping sites seal behaviour observations mirrored the haul-out site results.

We concluded that (at this location and under agreed licensed activity limitations), the recommended aircraft elevation for data collection was between 45 to 75 metres (ASL). Where there was a specific need, the aircraft elevation could be reduced to 40 metres (ASL) for the purpose of individual pelage identification and seal welfare purposes. These elevation protocols were established to minimise risk of disturbance.

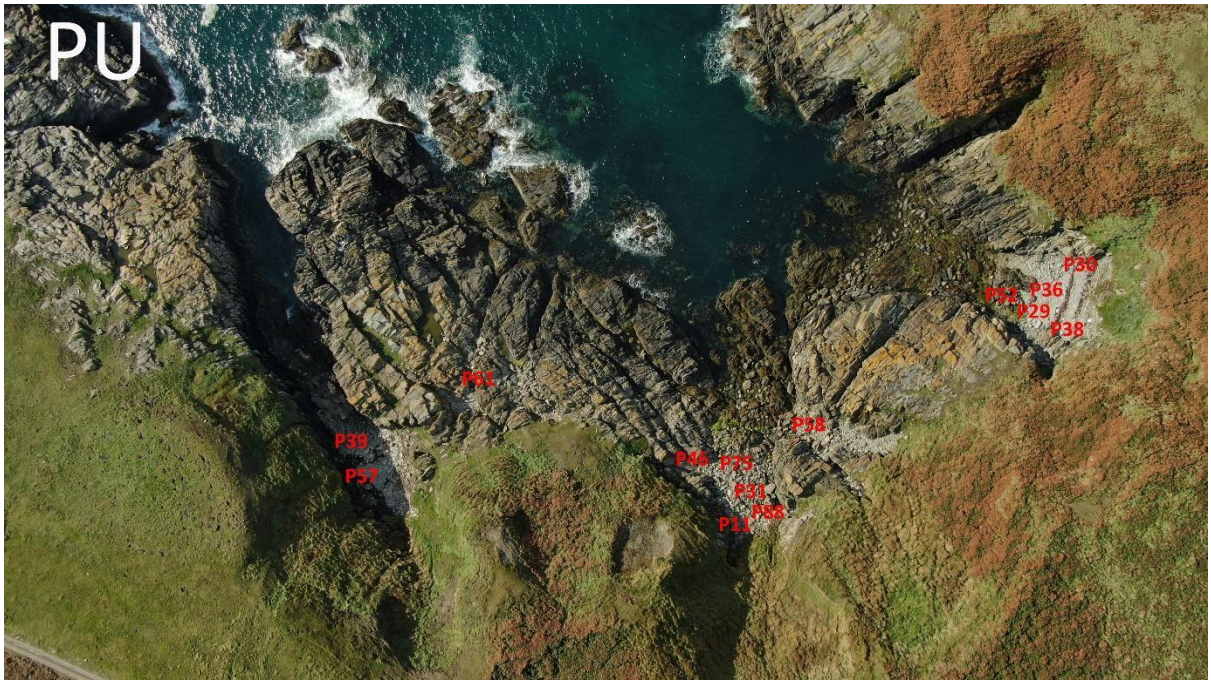


*Figure 17 An example of aerial maps created for each site.*

Additional Observations

**Allosuckling**

During this year's surveys on the Calf, one occurrence of allosuckling was observed; whereby a mother feeds a non-filial pup as well as providing protection and care (Maniscalco *et al.,* 2007). Cases of allosuckling have been recorded in the past four years on the Calf of Man, as well as in other studies of grey seals (McCulloch *et al.,* 1999) and many other pinniped species (Franco-Trecu *et al.*, 2010, Maniscalco *et al.,* 2007). Whilst it has been frequently recorded, little is understood about the behaviour. Roulin (2002) has come up with five hypotheses for the behaviour: (1) Allonursing results from misguided parental behaviour. (2) Females reciprocate by nursing each other's offspring. (3) Females nurse related juveniles for inclusive fitness benefits. (4) Females nurse alien offspring to evacuate milk that their own offspring did not drink. (5) Inexperienced females that lactate spontaneously without reproducing themselves or that have lost their litter nurse alien offspring to improve their maternal skills.

In 2023 allosuckling occurred during November at Cow Harbour (beach 2). Pup 84 was born at CH by mother 645 on 29/10/2023. On the same date and location, mother 576 gave birth to pup 85. On the 31/10/2023 Both pups and both mothers were present. Suckling was observed between 576 and 85 but not between 645 and 84. On 02/11/2023 both pups (84, 85) were present however only mother 576 was visible. Pup 85 was suckling (576), pup 84 was omitting audible sounds and then approached 576 and 85. After a short period of repositioning by pups and mother, both pups were observed suckling from 576 (Figure 18). Mother 645 was last seen at CH on 31/10/2023. To observe such instant acceptance by 576 and nursing behaviour contrasted significantly to the common aggression mothers usually show towards alien pups.

Of the hypothesis presented by Roulin (2002) misguided parental behaviour is the most likely reason for this female to allow the non-filial pup to suckle, whereby recognition errors and/or inattentiveness by lactating females can lead her to allow a non-filial pup to suckle (de Bruyn *et al.,* 2010). Although mothers and pups identify each other through vocalisation and olfactory cues, this does not prevent instances of allosuckling (McCulloch, Pomeroy & Slater, 1999). Separation of

mother and pups and density of pups has been shown to lead to allosuckling behaviour (McCulloch & Boness, 2000).

*Figure 18 Photograph of mother 576 showing allosuckling behaviour with biological pup, 85 and non-filial pup 84. Taken at Cow Harbour on 02/11/2023.*

**Disturbance**

In 2023 six notable disturbances were recorded during the season, outlined in the table below. Disturbance information was recorded in 2023 at SH and CH to identify potential impact on seals with pups in close proximity to the scheduled supply boat docking points. Out of ten observations (8 SH, 2 CH) of the island supply boat docking on the Calf of Man, five led to disturbances of seals. As the boat is an essential resource to island operations and docking is limited to tidal variants little can be done to minimise these occurrences when seals are using the harbours as pupping sites (Figure 19). Briefs on location of seals in the area and advice on minimising impact on them were given to the boat skipper and personnel assisting with the supply movements.

*Table 3 Seal disturbance on the Calf in 2023 (records made internally). Level of disturbance: 1 = little disturbance (lifting of heads); 2 = Seals enter water in response to perceived threat; 3 = major disturbance involving abandonment of pup or similar.*

| Date | Time | Location | Type | Severity | Comment |
|---|---|---|---|---|---|
| 10/09/2023 | 09:18 | PU3 | Human (Day visitors) | 2 | 2x day visitors snorkelling, swimming towards seals in the water. Flushed seals from the rocks and cleared the immediate area of seals. Disturbance lasted 30 minutes. No pups present at this location on this date. |
| 22/09/2023 | 09:45 | SH | Motorboat (Island supply boat) | 3 | Supply boat delivering supplies to the island. Adult female seal (361) abandoned pup (P13) on the left side beach. Returned to pup after 56 minutes absence. Seal 361 gave birth to pup P13 at first light the same day. |
| 29/09/2023 | 17:20 | CH | Yacht | 2 | Sailboat travelling West to East through the Sound close to shore at CH. Affecting 6 seals flushed into the water from beach 2. Pups were present on this beach on this date. |
| 09/10/2023 | 08:37 | SH | Motorboat (Island supply boat) | 1 | Supply boat delivering supplies to the island. Same seal (361) as previous occurrence (22/09/20223). Raised head and shuffled by the water line but did not enter the water or abandon pup (13). |
| 09/10/2023 | 13:30 | CH | Motorboat (Island supply boat) | 2 | Supply boat entered CH to pick up personnel. Stage 5 pup resting on the grass area beside the store building reacted and rushed away towards beach 1, scrambling across the rocks taking 2x small falls onto rocks. No |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | blood observed post incident on either the pup or the rocks. |
| 27/10/2023 | 09:00 | SH | Motorboat (Island supply boat) | 2 | Adult seal (new mother) with stage 2 pup entered the water but stayed near the pup. Adult seal showed signs of distress by constantly shuffling and moving. |


*Figure 19 Supply boat at South Harbour showing position of adult seal (1) protecting her pup (2).*

**Tagged Seals**

The 2023 season we identified three tagged seals on the island shown in the Figures below.

1. Observed at CL on 11/09/2023 with a rear flipper plastic tag. This individual was an adult male common seal released by Seal Rescue Ireland. We are awaiting updates on release date data.

*Figure 20 Tagged seal 1*

2. Observed at LE on 18/10/2023. This individual had a satellite tag attached to its head and identified as ID: 232 female grey seal from the Calf of Man seal identification catalogue.


*Figure 21 Tagged seal 2*

3. Observed at CH on 29/10/2023. This individual had a satellite tag attached to its head and identified as a female grey seal released by Sea Mammal Research Unit (St Andrews University, Scotland) near Anglesey in early 2023 as part of a project looking at use of high tidal flow areas, associated with tidal energy developments.


*Figure 22 Tagged seal 3*

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**Appendix**

Appendix A – Developmental stages of grey seal pups

| Stage | Age | Characteristics | |
|---|---|---|---|
| Stage 1 | 0-2 days | Thin baggy-skinned body<br>Yellow stained or white natal fur<br>Conspicuous umbilical cord<br>Docile & poorly coordinated |  |
| Stage 2 | 3-7 days | Smoother bodyline, few loose folds<br>Neck still distinguishable<br>Umbilical cord atrophied<br>Aware & coordinated |  |
| Stage 3 | 7-15 days | Rounded or barrel shaped body<br>Neck thickened/indistinguishable<br>Partial moulting from head or flippers<br>May be aggressive on approach |  |
| Stage 4 | 16-20 days | Rounded body<br>Partial moulting from torso<br>Head & flippers moulted<br>May be aggressive on approach |  |
| Stage 5 | 18-25+ days | Fully moulted to short fur coat<br>(< 100cm$^2$ natal coat remaining)<br>May be aggressive on approach |  |