Strategic Regional Pre-Construction Marine Mammal Monitoring Programme Annual Report 2017

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Executive Summary

In May 2014, a Marine Mammal Monitoring Programme (MMMP) was developed for the Moray Firth. The programme aims to address both project-specific and strategic research and monitoring questions relating to the potential impacts of offshore wind farm construction and operation upon key protected marine mammal populations.

Following extensive consultation with key stakeholders the programme focussed upon two key species, harbour seals and bottlenose dolphins, and key questions that address uncertainties identified during the consenting process. Specifically, the pre-construction MMMP aimed to collect additional data on the distribution, abundance and vital rates of both priority species, thereby providing a baseline against which the population consequences of disturbance during construction can be quantified.

The MMMP consists of work packages for each priority species, each including individual based studies of reproduction and survival rates, assessments of trends in abundance, and the collection of data on distribution patterns. This annual report provides background on the programme aims and the methodologies used within each of these work packages, and provides key results from studies undertaken from 2014 to 2016.

Harbour seal work focused upon the breeding population in Loch Fleet NNR. From 2014 to 2016, a total of 236 individuals were identified at Loch Fleet: 123 females, 98 males and 15 individuals of unknown sex. This included 83 females that were seen with a pup at Loch Fleet between 2014 and 2016. Preliminary mark-recapture modelling using data from 2007 to 2016 estimated the reproductive rate at 0.90 (95% CI: 0.87-0.93) for multiparous females. The median pupping date (2014-2016) ranged from the 19th to 21st June, later than for the preceding eight years from 2006 to 2013. Preliminary mark-recapture modelling using data from 2006 to 2016 estimated the survival rate at 0.97 (95% CI: 0.95-0.99) for females and 0.94 (95% CI: 0.90-0.97) for males. The mean count of adult harbour seals at Loch Fleet from 2014 to 2016 ranged from 93-102 during pupping and 123-159 during the moult. Combining pupping counts with data on the proportion of low tides on which harbour seals haul out produced an abundance estimate of 166 (95% CI: 147-184) for Loch Fleet in 2016. Estimated harbour seal abundance at Loch Fleet has been increasing since the mid-1990s, whereas in the Moray Firth Seal Management Area (SMA) the count of harbour seals during the moult has declined by 50% since 1996-1997. In 2014 and 2015, the mean count of harbour seals in Loch Fleet during the moult represented 17% of the total harbour seal count in the Moray Firth SMA. In September 2014, February 2015 and February-March 2017, 57 harbour seals were captured at Loch Fleet and fitted with GPS/GSM tags.

Bottlenose dolphin photo-identification surveys in the Moray Firth Special Area of Conservation (SAC) were made on 62 days between May and September 2014 to 2016, with 422 dolphin encounters. Using data from 2001 to 2016 the reproductive rate for females seen in the SAC appears to have increased from 0.16 to 0.30. The probability of apparent survival for dolphins using the SAC between 1990 and 2016 was preliminarily estimated to be 0.93 (95% CI: 0.91-0.94). However, this is likely to be negatively biased as evidence suggests this population has expanded its range outside the SAC and the method used cannot fully account for this. Between 2014 and 2016, a total of 125 (59 well-marked) individually identified bottlenose dolphins were seen in the SAC, 52 females, 30 males and 43 of unknown sex. Additionally, 45 individuals (22 well-marked) were seen on the south coast of the outer Moray Firth (18 females, 9 males) and of these 7 were only seen in this area. The estimated number of dolphins using the SAC in each summer of 2014 to 2016 ranged from 78 (95% CI: 65-94) to 98 (95% CI: 84-115), although there was no evidence of a trend in the number of dolphins using the SAC between 1990 and 2016. Data from across the population's range suggests that the east coast of Scotland dolphin population is increasing, with annual estimates of 101 (95% HPDI: 70-129) in 1990 and 195 (95% HPDI: 164-224) in 2015. Although the proportion of the population using the SAC has declined, >50% of the population use the SAC in the majority of years. Passive acoustic monitoring with CPODs was used to determine baseline levels of occurrence in favoured areas. Dolphin occurrence was highest at the Sutors and Chanonry in the inner Moray Firth and lower at sites along the southern coast of the Moray Firth. Dolphin detections varied seasonally but were generally highest from May to August.

In summary, all proposed fieldwork from 2014 to 2016 was successfully completed, the data have been archived and analyses used to address key project objectives. These data sets now provide a robust baseline on the vital rates, population status and distributions of these harbour seal and bottlenose dolphin populations. This information will now underpin ongoing construction monitoring for the BOWL wind farm and monitoring of future construction in the MORL development areas.

Background

The Moray Firth contains internationally important populations of marine mammals. European Union (EU) Special Areas of Conservation (SAC) have been designated for both harbour seals and bottlenose dolphins, and the area is frequented by other protected species such as grey seals, harbour porpoises and minke whales. There has also been a long history of research in the area, and Moray Firth harbour seals and bottlenose dolphins are now two of the most intensively studied marine mammal populations in the world. The presence of these well studied protected populations provides a unique mix of challenges and opportunities for regulators and industries wishing to undertake new developments in the Moray Firth. The region has long supported a broad range of economic activity, including fisheries, oil and gas developments, and tourism. For emerging industries such as offshore renewables, recent EU legislation has led to a challenging step change in assessment and monitoring requirements. Previous research has provided important baseline data, for both site-specific assessments and more general development of methods to meet new legislative requirements. Unique opportunities now exist for conducting research and monitoring alongside regional developments.

A key driver for this Marine Mammal Monitoring Programme (MMMP) has been the requirement for monitoring due to the proposed offshore wind farm developments in the Moray Firth namely, BOWL (Beatrice Offshore Windfarm Ltd.) and MORL (Moray Offshore Renewables Ltd.). However, this MMMP has wider relevance for two reasons. First, other stakeholders require the same monitoring data on trends in these protected populations, particularly for the bottlenose dolphins that range widely along the east coast of Scotland. For example, the UK government must provide regular status updates to the EU; and other developers both within (e.g. ports and harbours, oil and gas) and outside (e.g. other east coast wind farms) the region must consider cumulative impacts on the dolphin population that uses the Moray Firth SAC. Secondly, research around these regional developments can be used to test and develop assessment frameworks that are now being used in other areas, particularly those assessing the population consequences of disturbance.

Given the broader significance of this programme, the initial two-year pre-construction phase of work has been funded through a consortium that includes BOWL, MORL, Marine Scotland, The Crown Estate, and Highlands and Island Enterprise. The third year of work has been supported through a further contract from BOWL. In addition, the main elements of the bottlenose dolphin monitoring have been supported in Year 3 through a contract from Scottish Natural Heritage for monitoring the condition of the Moray Firth SAC. This document presents background on the programme aims and the methodologies being used for the study, and provides key results from studies undertaken from 2014 to 2016. This document also refers to data collected in February

and March 2017, as part of the construction monitoring programme, prior to the start of offshore construction in the BOWL wind farm site in April 2017.

Aims

The pre-construction MMMP aims to provide baseline data on two priority species (harbour seals and bottlenose dolphins) during the three years prior to construction (2014 to 2016).

Following extensive consultation with a range of stakeholders, the selection of these priority species was based upon the proximity of EU protected sites (SACs) to the BOWL and MORL sites (see Annex 1), and the opportunities to address key questions that can reduce uncertainty in future assessments (see Annex 2). Specifically, the pre-construction MMMP aims to collect additional data on the distribution, abundance and vital rates of both priority species, thereby providing a baseline against which the population consequences of disturbance during construction can be quantified.

Programme structure

The MMMP consists of two sets of work packages, the first covering the requirements for harbour seal monitoring, and the second for bottlenose dolphin monitoring.

Harbour Seal Monitoring

1) Individual based studies of reproduction and survival;
2) Trends in abundance; and
3) Characterisation of foraging areas.

Bottlenose Dolphin Monitoring

1) Individual based studies of reproduction and survival;
2) Trends in abundance; and
3) Baseline occurrence of dolphins in favoured areas.

Harbour Seal Monitoring Work Packages

WP 1.1: Individual based studies of reproduction and survival

Introduction and Objectives

This work package is being used to assess baseline variability in harbour seal vital rates and condition. This will permit future comparison with data collected during the construction period. These data will then be used to test and refine assumptions in the Moray Firth harbour seal assessment framework (Thompson *et al.* 2013b) that link noise exposure to changes in vital rates.

Parameters to be measured

- Female fecundity (i.e. reproductive rates);
- Female pupping dates;
- Sex specific survival rates.

Survey Design

Land-based photo-identification is being used to identify individual harbour seals from their distinct facial pelage markings (Figure 1) (Thompson & Wheeler 2008). Repeated observations of known females can then be used to determine whether or not different females in the population give birth each year, and data on the timing of births provides an index of over-winter body condition (see Cordes & Thompson 2013). Repeated sightings of males and females can be used to estimate sex-specific survival rates (Cordes & Thompson 2014).

Figure 1. Examples of suitable photographs for individual photo-identification, showing the distinct facial patterns on the left and right side of four individuals that regularly use the Loch Fleet haul-out site.

Methodology

Regular photo-identification surveys of harbour seals were carried out from late May until late July at Loch Fleet National Nature Reserve (NNR), which is the nearest major harbour seal breeding site to the BOWL and MORL developments (Figure 2). Over the last two decades, Loch Fleet has become an increasingly important breeding site for the Moray Firth harbour seal population (Cordes *et al.* 2011), and the proximity of the haul-out to a public road makes it particularly suitable for photo-identification studies.

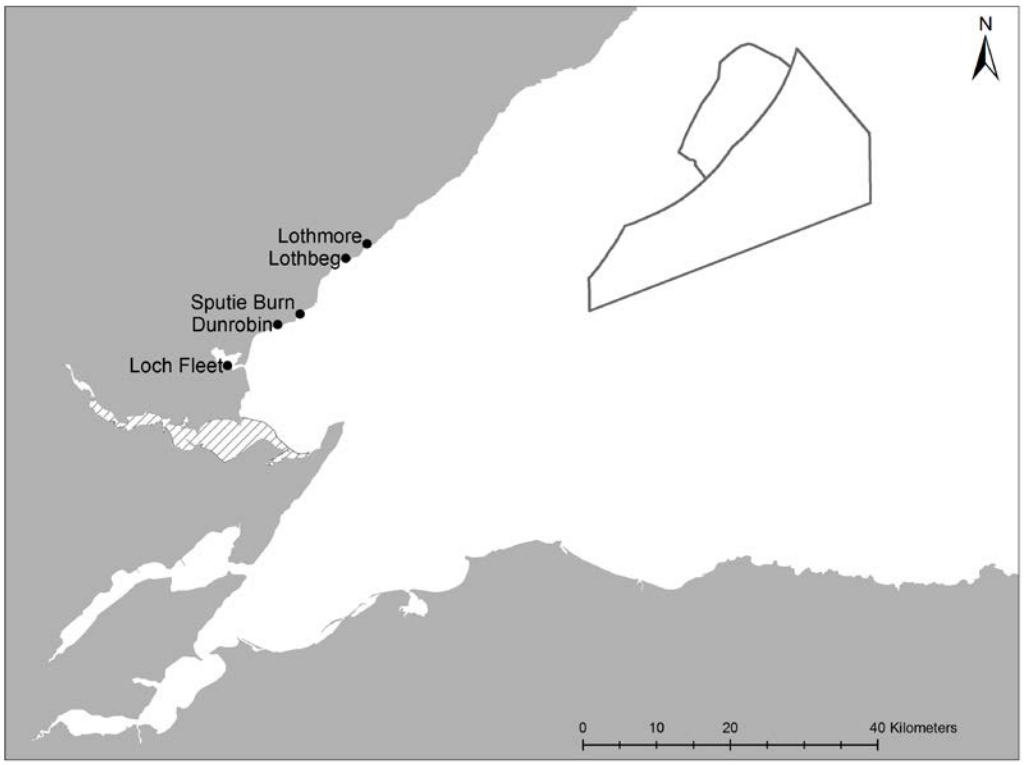


Figure 2. Map of the Moray Firth showing the position of the BOWL and MORL development areas and the five closest harbour seal haul-out sites. The Dornoch Firth and Morrich More SAC is hatched.

Surveys were started around low tide, with observations made from a vehicle parked at a standard vantage point (Grid Ref: NH 791 956). High quality photographic images were taken of all individuals using the main sandbank by trained observers using a digital SLR camera (Canon 60D) attached to a telescope (20–60 x 80 mm Swarovski HD-ATS 80). For adult females, data were also recorded, ideally by photograph, on whether or not a pup was present in close proximity to the female.

Data Analysis

All images were graded for photographic quality and the best quality pictures for each seal, each day, were matched to the existing photo-identification catalogue by an experienced analyst. These initial matches were confirmed by a second experienced analyst and archived with associated field data. Daily sightings of individual seals were used to create a capture history matrix, which included information on whether or not individual females were seen with a pup.

Data on the reproductive histories of females seen at Loch Fleet from 2006 to 2016 were used to provide unbiased estimates of reproductive rates using an open robust design multistate model accounting for uncertainty in breeding status, similar to the model used in Cordes & Thompson (2013) but including seasonality. The model included two states, namely breeders (females seen with a pup) and non-breeders (females without a pup). Females seen without pups could not be classed with certainty as non-breeders, as the pup may be on another sandbank, be obscured by the female, the female may have aborted, or the pup may have died or been abandoned prior to the sighting. Therefore the non-breeding state was not directly observable and females seen alone were recorded as uncertain (u) in the capture history. This model estimated the state transitions between years from non-breeder to breeder and breeder to breeder, which are the conditional reproductive rates (i.e. they are conditional on the state of the female). The model also estimates the proportion of females that breed in each year, which is the unconditional reproductive rate. A pupping probability is produced, which is the probability that the pup is present with the female. Similarly a weaning probability is estimated, which is the probability that the pup is no longer present. For this preliminary analysis, only multiparous females were included, by including sightings of females starting from the year after they were first seen with a pup (as 2006 was the first year that surveys were carried out in Loch Fleet, by default 2007 was the earliest year that multiparous females could be sighted). Analyses were carried out in R (R Core Team 2017) within the package RMark (Laake 2013) to construct models in MARK (White & Burnham 1999), and model selection conducted using Akaike's Information Criterion adjusted for small sample size (AICc) (Burnham & Anderson 2002).

Unless the birth was observed, pupping dates were calculated as the mid-point between the day that the female was last seen alone and the day that she was first seen with a pup (Thompson & Wheeler 2008). If this period was longer than 3 days, the pupping date was excluded from analyses of timing of pupping (see Cordes & Thompson 2013).

The Cormack-Jolly-Seber (CJS) model described in Cordes and Thompson (2014) was used to estimate sex-specific survival. To avoid biasing the survival estimates, sightings of individuals of unknown sex were removed from the capture history. Similarly, sightings of known-sex individuals were removed from the capture history prior to the year sex was identified. Capture histories included sightings and non-sightings by year, and sex (male or female) was

used as a covariate. Analyses were again carried out in R (R Core Team 2017) within the package RMark (Laake 2013) to construct models in MARK (White & Burnham 1999), and model selection conducted using AICc (Burnham & Anderson 2002).

Results

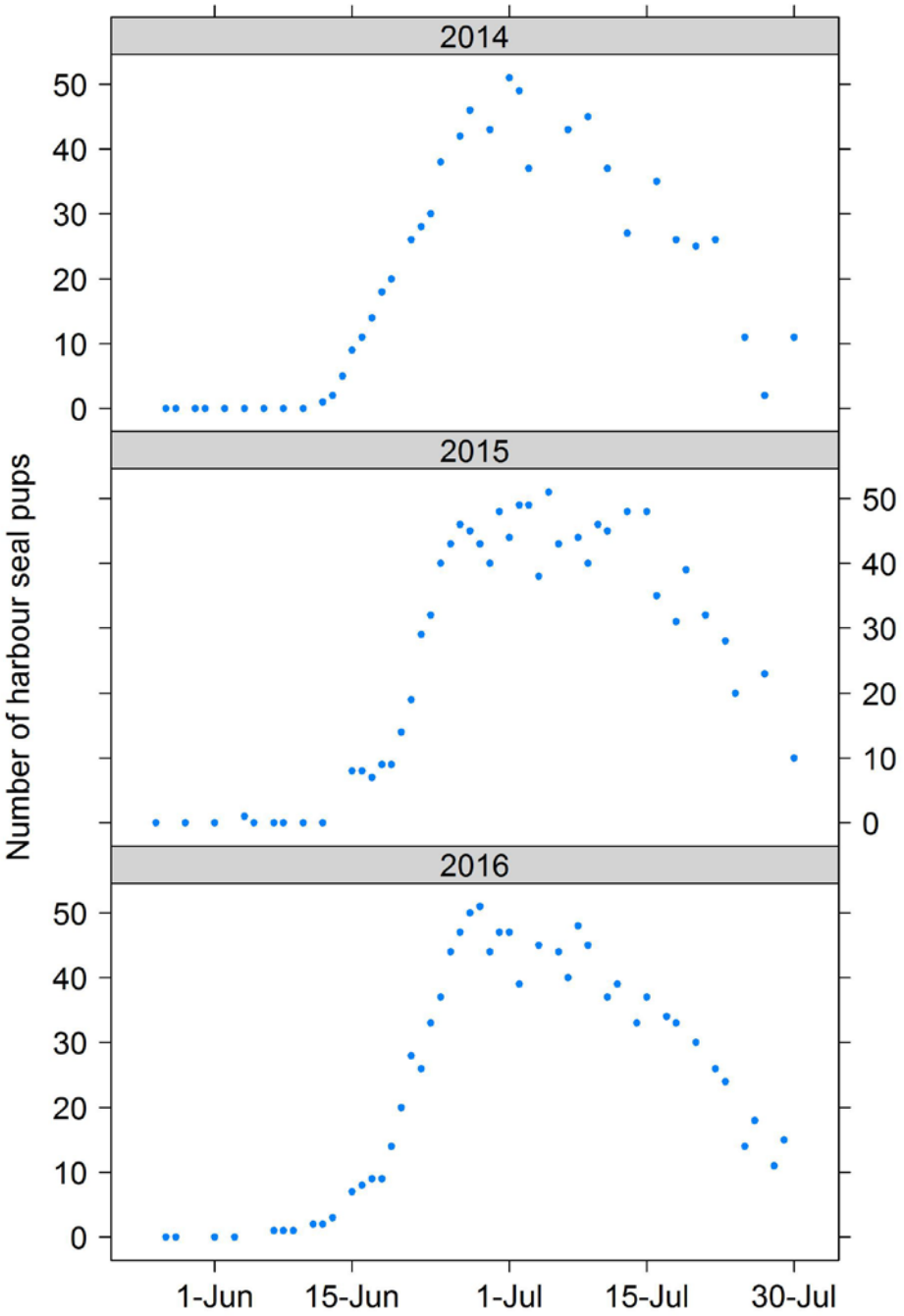


Figure 3. The number of harbour seal pups (living and dead) counted at Loch Fleet during the pupping period from the 26th May to the 30th July 2014-2016.

Table 1 shows the number of photo-identification trips that were conducted during the pupping period at Loch Fleet from the 26th May to the 30th July each year from 2014-2016. The date that the first pup was seen ranged from the 4th to 12th June and the maximum pup count was 51 each year (Table 1, Figure 3). The majority of seals present were successfully photographed on all trips, and particular effort was made to ensure that all attending mothers were photographed to allow analysis of pupping dates and individual reproductive success.

Table 1. Summary data on photo-identification surveys to Loch Fleet during the pupping period from 26th May to 30th July each year between 2014 and 2016.

Year	Number of trips	First pup seen	Maximum pup count	Date of maximum pup count
2014	39	12th June	51	1st July
2015	45	4th June	51	5th July
2016	44	6th June	51	27th June

Female Fecundity

Reproductive histories were available for 86 multiparous females seen at Loch Fleet between 2007 and 2016. The reproductive histories of females that were seen with a pup at Loch Fleet 2014-2016 are provided in Annex 3. Preliminary analysis of the reproductive histories of multiparous females revealed one top model that included a linear time trend and an additive effect of state on survival and a constant proportion of breeders and non-breeders. The unconditional reproductive rate was stable over time, and the mean proportion of breeders was (0.90; 95% CI: 0.87-0.93). The model suggested a difference in survival for breeders and non-breeders, and a slight decline in survival over time (Figures 4a & 4b). Recapture rates of breeders were significantly higher than for non-breeders (Figures 4c & 4d). The pupping probability was greatest around mid-June and then declined to zero around the end of June (Figure 4e). The weaning probability showed a significant increase after the last week of June (Figure 4f).

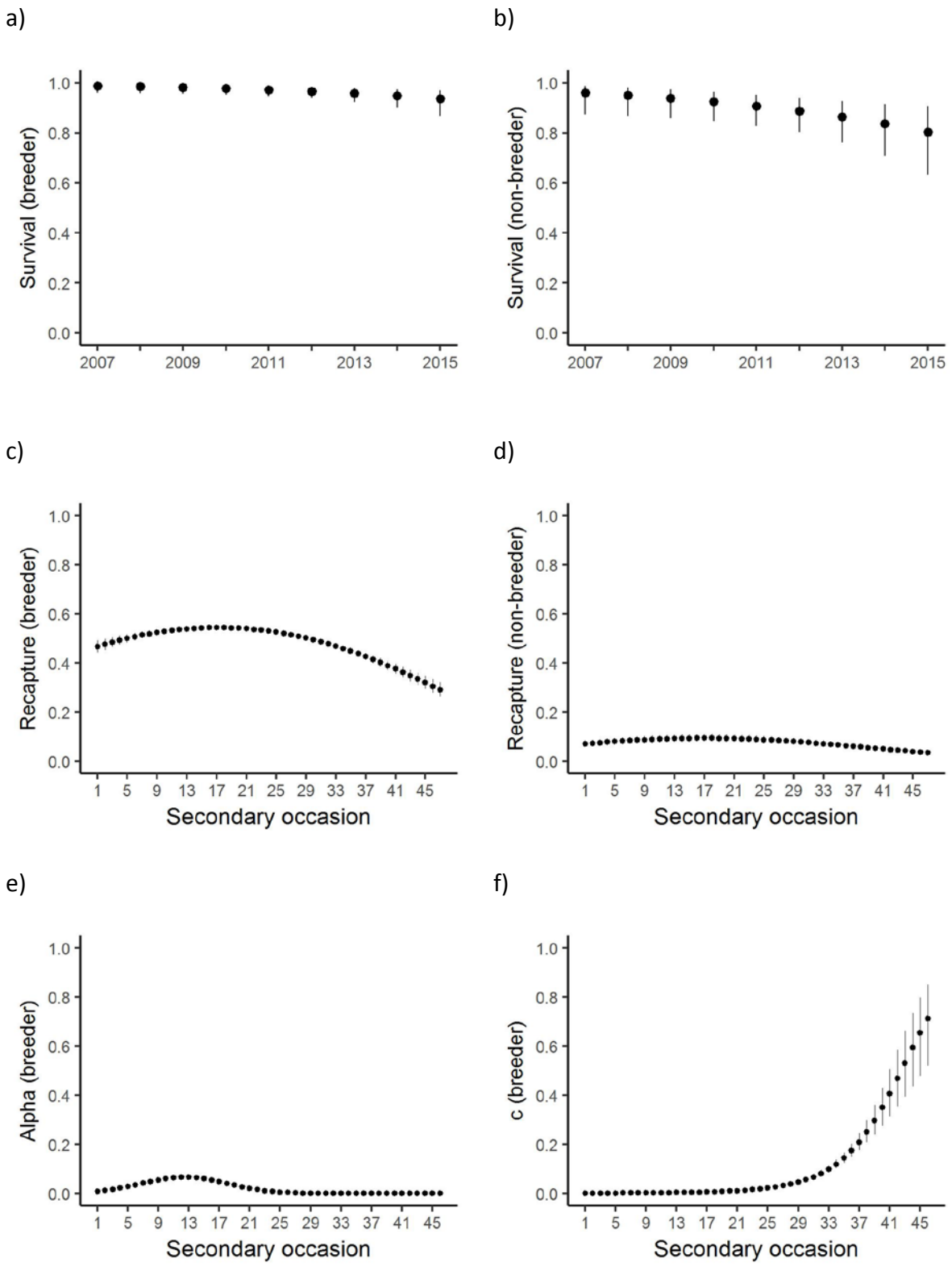


Figure 4. Results of the reproductive rate analysis using the open robust design multistate model with state uncertainty and seasonality: a) survival probability (breeder); b) survival probability (non-breeder); c) recapture rate (breeder); d) recapture rate (non-breeder); e) pupping probability (alpha); f) weaning probability (c).

Timing of Pupping

The number of females seen with a pup at Loch Fleet and the median annual pupping dates 2014-2016 are summarised in Table 2. The median pupping date 2014-2016 was later than the preceding eight years from 2006 to 2013 (Figure 5).

Table 2. Annual summary data on the number of females seen with a pup, the median annual pupping date and the period in which 90% of pups were born at Loch Fleet.

Year	Number of pups	Number of accurate pupping dates	Pupping date	90% range (days)
2014	54	40	170 (19 June)	13
2015	56	37	172 (21 June)	19
2016*	58	27	173 (21 June)	13

* Leap year.

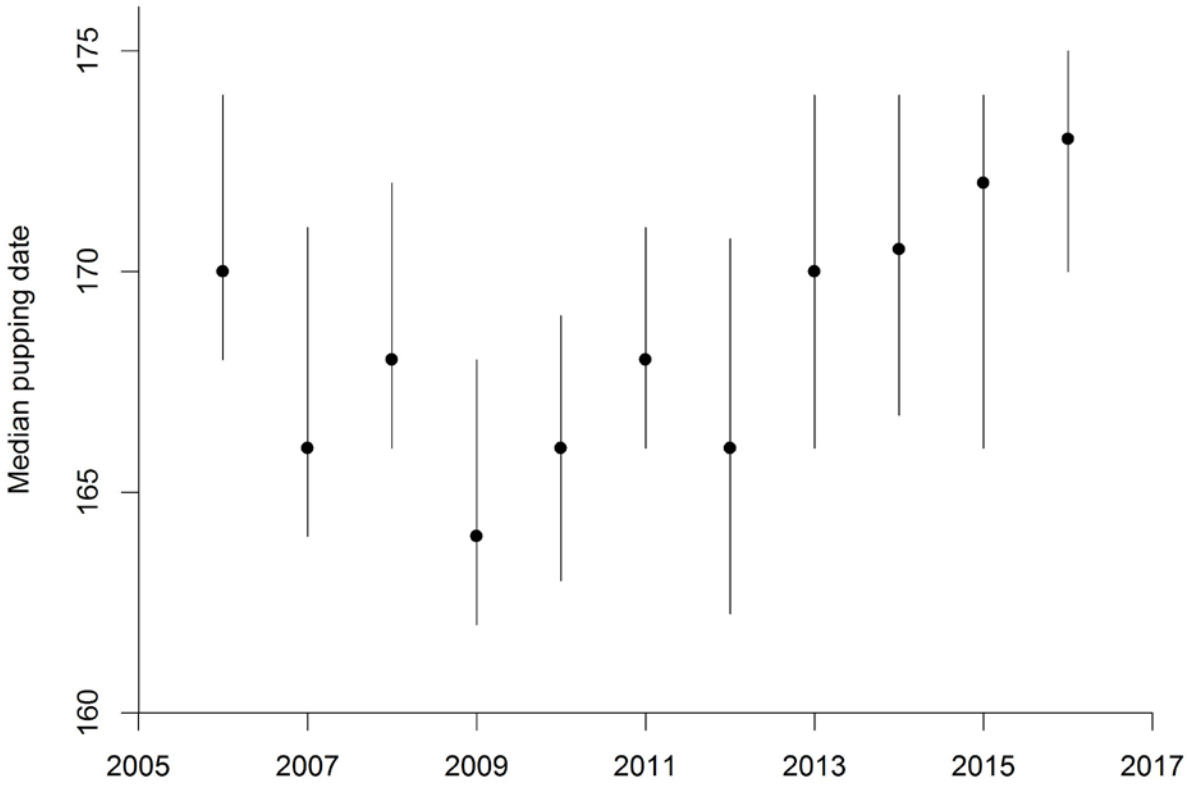


Figure 5. Annual variation in the timing of pupping at Loch Fleet. Points represent the median pupping date with interquartile ranges.

Sex Specific Survival

The number of individuals identified each year at Loch Fleet 2014-2016 is shown in Table 3. The sighting histories of individual harbour seals seen in Loch Fleet 2014-2016 are provided in Annex 4.

Table 3. Annual summary data on the number of females, males and individuals of unknown sex identified at Loch Fleet 2014-2016.

Year	Females	Males	Unknown sex	Total
2014	102	80	1	183
2015	107	76	3	186
2016	110	86	14	210

Preliminary mark-recapture analysis of sightings of 124 males and 144 females at Loch Fleet from 2006 to 2016 revealed four models with good support from the data, all suggesting a sex-specific difference in survival as well as inter-annual variation in survival rates. Mean survival probability from 2006 to 2015 was higher for females (0.97, 95% CI: 0.95-0.99) compared to males (0.94, 95% CI: 0.90-0.97). In the top model, between year recapture rates were high and stable over the study period 0.94 (95% CI: 0.92-0.95) and showed no difference between males and females.

WP 1.2: Trends in abundance

Introduction and Objectives

This work package is being used to assess baseline variability in summer and winter abundance at harbour seal haul-out sites along the northern Moray Firth coast (Figure 2: Loch Fleet and smaller sites near Brora and Helmsdale). These finer-scale summer abundance data from sites that are closest to the BOWL and MORL developments can then be related to broad-scale survey data that are routinely collected by the University of St Andrews Sea Mammal Research Unit (SMRU); i.e. Regional Site Condition Monitoring data from the Dornoch Firth and Morrich More SAC and national harbour seal survey data. This will permit future comparison with data collected during the construction and post-construction period, allowing a test of the short term decline and subsequent recovery predicted under the Moray Firth seal assessment framework.

Parameters to be measured

- Summer abundance of harbour seals during the pupping season and moult;
- Winter abundance of harbour seals.

Survey Design

Throughout their global range, trends in harbour seal abundance are based upon low-tide counts made during either the pupping season (Thompson *et al.* 1997; Huber *et al.* 2001) or moult (Thompson & Harwood 1990; Lonergan *et al.* 2007), when a higher and more consistent proportion of seals are ashore. A range of counting methods has been used in other studies, including land-based counts (Thompson *et al.* 1997), aerial photographic survey (Thompson & Harwood 1990) and thermal imagery (Lonergan *et al.* 2007). In future it is likely that UAVs (unmanned aerial vehicles) may also become a viable survey platform.

Methodology

Land-based counts were made at five sites (Figure 2) during the pupping season (15th June – 15th July) and moult (1st – 31st August) following the protocols used by the University of Aberdeen during previous studies of trends in harbour seal abundance (Thompson *et al.* 1996; Thompson *et al.* 1997; Thompson *et al.* 2007; Cordes *et al.* 2011). Monthly counts were also made at all sites throughout the winter months (from September to May). Counts were made at Dunrobin, Sputie Burn and Lothmore from June 2014 and at Lothbeg from May 2015, and have been ongoing at Loch Fleet since 1988.

Counts were made around low tide and, when possible, on days with good sighting conditions (good visibility and an absence of rain). Counts were made from suitable vantage points by an experienced observer, using a Swarovski HD-ATS 80 telescope. In Loch Fleet, counts were made as part of the on-going photo-identification studies. Where conditions allowed at other sites, opportunistic photographs were also taken and these are being processed using the same approaches outlined in WP 1.1.

Data Analysis

Total abundance was estimated by adjusting counts made during the pupping season following the approach described in Thompson *et al.* (1997). The estimated proportion of low tides on which male and female harbour seals haul out used to adjust counts was taken from Thompson *et al.* (1997) but will be revised using telemetry data from the 57 seals tagged in September 2014, February 2015 and February/March 2017 (see WP 1.3). The matrix of photographic recaptures used to estimate survival (WP 1.1) will also be used to provide mark-recapture estimates of absolute abundance in Loch Fleet (Cordes 2011) and, potentially, at the other sites.

The mean annual pupping season and moult counts will be related to broader scale harbour seal survey data from the east coast of Scotland that are made available through the Natural Environment Research Council Special Committee on Seals (e.g. SCOS 2016).

Results

A minimum of four counts were made at all sites during the pupping season and moult from 2014 to 2016, with the exception of Lothbeg in 2014 (Tables 4 & 5, Figure 6). In addition, throughout the winter, monthly counts were made at each of these sites from September 2014 to March 2017, again excluding Lothbeg from September 2014 to April 2015 (Tables 4 & 6).

Table 4. Number of count trips made to each site 2014 – 2016 during the pupping season (15th June to 15th July), moult (1st to 31st August), winter 2014 and 2015 (1st September to 31st May), and winter 2016 (1st September 2016 to 31st March 2017).

		Lothmore	Lothbeg	Sputie Burn	Dunrobin	Loch Fleet
Pupping	2014	5	-	5	4	19*
	2015	4	4	4	4	28
	2016	4	4	4	4	26
Moult	2014	4	-	4	4	5
	2015	4	4	4	4	4
	2016	4	4	4	4	4
Winter	2014	9	1	9	9	19*
	2015	9	9	9	9	15*
	2016	7	7	7	7	9*

* includes 1 trip (pupping 2014), 4 trips (winter 2014), 5 trips (winter 2015) and 2 trips (winter 2016) made to Loch Fleet for non-MMMP fieldwork activities

Table 5. Mean counts (± 1 SE) of adult harbour seals at each site during the pupping season (15th June to 15th July) and moult (1st to 31st August) 2014 – 2016.

		Lothmore	Lothbeg	Sputie Burn	Dunrobin	Loch Fleet
Pupping	2014	0.2 (0.2)	-	22.4 (1.33)	0 (0)	92.84 (4.21)
	2015	2.0 (0.41)	0.75 (0.48)	29.0 (2.2)	0 (0)	101.57 (4.11)
	2016	1.0 (0.41)	2.75 (0.95)	23.5 (4.7)	2.25 (2.25)	101.31 (3.16)
Moult	2014	6.25 (1.89)	-	38.75 (4.96)	0.25 (0.25)	123.2 (8.25)
	2015	3.0 (1.22)	1.75 (1.18)	37.5 (7.19)	2.0 (1.08)	128.75 (11.17)
	2016	0.75 (0.48)	3.75 (0.63)	41.5 (7.4)	4.0 (1.87)	158.5 (6.20)

Table 6. Mean counts (± 1 SE) of adult harbour seals at each site during the winter 2014 and 2015 (1st September to 31st May) and 2016 (1st September 2016 to 31st March 2017).

	Lothmore	Lothbeg	Sputie Burn	Dunrobin	Loch Fleet
Winter 2014	2.22 (1.06)	3.00 (-)	24.56 (4.19)	0 (0)	79.84 (9.95)
Winter 2015	0.78 (0.52)	3.11 (0.86)	31.22 (4.24)	1.00 (0.78)	91.67 (7.75)
Winter 2016	0.86 (0.40)	2.29 (1.17)	25.71 (3.15)	1.43 (0.81)	72.22 (9.07)

Table 7. Estimated abundance of harbour seals using Loch Fleet 2014 – 2016.

	Estimated Abundance	Lower 95% Confidence Interval	Upper 95% Confidence Interval
2014	152	132.9	171.8
2015	167	146.5	186.8
2016	166	147.4	184.2

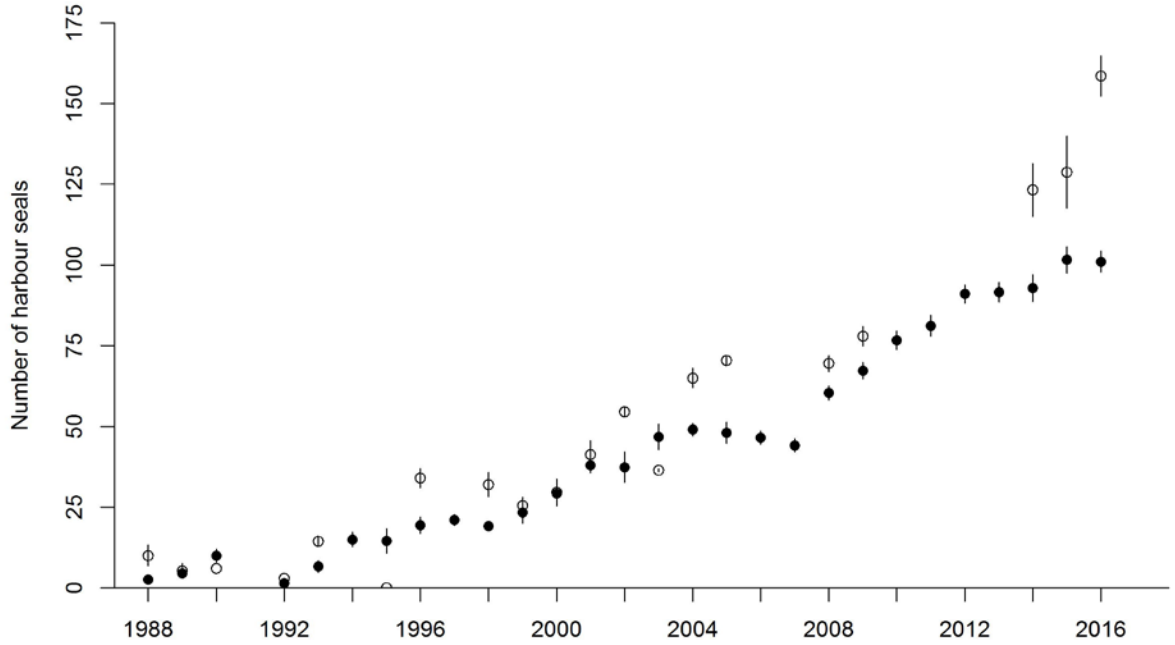


Figure 6. Counts of adult harbour seals at Loch Fleet, 1988-2016: filled circles are counts during the pupping season; open circles are counts during the moult. Plotted values are the means ± SE.

In 2014 and 2015, the mean counts of harbour seals in Loch Fleet during the moult exceeded the counts in the Dornoch Firth SAC (SCOS 2016) and represented 17% of the total harbour seal counts in the Moray Firth Seal Management Area (SMA) (Table 5; SCOS 2016). In the Moray Firth SMA, the overall total moult counts were similar in 2011-2015 and 2007-2009 but have declined by 50% since 1996-1997 (SCOS 2016). In contrast, the estimated number of harbour seals using Loch Fleet has increased since the mid-1990s (Table 7, Figures 6 & 7). Counts at Culbin Sands and Findhorn have similarly increased, suggesting a re-distribution of seals away from the inner firths (SCOS 2016).

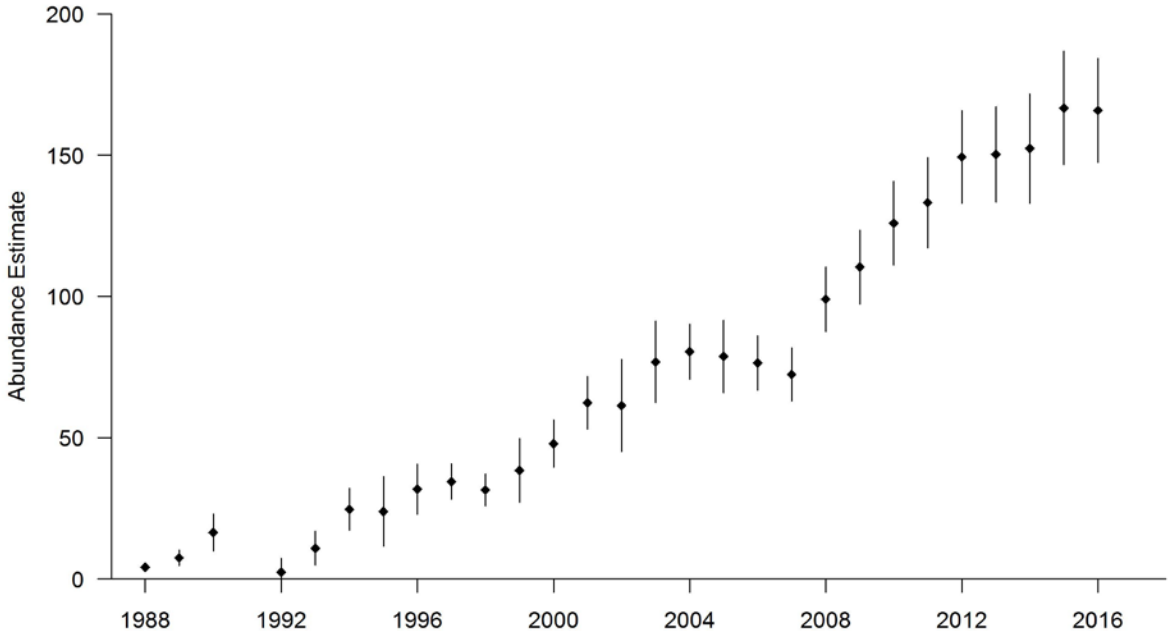


Figure 7. Estimated number of seals using Loch Fleet from 1988 to 2016 with 95% confidence intervals.

WP 1.3: Characterisation of foraging areas

Introduction and Objectives

This work package will be used to obtain up to date information on baseline variability in the at-sea distribution and foraging patterns of harbour seals breeding at haul-out sites in the northern part of the Moray Firth. This will permit future comparison with data collected from animals that are exposed to piling noise. These data will also be used to characterise the foraging areas used by different identifiable individuals (see WP 1.1). This will, in turn, allow us to evaluate whether individual variation in vital rates is related to the extent of overlap between individual foraging ranges and areas impacted by construction noise.

Parameters to be measured

- Population distribution at sea during summer and winter;
- Individual home ranges and foraging areas;
- Dive patterns.

Survey Design

A wide range of telemetry devices have previously been used to track harbour seals. This study is using GPS/GSM tags produced by SMRU Instrumentation, that have been widely used to obtain fine-scale data on distribution and activity of harbour seals in UK waters (Cordes *et al.* 2011; Sharples *et al.* 2012).

Tags were expected to last 3-9 months, and the survey was designed to include three capture periods to maximise the chance of obtaining a balanced dataset across both winter and summer seasons.

Methodology

To collect pre-construction data during the winter of 2014/15, spring/summer of 2015 and spring 2017, harbour seals were captured in Loch Fleet (Figure 2) in September 2014, February 2015 and February/March 2017. These data include those resulting from the pre-construction MMMP and the initial stages of the BOWL construction monitoring programme. Study individuals were captured using barrier nets as they flushed from their haul-out sites, before being weighed and anaesthetized. Handling and anaesthesia was conducted by suitably trained and licensed personnel, using specialist boats and equipment (see Sharples *et al.* 2012 for full details).

GPS/GSM tags were attached to the hair at the back of the neck using Loctite® 422 Instant Adhesive and the seals released following collection of standard samples and measurements. Seal capture and handling was conducted under the terms of licences issued by the UK Home Office under the Animals (Scientific Procedures) Act 1986 (# 70/7806) and Marine Scotland under the Marine (Scotland) Act 2010.

Data Analysis

Data on the locations and activity patterns of individual tagged seals are transmitted via GSM to the University of St Andrews when seals move within range of mobile phone masts. The data are then subject to routine error checking and estimation of summary statistics, and archived on a server from which data can regularly be extracted via a secure web portal.

Results

57 harbour seals were tagged at Loch Fleet with GPS/GSM tags: 12 harbour seals, six female and six male, in September 2014; 13 harbour seals, seven female and six male, in February 2015; and 32 harbour seals, 20 female and 12 male, in February and March 2017 (Table 8). The individual sighting histories, reproductive histories, capture information and tracks up to the 31st March 2017 for the 57 tagged seals are provided in Annex 5. Following the start of piling on 2nd April 2017, there will be ongoing data collection from seals tagged in spring 2017 as part of BOWL's construction monitoring. Annex 6 summarises information on the 28 harbour seals that were captured but not tagged in Loch Fleet during September 2014, February 2015 and February/March 2017.

Figure 8 shows the tracks for all 12 harbour seals tagged in September 2014, Figure 9 shows the tracks for all 13 harbour seals tagged in February 2015 and Figure 10 shows the tracks, up to 31st March 2017, for all 32 harbour seals tagged in February and March 2017. Two individuals used the wind farm sites. These new data can be compared with earlier data used to underpin the Moray Firth Seal Assessment Framework (Figure 11).

Table 9 summarises the number and sex ratio of harbour seals tagged in the Dornoch Firth and at Loch Fleet from 1989-2017.

Table 8. Harbour seals tagged at Loch Fleet, September 2014, February 2015 and February/March 2017.

Seal ID	Date captured	Sex	Flipper tag #	GPS/GSM tag #	Weight (kg)	Length (cm)	Girth (cm)
013	28-Sep-14	F	00518	12915	84.6	148.5	97.0
014	08-Mar-17	F	D077	14426	80.2	131.0	105.0
030	04-Mar-17	F	D064	14429	90.4	141.0	115.0
042	27-Feb-15	F	00558	13120	83.2	144.0	107.0
053	04-Mar-17	F	D070	14430	87.0	142.0	111.0
056	06-Mar-17	F	D074	14466	76.6	142.0	104.0
059	06-Mar-17	F	D029	14427	88.0	139.0	110.0
063	06-Mar-17	F	D075	14434	81.0	129.0	118.0
072	23-Feb-15	M	00544	13282	83.4	142.0	111.0
072	18-Feb-17	M	D043	14470	86.2	136.0	115.5
075	04-Mar-17	F	D066	14468	90.4	141.0	114.0
076	25-Feb-15	F	00554	13314	71.7	135.0	100.0
081	15-Feb-17	F	D036	14433	82.2	143.0	111.0
086	17-Feb-17	M	D039	14439	97.3	142.0	120.0
090	29-Sep-14	M	00503	13115	71.0	142.0	102.0
090	19-Feb-17	M	D057	14438	92.2	149.0	112.0
099	25-Feb-15	M	00543	13313	94.9	154.0	115.0
105	25-Feb-15	F	00545	13203	86.3	139.0	111.0
127	29-Sep-14	F	00527	13212	71.4	143.0	96.0
158	25-Feb-15	F	00548	13286	94.5	145.0	106.0
158	19-Feb-17	F	00548	14478	96.4	144.0	108.0
169	19-Feb-17	M	D050	14424	87.8	147.0	113.0
174	15-Feb-17	F	D030	14461	91.0	141.0	119.5
178	17-Feb-17	M	D038	14467	89.4	147.0	112.5
191	15-Feb-17	M	D031	14471	81.6	138.0	110.0
216	19-Feb-17	F	D055	14437	103.6	143.0	125.0
219	15-Feb-17	M	D032	14460	89.6	148.0	113.0
230	26-Feb-15	M	00553	13284	90.6	149.0	115.0
242	29-Sep-14	F	00528	12922	64.4	130.0	97.5
242	07-Mar-17	F	D076	14464	86.2	138.0	113.0
250	04-Mar-17	F	D069	14463	79.4	135.0	105.0
253	28-Sep-14	F	00522	13207	64.4	135.0	100.0
260	28-Sep-14	M	00519	13214	63.2	133.4	100.0
264	23-Feb-15	M	00541	13255	64.2	140.0	99.0

Seal ID	Date captured	Sex	Flipper tag #	GPS/GSM tag #	Weight (kg)	Length (cm)	Girth (cm)
267	29-Sep-14	M	00529	12919	91.8	137.0	95.0
268	19-Feb-17	F	D052	14462	82.6	147.0	109.5
270	26-Feb-15	M	00556	13316	76.3	142.0	105.0
272	18-Feb-17	M	D040	14207	105.2	156.0	119.0
274	28-Sep-14	M	00521	13208	48.2	129.0	91.0
276	04-Mar-17	F	D071	14436	66.4	131.0	91.0
280	18-Feb-17	M	D045	14472	88.0	133.0	114.0
283	04-Mar-17	F	D068	14479	66.8	129.0	96.0
285	19-Feb-17	F	D058	14477	73.2	134.0	104.0
294	28-Sep-14	F	00523	12921	59.2	130.0	98.0
307	29-Sep-14	M	00526	13209	71.2	147.0	99.0
314	19-Feb-17	F	D054	14474	73.2	138.0	102.0
317	28-Sep-14	F	00520	13210	55.2	132.6	90.0
322	29-Sep-14	M	00525	13213	53.4	120.0	96.0
331	18-Feb-17	M	D041	14428	84.6	148.0	109.0
337	16-Feb-17	F	D037	14473	74.2	132.0	108.0
338	27-Feb-15	M	00551	13204	100.6	157.0	118.0
341	27-Feb-15	F	00550	13318	73.1	141.0	108.0
376	05-Mar-17	M	D072	14432	115.2	154.0	123.0
380	15-Feb-17	M	D035	14432	98.6	144.0	120.0
383	25-Feb-15	F	00531	13322	89.7	144.0	103.0
384	26-Feb-15	F	00555	13320	94.0	143.0	112.0
384	17-Feb-17	F	00555	14431	87.8	143.0	110.0

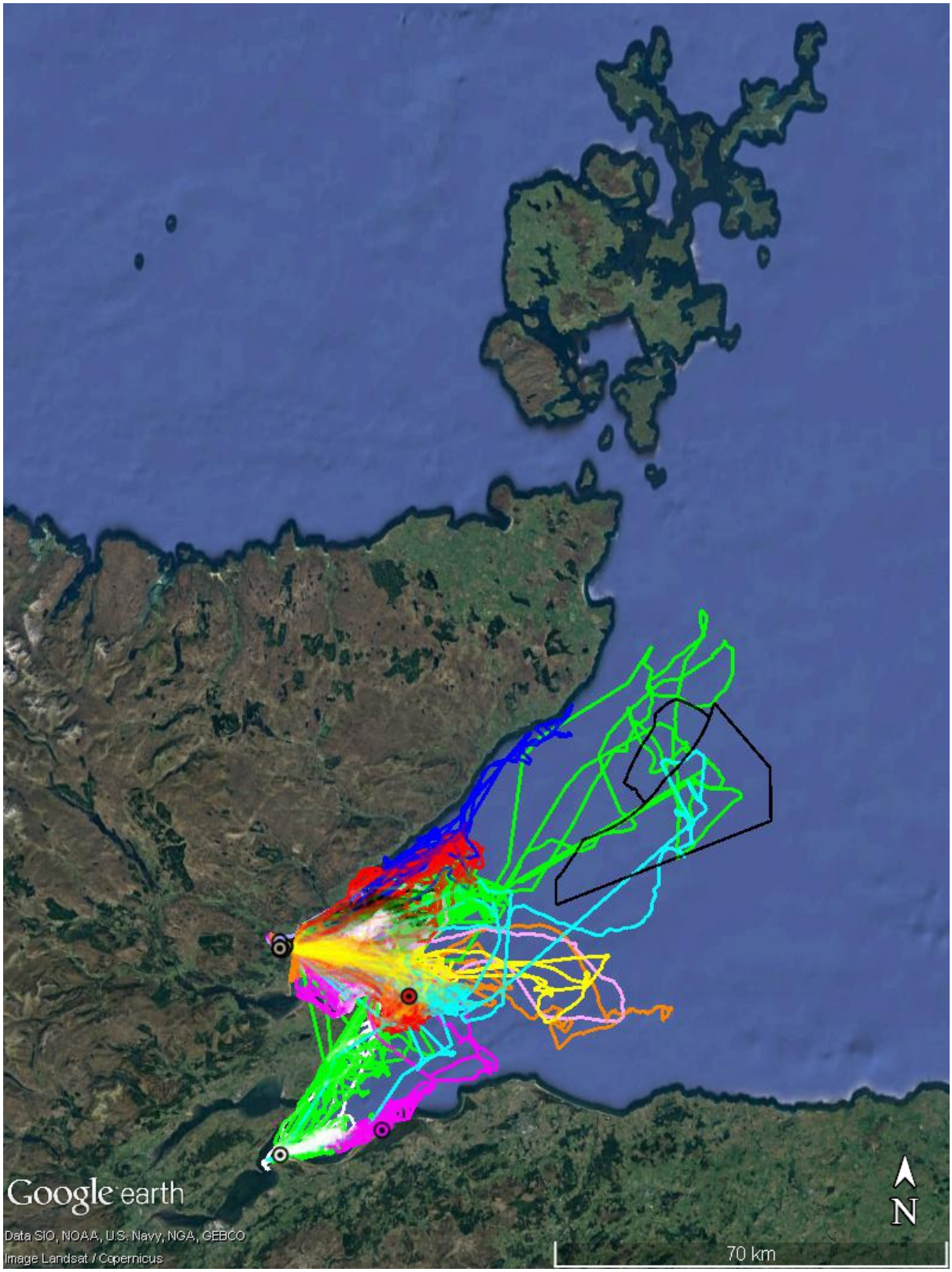


Figure 8. Raw GPS tracks from 12 harbour seals tagged at Loch Fleet in September 2014: each colour represents a different individual.

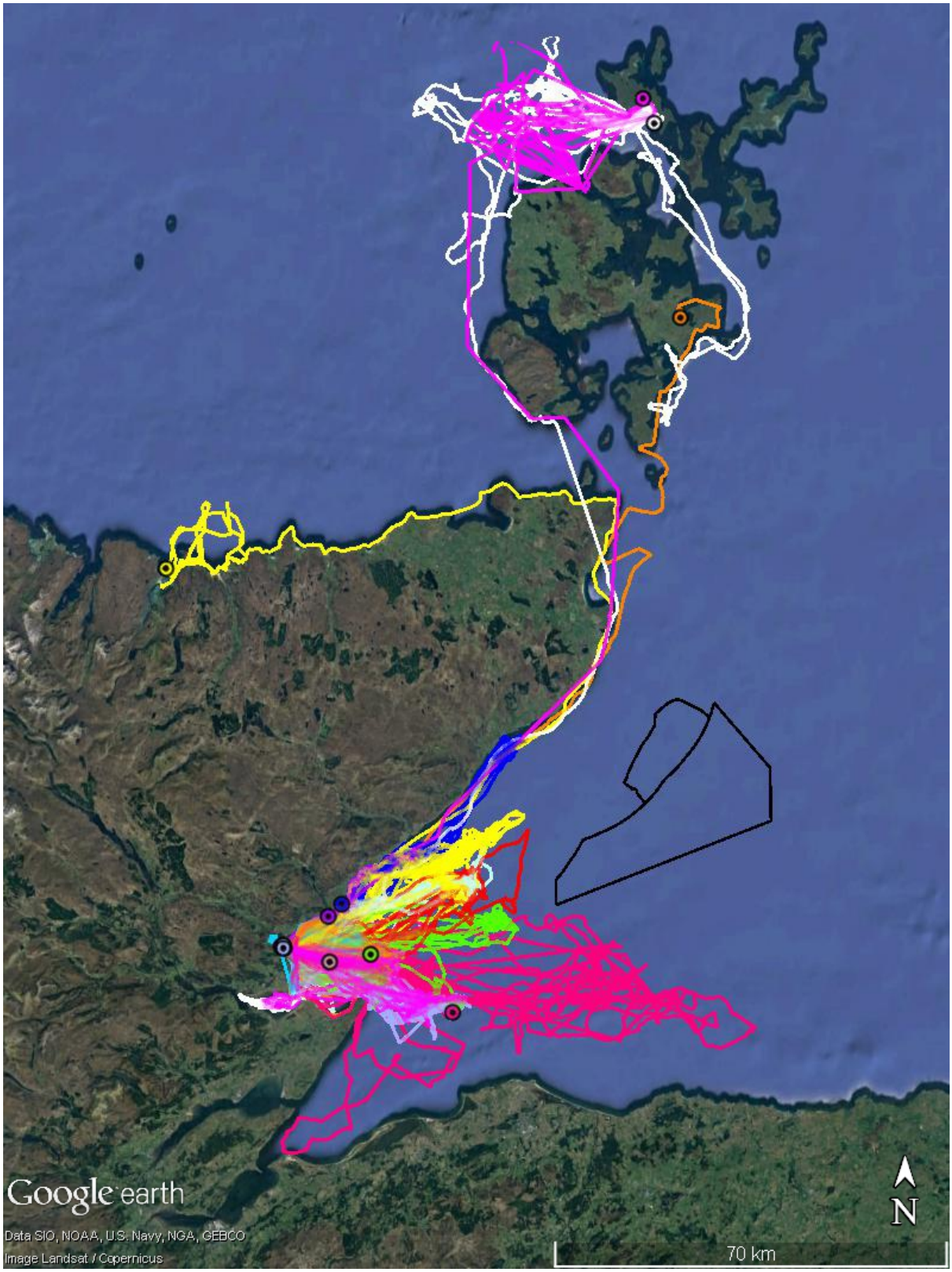


Figure 9. Raw GPS tracks from 13 harbour seals tagged at Loch Fleet in February 2015: each colour represents a different individual.

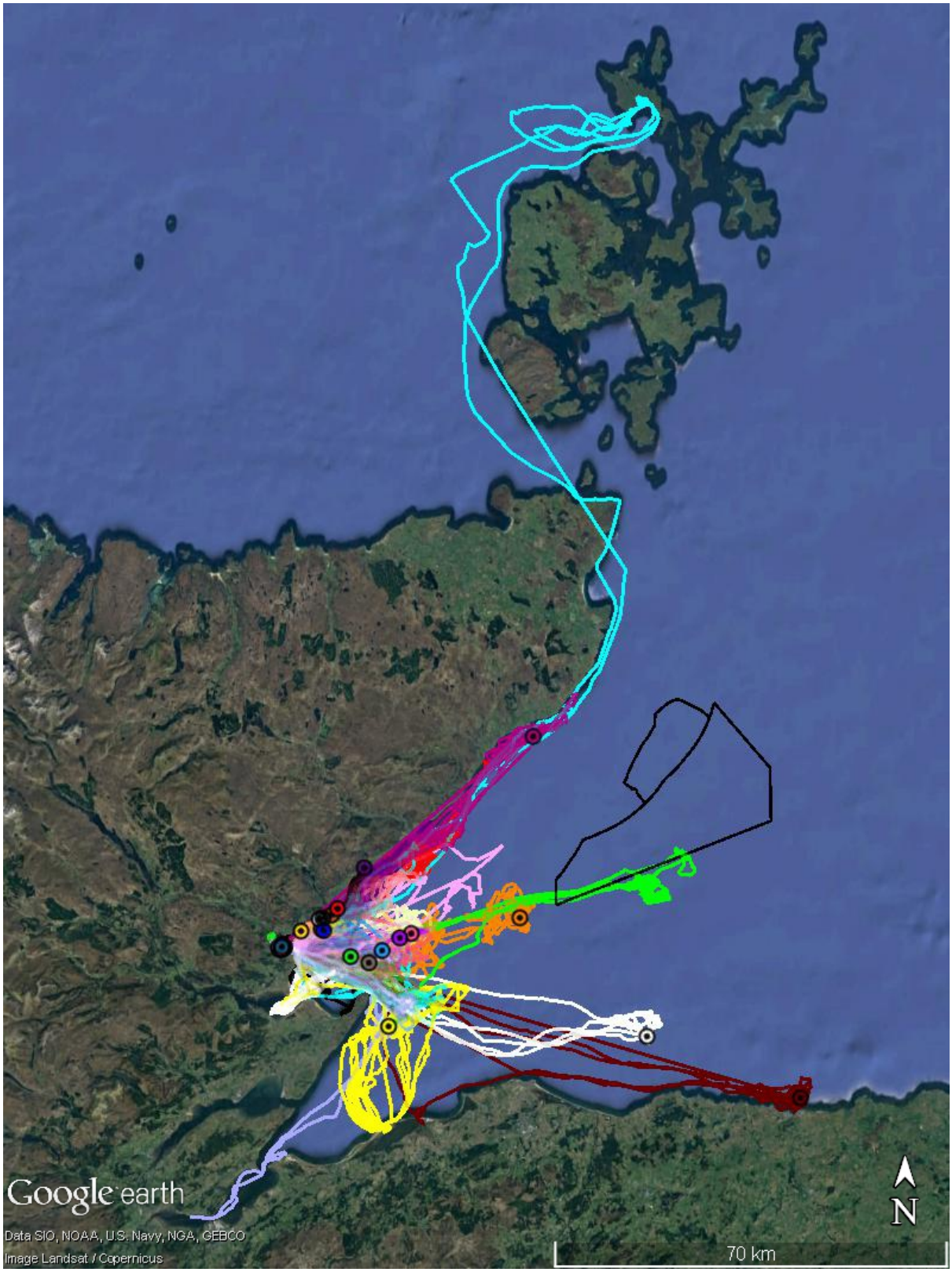


Figure 10. Raw GPS tracks up to 31st March 2017 from 32 harbour seals tagged at Loch Fleet in February and March 2017: each colour represents a different individual.

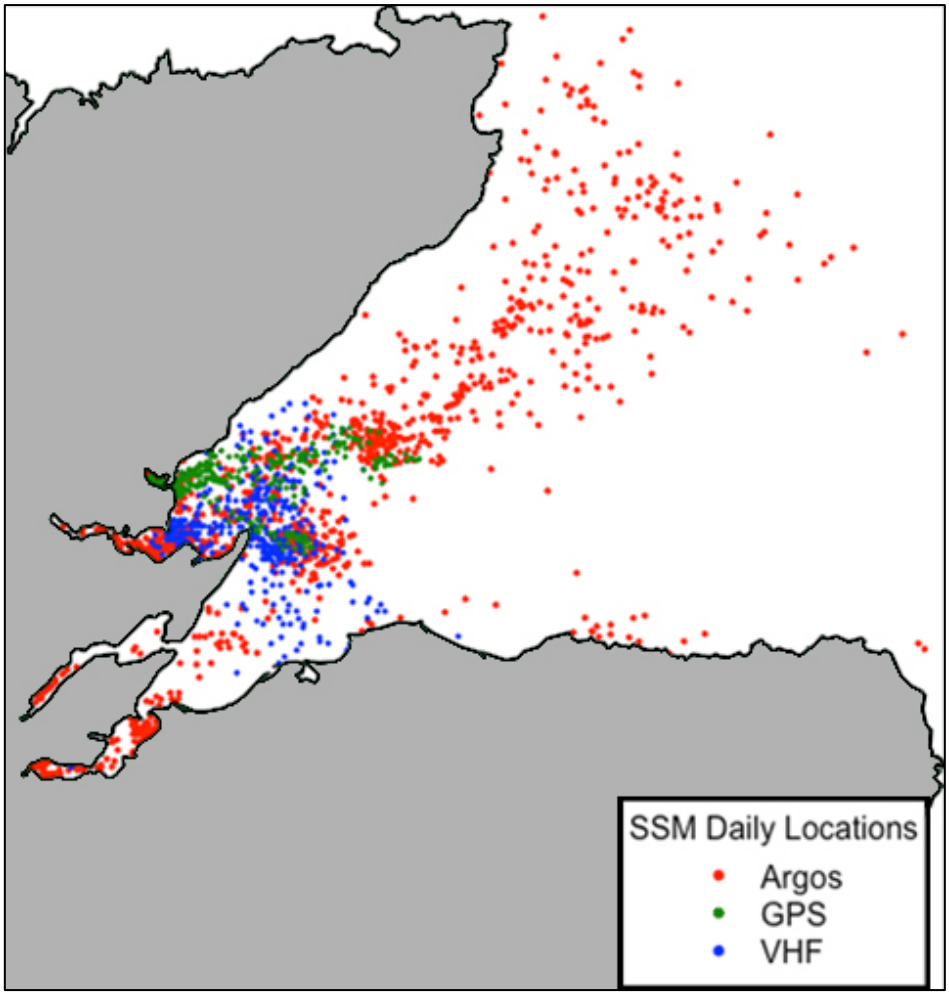


Figure 11. Daily harbour seal state-space model (SSM) locations from 37 individual seals that were captured in either Loch Fleet or the Dornoch Firth and tagged between 1989 and 2009. Locations were derived from Argos satellite (red), GPS (green), and VHF (blue) positions (circles). See Bailey, Hammond and Thompson (2014) for further details.

Table 9. Summary of the harbour seals tagged in the Dornoch Firth and at Loch Fleet from 1989-2017. Telemetry techniques used were very high frequency (VHF) radio tracking, Argos satellite (SRDL) and a Global Positioning System sensor combined with a mobile phone Global System for Mobile Communications modem to relay data ashore (GPS-GSM).

Tag Type	Deployment years	Number of tag deployments	Sex ratio (Male:Female)
VHF	1989-1991	21	12:9
SRDL	2004-2005	10	6:4
GPS-GSM	2009, 2014-2015, 2017	62*	24:38
Total		**93**	**42:51**

* includes one tag that was deployed on one male for two weeks and then transferred to a second male

Bottlenose Dolphin Monitoring Work Packages

WP 2.1: Individual based studies of reproduction and survival

Introduction and Objectives

This work package is being used to assess baseline variability in bottlenose dolphin vital rates. This will permit future comparison with data collected during the construction period.

Parameters to be measured

- Female fecundity;
- Survival rates.

Survey Design

Established boat-based photo-identification techniques are used to identify individual bottlenose dolphins from their distinct dorsal fin markings (Figure 12) (Wilson, Hammond & Thompson 1999; Wilson *et al.* 2004; Cheney *et al.* 2013). Following agreed methods for monitoring the population that uses the Moray Firth SAC (Thompson *et al.* 2004; Cheney *et al.* 2014b), repeated observations can then be used to determine whether or not different females in the population give birth each year. Repeated sightings of well-marked individuals can be used to estimate survival rates.

Figure 12. Examples of suitable photographs for individual photo-identification, showing the distinct nicks and tooth rake marks on the left and right side of four individuals that regularly use the Moray Firth SAC.

Methodology

Sampling Techniques

Photo-identification surveys within the Moray Firth SAC were conducted between May and September. Surveys were conducted from the Lighthouse Field Station in Cromarty using a specialist MCA coded workboat. Standard and established protocols for monitoring the Moray Firth SAC have been agreed with SNH (Thompson *et al.* 2004; Cheney *et al.* 2014b). Surveys aimed to target areas that maximise the probability of encountering bottlenose dolphins. Whenever groups were encountered, the boat was manoeuvred at slow speed around the dolphins to allow dorsal fin photographs to be taken with an SLR camera. Surveys aimed to obtain high quality pictures of the left and right sides of the dorsal fins of as many individuals as possible, whilst minimising disturbance and ensuring that as many different members of the group were photographed as possible. All survey work was conducted under SNH licence that permits disturbance to dolphins for scientific research. Surveys were carried out by at least three personnel, including an experienced photographer and a suitably certified boat skipper.

Data Analysis

Field data from each survey were archived in an access database. All images were graded for photographic quality (Wilson, Hammond & Thompson 1999; Cheney *et al.* 2014b). All high quality pictures were matched to our existing photo-identification catalogue by an experienced analyst. At the end of this process, all the initial matches were confirmed by a second experienced analyst and the data and photographs were archived.

To estimate fecundity we used data from 2001 to 2016, as during this time period the majority of calves could be associated with known females (e.g. calf seen in echelon position, consistently surfacing alongside the mother's dorsal fin), avoiding possible duplication. The year of birth of calves was estimated using foetal folds (vertical creases down their sides from their position in the womb, which fade over time), their paler colour and relative size. Females were included once they had been seen with a calf. An open robust design multistate model with state uncertainty and seasonal effects was used. In addition to accounting for misclassification or uncertainty in breeding status (for full details of the state uncertainty model see Kendall, Hines & Nichols 2003; Cordes & Thompson 2014) this new model also incorporates two new parameters which allow a change in female state (i.e. arrival or departure of a calf) during secondary occasions. Females could be assigned to one of three states namely females with new-born calves, females with 1 or 2 year old calves, and non-breeders. However, non-breeders were never observed with certainty (i.e. females without a calf cannot unambiguously be classified as non-breeders as the calf may not be detected) (Kendall, Hines & Nichols 2003). Therefore, the model also included an uncertain state which was assigned to females when they were not observed with a calf (i.e. a mixture of non-breeders and breeders where the calf was hidden or obscured, not photographed, missing or already dead). Sightings histories for each female

were summarised into weeks (i.e. secondary capture occasions) within each year (i.e. primary occasion). The model parameter of interest was the estimate of the proportion of females within the study area that have a new-born calf (unconditional reproductive rate). Analyses were carried out in R (R Core Team 2017) within the package RMark (Laake 2013) to construct models in MARK (White & Burnham 1999). Model selection was conducted using Akaike's Information Criterion (AIC) (Akaike 1998) adjusted for small sample size (AICc) (Burnham & Anderson 2002).

To estimate survival we used data collected between 1990 and 2016 within the Moray Firth SAC and Robust design models (Pollock 1982; Kendall, Pollock & Brownie 1995; Kendall, Nichols & Hines 1997). These models account for heterogeneity in capture probabilities due to temporary emigration and have previously been used to estimate survival for the entire east coast of Scotland population (see Arso Civil 2014 for full details). A series of robust design models were specified using the package RMark (Laake 2013) in R (R Core Team 2017) and implemented in program MARK (White & Burnham 1999). Again, the model with the lowest AICc (Burnham & Anderson 2002) was selected as having most support from the data.

Results

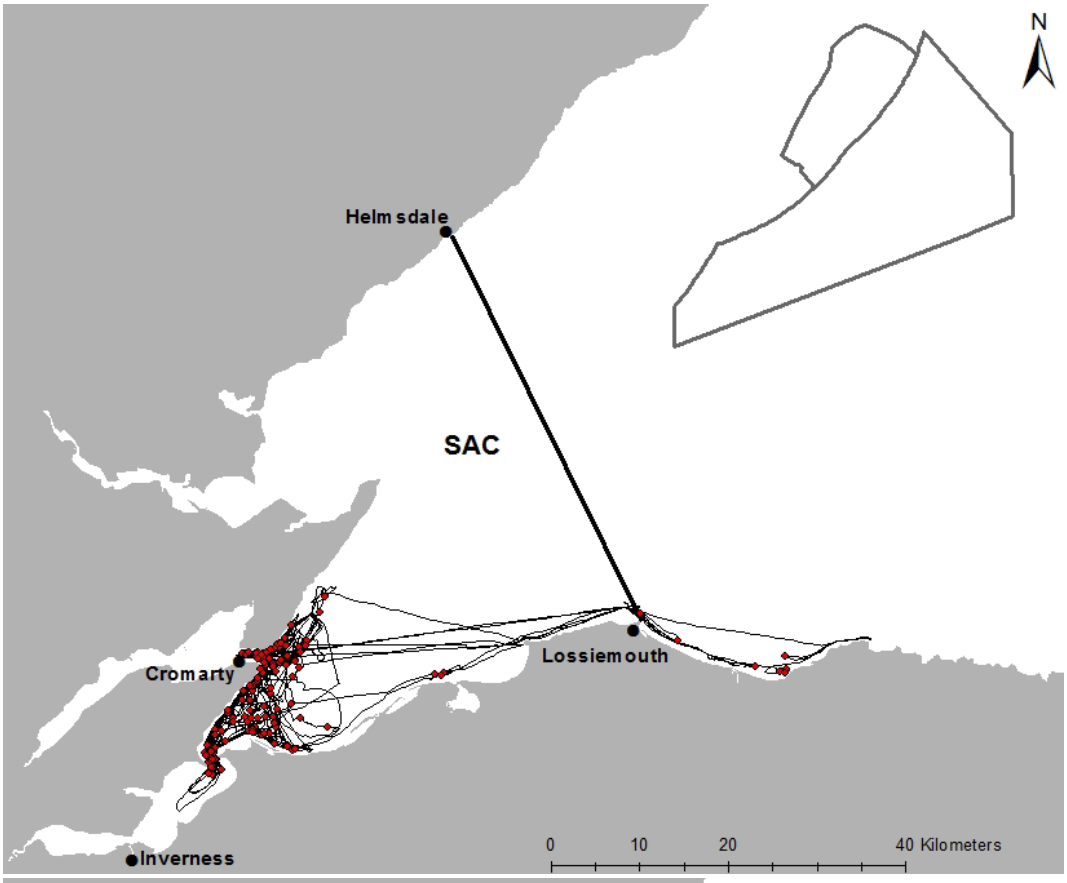
2014 to 2016 Photo-Identification Surveys

Between May and September 2014 to 2016, a total of 62 photo-identification surveys were conducted in the Moray Firth (Table 10 and Figure 13). Of these, 5 surveys also went outside the SAC along the south coast of the Moray Firth (Figure 13).

Table 10. 2014 to 2016 photo-identification survey details for the Moray Firth.

	Number of Surveys	Survey Duration (hours)	Number of Encounters	Time on Encounters (hours)	% of survey time with dolphins
2014	21	136.18	135	52.77	39%
2015	20	124.42	122	48.63	39%
2016	21	142.67	165	48.17	34%
Total	**62**	**403.27**	**422**	**149.57**	**37%**

a.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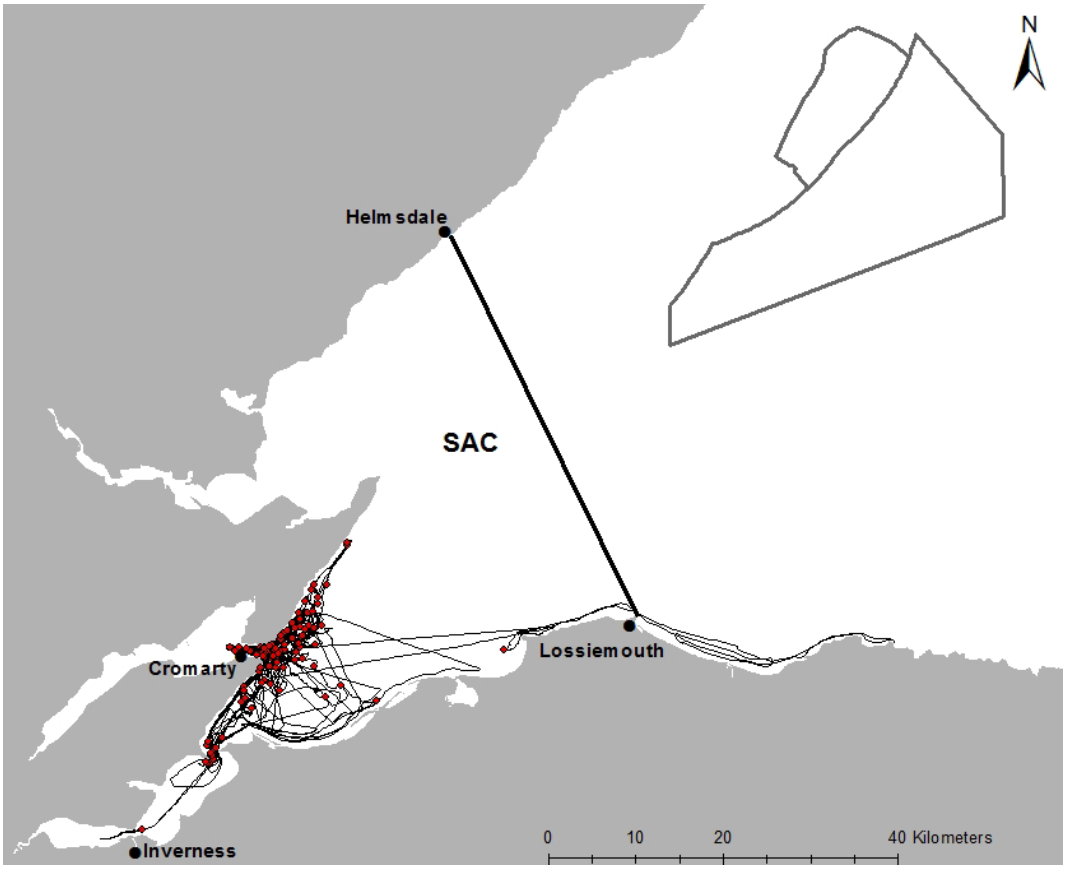
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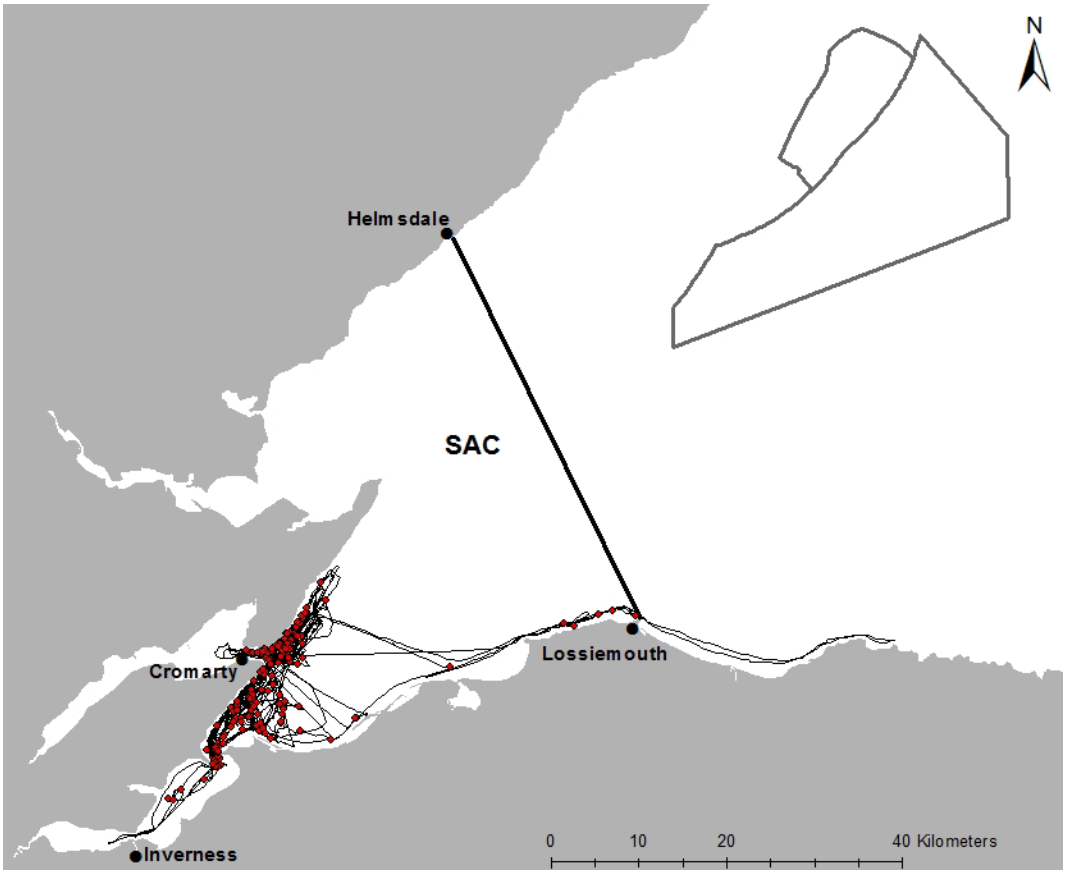


Figure 13. Maps showing all the areas covered by photo-identification surveys (black lines) and the location of all encounters with groups of bottlenose dolphins (red dots), a. 2014, b. 2015 and c. 2016

Over 403 hours were spent on photo-identification surveys within the Moray Firth, from 2014 to 2016 with bottlenose dolphins seen on every survey. In total there were 422 encounters with bottlenose dolphins lasting on average 21 minutes each. This equates to a total of 150 hours spent with dolphins in the Moray Firth, approximately 37% of our survey time (Table 10). A total of 7 encounters were outside the Moray Firth SAC (Figure 13). Estimates of group sizes ranged from 1 to 41 dolphins, with a median of 5 (interquartile range = 3 to 10) (Figure 14).

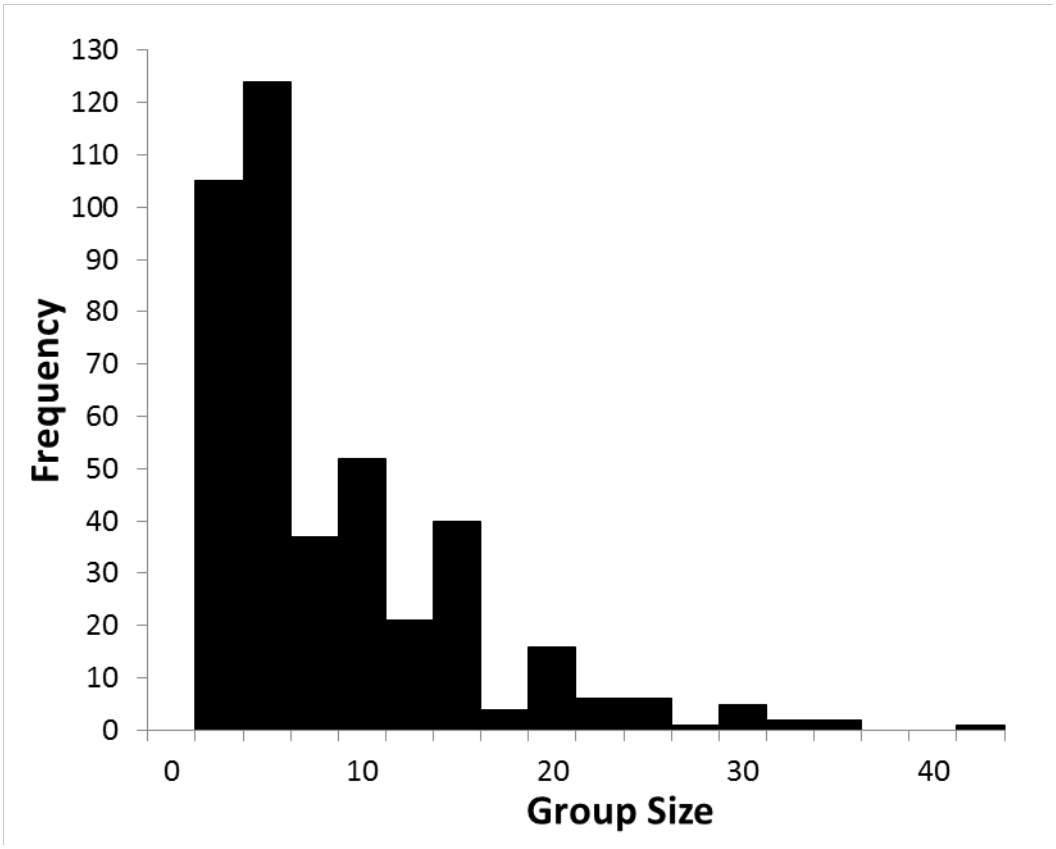


Figure 14. Frequency distribution of different dolphin group sizes during photo-identification surveys from 2014 to 2016.

Female Fecundity

Reproductive histories were available for 59 known females with 112 calves seen in the SAC between 2001 and 2016. An average of 7 new-born calves (minimum=3, maximum=12) were identified each year during this time period. Annex 7 shows the reproductive history of females with calves born between 2014 and 2016 and seen in the SAC.

Preliminary analysis revealed the top model included a state and linear time trend on state transition probabilities and the proportions of females occupying the different states. This top model highlighted a significant increase in the proportion of females with a newborn calf from 2001 to 2016 (unconditional reproductive rate, omega^{A}), from 0.16 to 0.30 (Figure 15).

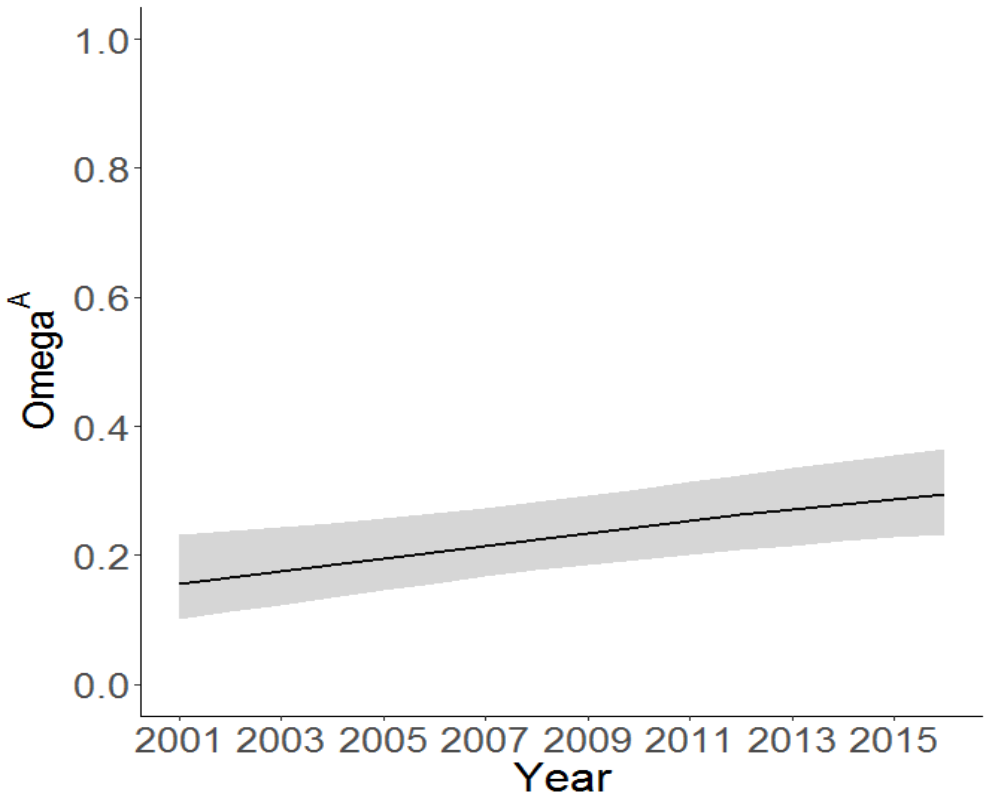


Figure 15. Proportion of females with new-born calves (the unconditional reproductive rate, Omega^{A}) from 2001 to 2016 (with 95% confidence limits).

Survival Rates

Sightings histories were available for 168 well-marked dolphins seen in the SAC between 1990 and 2016. Preliminary analyses suggested that the most supported robust design model included constant survival, a different capture probability for each capture occasion and constant Markovian emigration (i.e. the probability of temporary emigration depends on whether or not the animal was available in the study area during the previous sampling occasion). Based on this model, the probability of apparent survival for dolphins within the SAC between 1990 and 2016 was estimated to be 0.93 (95% confidence interval (CI): 0.91-0.94). However, this estimate for individuals seen in the SAC is likely to be negatively biased. Arso Civil (2014) estimated the probability of apparent survival for the population as 0.95 (95% CI: 0.93-0.96). While robust design models can account for temporary emigration, they cannot account for permanent emigration (i.e. when animals leave the study area) nor adequately for situations where probability of capture of some animals has declined over time to a low level. This population's range has expanded outside the SAC over this time period (Wilson *et al.* 2004), with spatial and temporal variation in individual ranging patterns (Cheney *et al.* 2013; Quick *et al.* 2014). This type of movement cannot be fully separated from mortality and, consequently, leads to an underestimate of the probability of survival.

WP 2.2: Trends in abundance

Introduction and Objectives

This work package is being used to assess baseline variability in the abundance of bottlenose within the Moray Firth SAC and relate these numbers to the overall size of the east coast bottlenose population. This will permit future comparison with data collected during the construction period, allowing an assessment of whether far-field disturbance has led to change in the number of dolphins using the SAC.

Parameters to be measured

- Abundance of dolphins using the Moray Firth SAC in each summer;
- Trends in overall population size.

Survey Design

Regular photo-identification surveys have been carried out from May to September (summer) in the Moray Firth SAC from 1990 to 2016. As per WP 2.1 surveys use established boat-based photo-identification techniques to recognise individual bottlenose dolphins using their distinct dorsal fin markings (Wilson, Hammond & Thompson 1999; Wilson *et al.* 2004; Cheney *et al.* 2013). Following agreed methods for monitoring the population that uses the Moray Firth SAC (Thompson *et al.* 2004; Cheney *et al.* 2014b), repeated observations will be used to provide annual estimates of the abundance of bottlenose dolphins within the SAC.

In most years, some data have also been collected during less regular summer surveys in other parts of the population's range (Cheney *et al.* 2013). These data have also been collected using standardised photo-identification procedures (Wilson *et al.* 2004; Quick & Janik 2008; Quick, Rendell & Janik 2008; Islas-Villanueva 2010; Cheney *et al.* 2013). However, the design and number of surveys has varied among survey areas and years.

Methodology

Sampling Techniques

Abundance estimates are based upon the individual based data collected to estimate vital rates outlined in WP 2.1.

To estimate the abundance of dolphins using the Moray Firth SAC each year, sampling was based upon the University of Aberdeen summer boat based photo-identification surveys from 1990 to 2016.

Our own sampling effort is focussed within the Moray Firth SAC, but analyses of population trends integrate additional data available from other parts of the population's range through continued collaboration with other research groups (see Cheney *et al.* 2013).

Data Analysis

Abundance of dolphins using the Moray Firth SAC in each summer
Between 2014 and 2016, a total of 125 (59 well-marked) individually identified bottlenose dolphins were seen in the SAC, 52 females, 30 males and 43 of unknown sex. Additionally, 45 individuals (22 well-marked) were seen on the south coast of the outer Moray Firth (18 females, 9 males) and of these 7 were only seen in this area.

Data from our photo-identification surveys in the Moray Firth SAC from 1990 to 2016 were used to create a capture matrix of well-marked individuals seen each year (Annex 8 has an example of these data and shows the SAC sightings history of all well-marked dolphins seen in the SAC between 2014 and 2016). PROGRAM CAPTURE provided annual estimates of the abundance of dolphins within the SAC. This technique is based on the approach described by Wilson, Hammond and Thompson (1999), with modifications described in Cheney *et al.* (2014a).

Trends in overall population size.
A second capture matrix was created incorporating annual sighting from across the range of this population for all available years (1990 to 2015). This was used in the state-space model described in Corkrey *et al.* (2008) which provides an updated estimate of trends in the total size of the east coast bottlenose dolphin population (see Cheney *et al.* 2014a for details).

Trends in the proportion of the total population using the SAC were also investigated (see Cheney *et al.* 2014a for details).

Results

2014 - 2016 Photo-Identification Surveys
The results from our 2014 to 2016 photo-identification surveys are outlined in WP 2.1.

Abundance of dolphins using the Moray Firth SAC in each summer
High quality pictures were obtained from 41, 53 and 46 well-marked individuals during the 2014, 2015 and 2016 surveys, respectively. The mark-recapture estimate of the total number of well-marked individuals ($\widehat{N}$) was inflated with the modelled proportion of well-marked individuals (0.5609, see Cheney *et al.* 2014a for full details). This provided an estimate of the number of dolphins using the SAC in the summers of 2014 to 2016 (Table 11).

Table 11. Annual estimates of abundance for the Moray Firth SAC from mark recapture analysis from 2014 to 2016.

Year	Well-marked	$\hat{N}$	95% Confidence Interval	Theta (θ)	Total Abundance	95% Confidence Interval
2014	41	44	45-52	0.5609	78	65-94
2015	53	55	54-61	0.5609	98	84-115
2016	46	47	47-52	0.5609	84	72-98

Annual estimates of the number of dolphins using the SAC in summer show considerable variability from year to year (Figure 16). However, there is no significant linear trend in these annual estimates ($F_{1,25}$ = 0.324, p = 0.574).

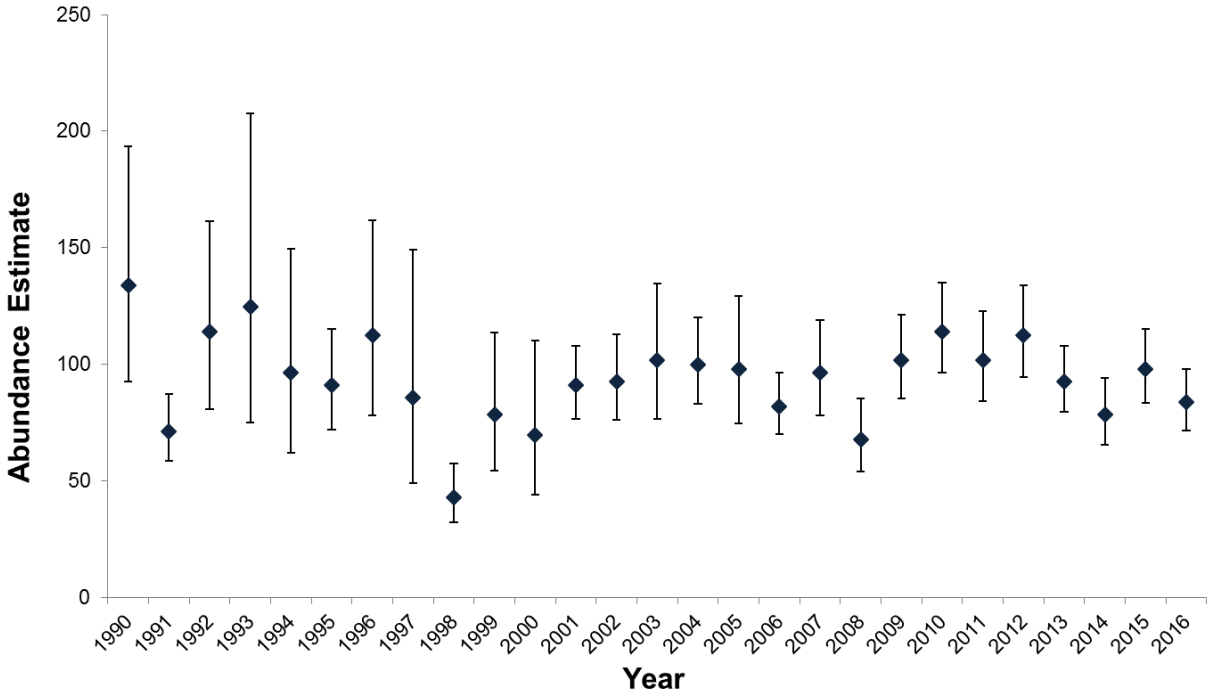


Figure 16. Annual estimates of the number of dolphins using the Moray Firth Special Area of Conservation from 1990 to 2016 with 95% confidence intervals.

Trends in overall population size.

A Bayesian linear regression suggests that the population of dolphins on the east coast of Scotland is increasing with annual estimates of 101 (95% HPDI: 70-129) in 1990 and 195 (95% HPDI: 164-224) in 2015 (Figure 17). Evidence suggests that the proportion of the population using the SAC has declined (mean slope = -0.08, SE= 0.0004). However, results indicate that >50% of the population use the SAC in most years.

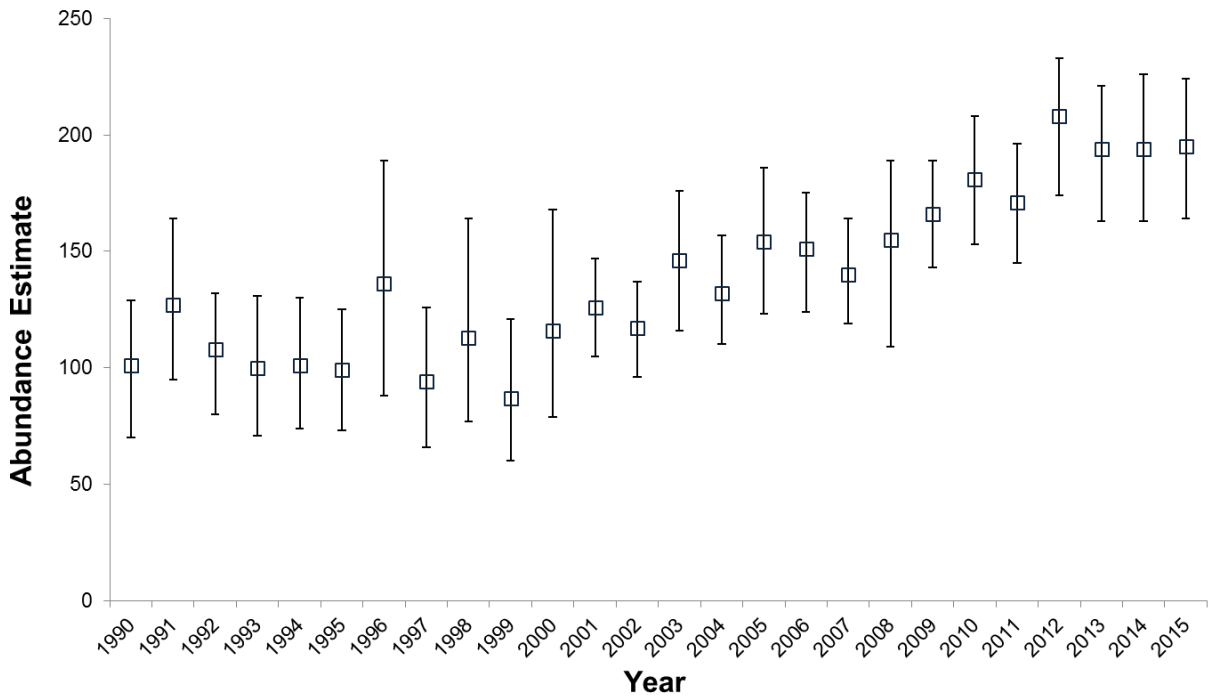


Figure 17. Annual estimates of the east coast of Scotland bottlenose dolphin population from 1990 to 2015 with 95% highest posterior density intervals (HPDI).

These results suggest that, despite interannual variability, the number of dolphins using the SAC appears to be stable yet the east coast population is increasing. Although, there has therefore been a decline in the relative use of the SAC, the majority of the wider population continue to use this area to some extent.

WP 2.3: Baseline occurrence of dolphins in favoured areas

Introduction and Objectives

This work package is being used to assess baseline variability in the occurrence of bottlenose dolphins at key sites within the Moray Firth SAC and along the southern Moray Firth coast. This will permit future comparison with data collected during the construction period, allowing an assessment of whether far-field disturbance has led to a change in the occurrence of dolphins within these areas.

Parameters to be measured

- Presence of dolphin echolocation clicks in given time periods (minutes, hours and days).

Survey Design

Passive acoustic studies using CPODs use established techniques for monitoring changes in the occurrence of dolphins in different parts of the SAC. This study design is based on previous work that has demonstrated that echolocation detections can be used to provide a robust index of occurrence for small cetaceans when compared to visual observations (Philpott *et al.* 2007; Bailey *et al.* 2010; Williamson *et al.* 2016). These techniques have subsequently been used to compare broad scale spatial variation in the occurrence of bottlenose dolphins around the east coast of Scotland (Thompson *et al.* 2011) and year to year variation in the occurrence of dolphins at key sites within the Moray Firth SAC (Cheney *et al.* 2012; Cheney *et al.* 2014b). These techniques have the advantage that dolphin occurrence at sampling sites can be remotely monitored for 24 hr/day over periods of several months.

Methodology

Year-round samples have been collected at four inshore long-term monitoring sites (Figure 18). Between May and September of each year, deployments were also made at four additional sites on the south coast of the Moray Firth (Figure 18). Data were collected using V0 and V1 CPODs using seabed moorings that have been optimised for deployments at these sites, licensed for scientific use by Marine Scotland, and consented by the Crown Estate.

Deployments and recoveries were made using specialist workboats operated by Moray First Marine, who have extensive experience of these activities through previous work for the University of Aberdeen on Department of Energy and Climate Change funded studies (Thompson *et al.* 2013a) and during baseline data collection for MORL and BOWL.

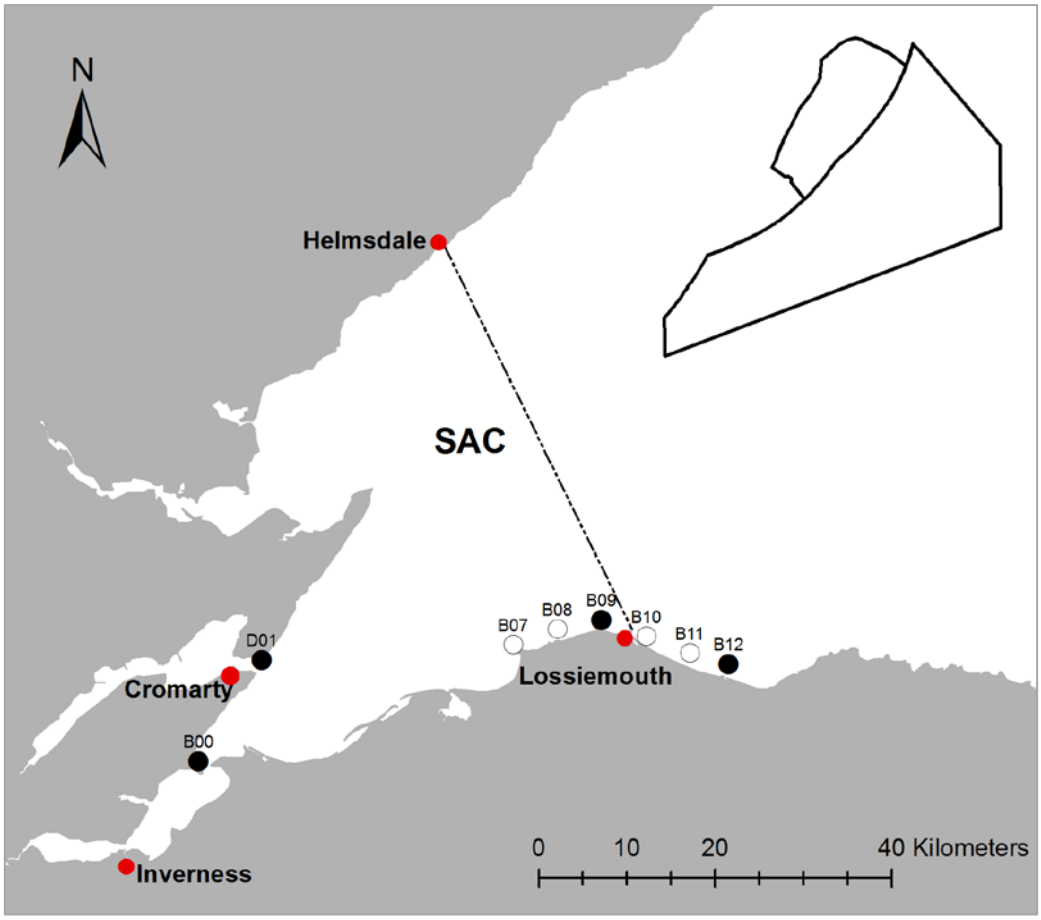


Figure 18. A map showing the CPOD locations (inshore long-term sites = black circles; summer only sites = clear circles). The location of the Moray Firth SAC is shown.

Data Analysis

Data were downloaded using the manufacturer's software, which is also used to identify click trains and categorise these as either porpoise or dolphin clicks with high, medium or low levels of confidence. Only click trains categorized with high or medium confidence were used in subsequent analyses (Brookes, Bailey & Thompson 2013). Data were processed using established routines and summarised to provide an indication of whether click trains were detected in each minute or hour of the day. Spatial and temporal variation in occurrence is expressed in terms of detection positive hours per day, or distributions of waiting times. Further details of the analysis approaches are provided in Bailey *et al.* (2010); Thompson *et al.* (2010); Brookes, Bailey and Thompson (2013); Thompson *et al.* (2013a).

Results

Details of the data for each CPOD deployment from 2014 to 2016 are given in Table 12. Dolphin occurrence during summer, June to September, 2014 to 2016 varied between sites (Table 13 and Figure 19). Dolphins were detected more often and spent more time at the Sutors (D01) and Chanonry (B00) than at the other six sites on the south coast (Figure 19).

Table 12. Summary of the CPOD data for the four long-term and four additional sites on the south coast.

Location	Deployment Date	Data End Date	Data
Long-term sites:			
Sutors (D01)	04/04/14	03/07/14	✓
	03/07/14	08/08/14	✓
	08/08/14	30/01/15	✓
	04/12/14	09/04/15	✓
	09/04/15	02/07/15	✓
	02/07/15	09/10/15	✓
	09/10/15	15/02/16	✓
	07/03/16	18/07/16	✓
	18/07/16	29/10/16	✓
	29/10/16	10/03/17	✓
	10/03/17		
Chanonry (B00)	18/03/14	05/07/14	✓
	05/07/14	08/11/14	✓
	08/11/14	No data	×
	19/03/15	02/07/15	✓
	02/07/15	09/10/15	✓
	09/10/15	25/12/15	✓
	07/03/16	18/07/16	✓
	19/07/16	29/10/16	✓
	29/10/16	10/03/17	✓
	10/03/17		
Lossiemouth (B09)	27/05/14	29/11/14	✓
	15/12/14	19/03/15	✓
	19/03/15	29/06/15	✓
	29/06/15	10/10/15	✓
	10/10/15	19/11/15	✓
	14/03/16	No data	×
	18/07/16	25/10/16	✓
	25/10/16	15/03/17	✓
	15/03/17		
Spey Bay (B12)	27/05/14	22/10/14	✓
	22/10/14	24/03/15	✓
	24/03/15	29/06/15	✓
	29/06/15	05/10/15	✓
	05/10/15	04/03/16	✓
	04/03/16	23/04/16	✓
	18/05/16	18/07/16	✓
	18/07/16	25/10/16	✓
	25/10/16	15/03/17	✓
	15/03/17		

Location	Deployment Date	Data End Date	Data
Additional south coast sites:			
B07	27/05/14	10/11/14	✓
	23/05/15	08/10/15	✓
	18/05/16	30/07/16	✓
B08	27/05/14	Trawled	×
	23/05/15	08/10/15	✓
	18/05/16	25/10/16	✓
B10	27/05/14	22/10/14	✓
	23/05/15	05/10/15	✓
	18/05/16	25/10/16	✓
B11	27/05/14	14/10/14	✓
	23/05/15	05/10/15	✓
	18/05/16	25/10/16	✓

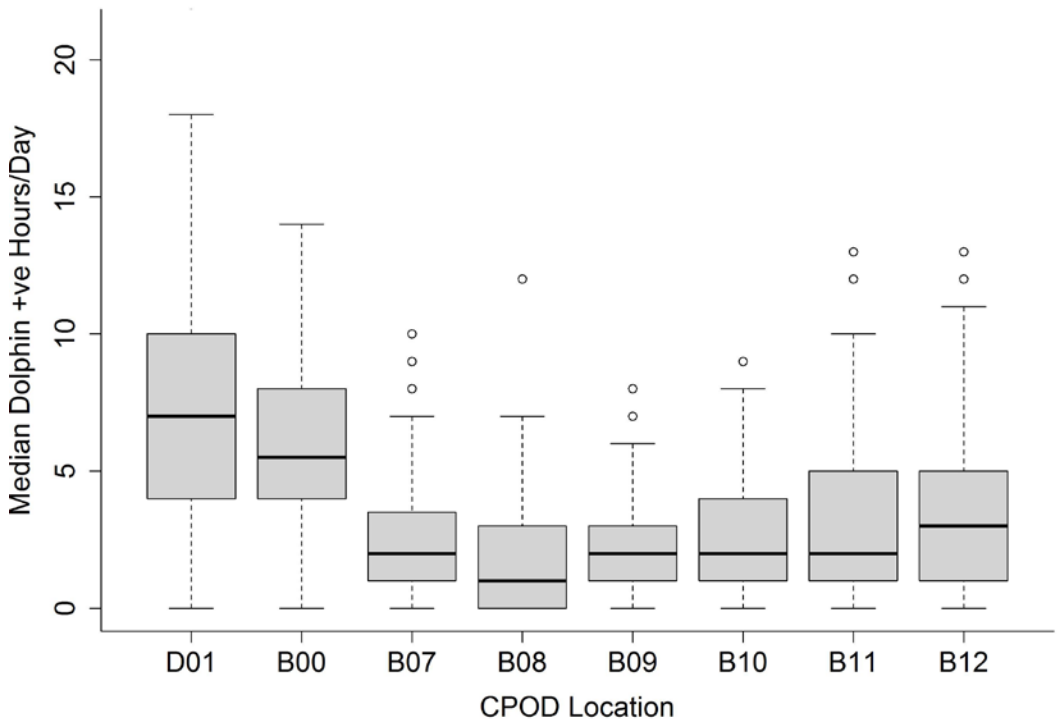


Figure 19. Site variation in the median number of hours/day (± interquartile ranges) that dolphins were detected on CPODs at all sites from June to September 2014-2016.

Table 13. Summary data on dolphin detections for the CPODs at all sites from June to September 2014-2016.

Site	No. years with data	No. days sampled	% days dolphins detected	Median detection positive hrs/day	Interquartile range
D01	3	362	98.9	7	4-10
B00	3	362	97.2	5.5	4-8
B07	3	304	84.5	2	1-3.25
B08	2	244	68.9	1	0-3
B09	3	317	83.6	2	1-3
B10	3	366	82.8	2	1-4
B11	3	366	79.2	2	1-5
B12	3	364	81.6	3	1-5

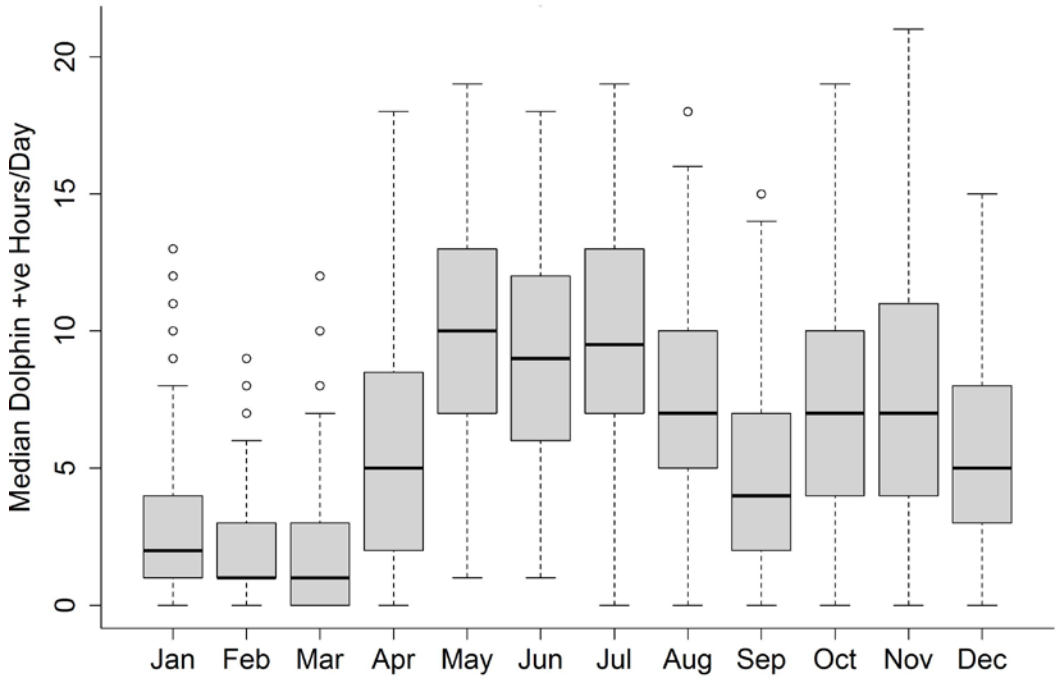
Data on the seasonal variation in dolphin detections by the CPODs at the four long-term sites from 2011 to 2016 are presented in Table 14 and Figure 19. At all four sites dolphin occurrence tended to be highest from May to August, although at the Sutors dolphin occurrence was also relatively high from October to December (Figure 20). Data on the monthly variation in dolphin detections by the CPODs at the four south coast sites from 2014 to 2016 are presented in Table 15 and Figure 21.

Table 14. Monthly variation in dolphin detections for the CPODs at the four long-term sites from 2011 to 2016. Months in which the number of days sampled was less than 10 were excluded.

	No. years with data	No. days sampled	% days dolphins detected	Median detection positive hrs/day	Interquartile range
Sutors:					
Jan	4	124	80.6	2	1-4
Feb	4	84	77.4	1	1-3
Mar	3	86	62.8	1	0-3
Apr	6	156	92.3	5	2-8.25
May	6	186	100	10	7-13
Jun	6	180	100	9	6-12
Jul	6	180	99.4	9.5	7-13
Aug	6	184	98.4	7	5-10
Sep	6	180	95.6	4	2-7
Oct	6	183	96.2	7	4-10
Nov	6	167	99.4	7	4-11
Dec	5	155	92.9	5	3-8

	No. years with data	No. days sampled	% days dolphins detected	Median detection positive hrs/day	Interquartile range
Chanonry:					
Jan	3	93	53.8	1	0-3
Feb	3	85	47.1	0	0-3
Mar	5	114	48.2	0	0-2
Apr	5	149	87.9	2	1-4
May	6	183	91.8	4	2-7
Jun	6	180	98.3	5	3-8
Jul	6	181	98.9	7	4-9
Aug	6	174	98.9	7	5-9
Sep	5	150	94.0	4.5	3-7
Oct	5	153	78.4	3	1-5
Nov	5	141	75.9	3	1-5
Dec	5	145	73.1	2	0-4
Lossiemouth:					
Jan	4	124	46.0	0	0-1
Feb	4	113	54.9	1	0-1
Mar	5	111	64.0	1	0-2
Apr	5	150	77.3	2	1-3
May	5	154	81.2	2	1-3
Jun	5	149	85.2	2	1-4
Jul	6	166	77.7	2	1-3
Aug	6	185	75.7	1	1-3
Sep	6	180	72.8	1	0-3
Oct	6	184	43.5	0	0-1
Nov	6	155	58.7	1	0-2
Dec	5	132	53.0	1	0-1
Spey Bay:					
Jan	5	155	25.2	0	0-0.5
Feb	5	140	22.1	0	0-0
Mar	5	123	35.8	0	0-1
Apr	6	173	65.3	1	0-3
May	6	167	89.8	4	2-6
Jun	6	179	91.6	4	2-7
Jul	6	178	89.3	3	2-5
Aug	5	155	76.8	2	1-5
Sep	5	150	78.0	2	1-4
Oct	5	152	58.6	1	0-2
Nov	5	148	54.7	1	0-2
Dec	5	155	48.4	0	0-2

a) Sutors



b) Chanonry

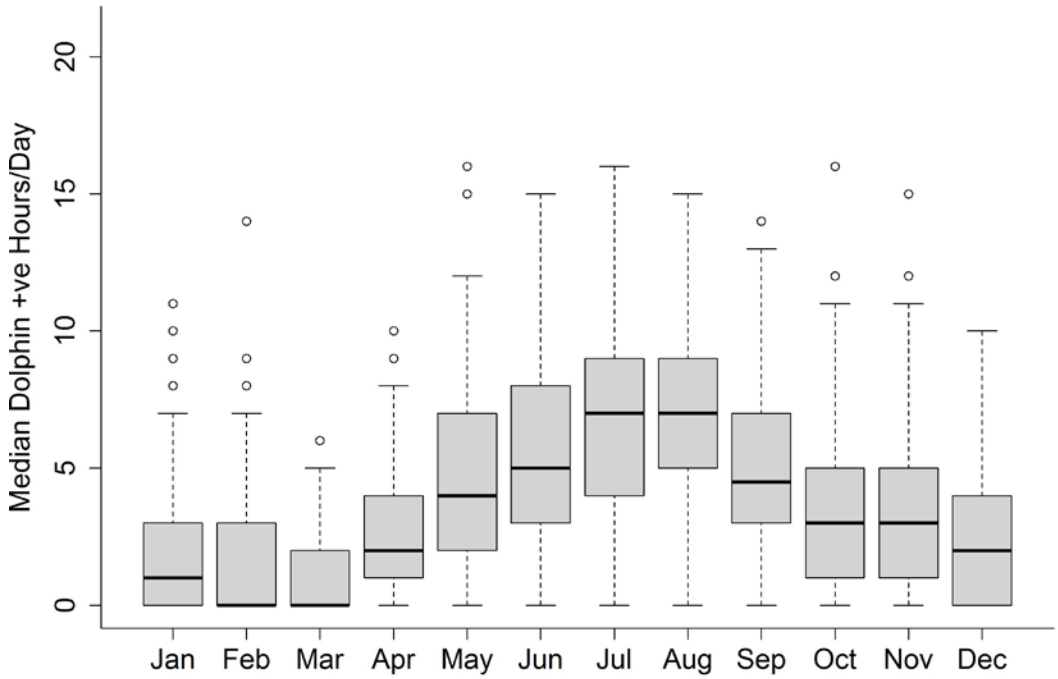
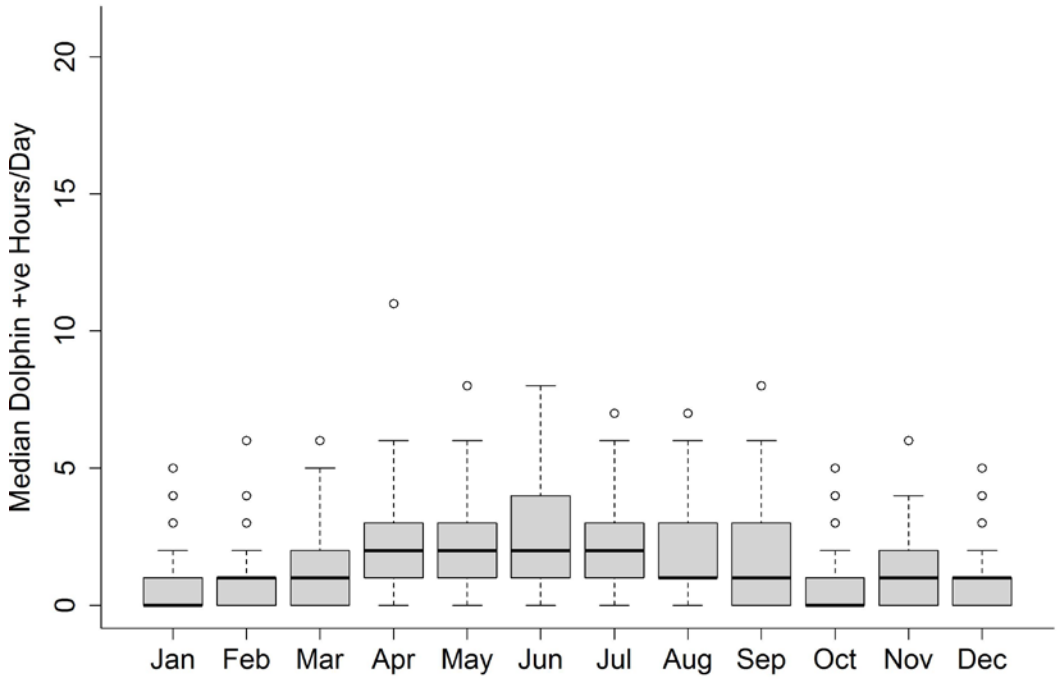


Figure 20 a & b. Seasonal variation in the median number of hours/day (± interquartile ranges) that dolphins were detected on CPODs at a) the Sutors and b) Chanonry from 2011 to 2016.

c) Lossiemouth



d) Spey Bay

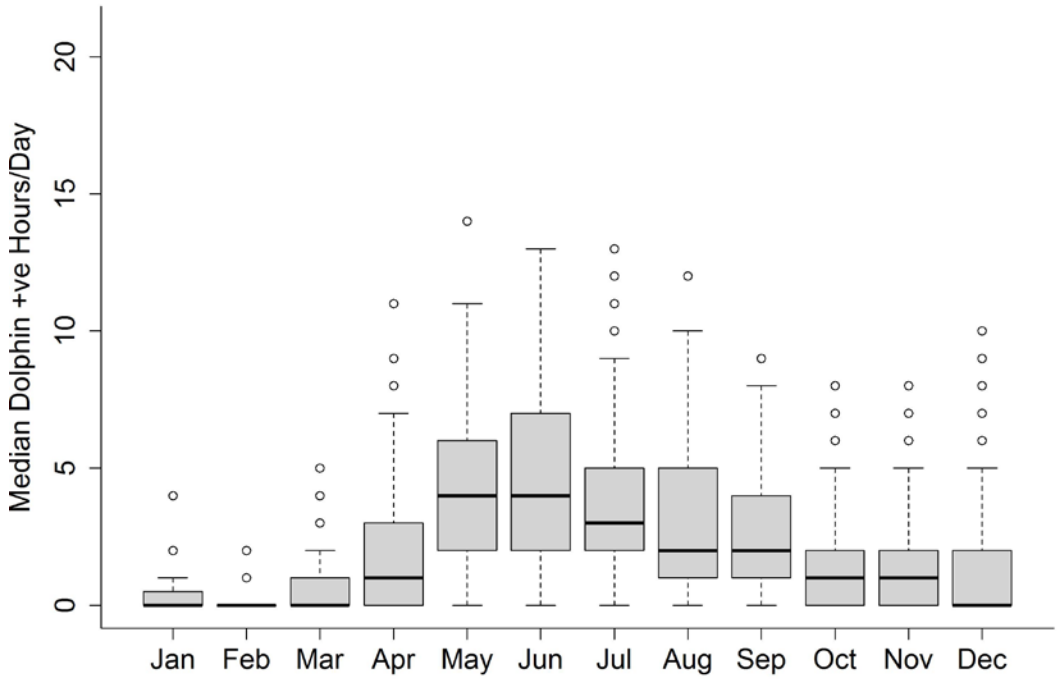


Figure 20 c & d. Seasonal variation in the median number of hours/day (± interquartile ranges) that dolphins were detected on CPODs at c) Lossiemouth and d) Spey Bay from 2011 to 2016.

Table 15. Monthly variation in dolphin detections for the CPODs at the four south coast sites from 2014 to 2016. Months in which the number of days sampled was less than 10 were excluded.

	No. years with data	No. days sampled	% days dolphins detected	Median detection positive hrs/day	Interquartile range
B07:					
May	1	13	76.9	3	1-3
Jun	3	90	84.4	2	1-4
Jul	3	92	89.1	2.5	1-4
Aug	2	62	79.0	2	1-3
Sep	2	60	83.3	1.5	1-3
B08:					
May	1	13	69.2	2	0-3
Jun	2	60	78.3	2	1-4
Jul	2	62	80.6	2	1-3
Aug	2	62	53.2	1	0-2
Sep	2	60	63.3	1	0-2
B10:					
May	1	13	76.9	2	1-4
Jun	3	90	88.9	3	2-5
Jul	3	93	95.7	3	2-4
Aug	3	93	68.8	1	0-3
Sep	3	90	77.8	2	1-4
B11:					
May	1	13	69.2	2	0-3
Jun	3	90	88.9	4	2-5.75
Jul	3	93	91.4	3	2-5
Aug	3	93	65.6	1	0-3
Sep	3	90	71.1	2	0-3

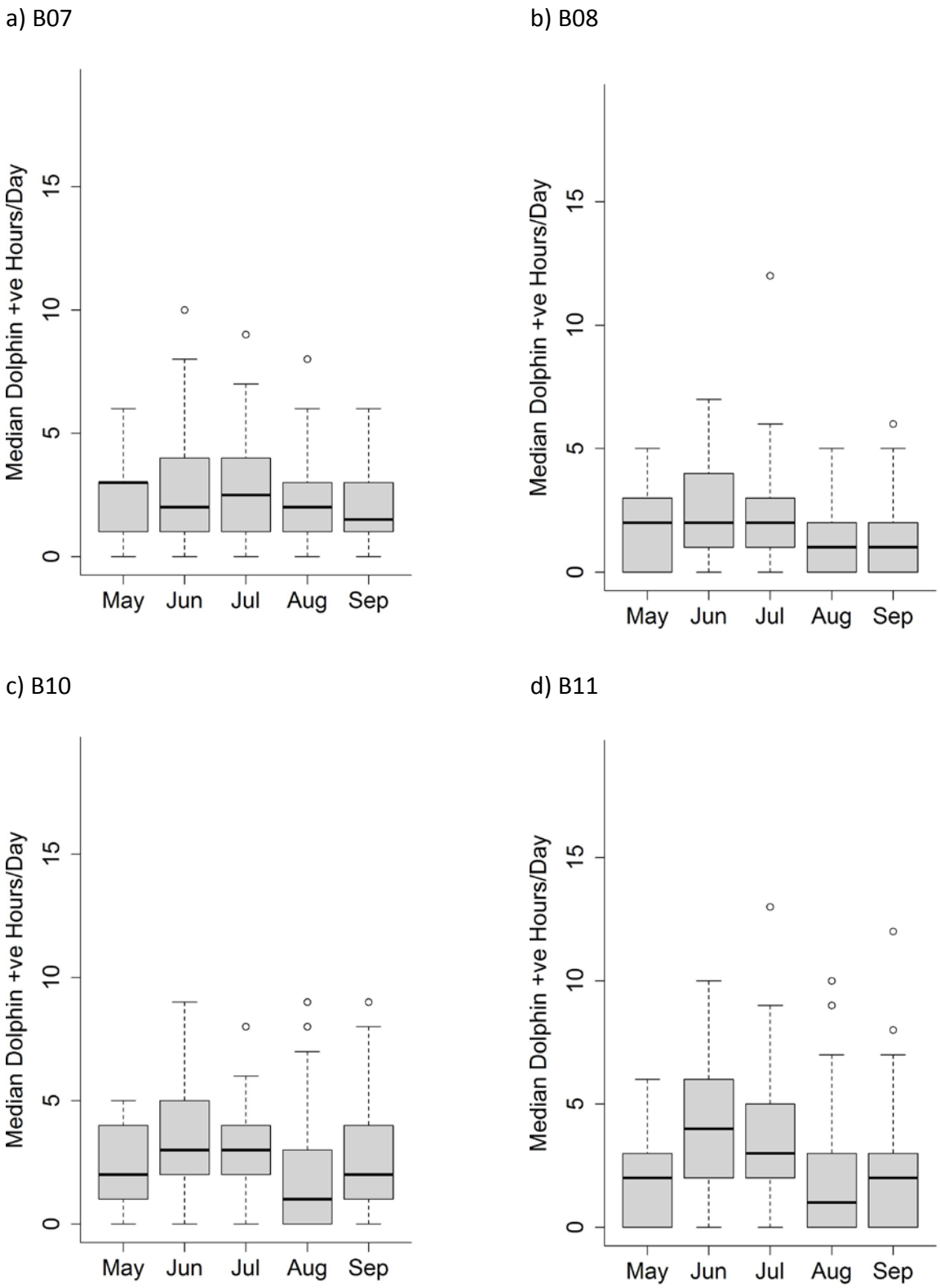


Figure 21. Monthly variation in the median number of hours/day (± interquartile ranges) that dolphins were detected on CPODs at the south coast sites from 2014 to 2016.

ACKNOWLEDGEMENTS

The initial two-year pre-construction phase of work was funded through a consortium that included BOWL, MORL, Marine Scotland, The Crown Estate and Highlands and Island Enterprise. The third year of work was supported by BOWL and Marine Scotland, with the main elements of the bottlenose dolphin monitoring supported by Scottish Natural Heritage (SNH). Thanks to Phil Hammond at the University of St Andrews who provided data and code for some aspects of the bottlenose dolphin work packages as part of our collaborative project. We thank Bill Ruck and all the colleagues who have helped to collect and analyse data. The BES, ASAB, Greenpeace Environmental Trust, SNH, Scottish Government, Whale and Dolphin Conservation, Talisman Energy (UK) Ltd., Department of Energy and Climate Change, Chevron, Natural Environment Research Council and the Universities of Aberdeen and St Andrews have all provided funding for the bottlenose dolphin photo-identification study over the last 27 years.

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ANNEX 1. *Rationale for prioritization of monitoring for different marine mammal species as presented in earlier consultation documents.*

Harbour seal	**High priority** species for monitoring at Moray Firth sites • Due to proximity to the Dornoch Firth and Morrich More SAC • Because of predictions of significant short-term impacts on this SAC population in the ES under conservative worst case scenarios • To reduce uncertainties and improve predictions of most likely impacts using the Moray Firth Seal Assessment Framework.
Bottlenose dolphin	**High priority** species for monitoring at Moray Firth sites • Due to proximity of Moray Firth SAC • Monitoring is required in the SAC and along southern Moray Firth coast to test worst case predictions of partial displacement and assess whether this influences movements between the SAC and other parts of their East coast range.
Harbour porpoise	**Medium priority** species for monitoring at Moray Firth sites • No local SAC population • Predictions of significant short-term impacts through displacement are likely to be common at other sites • Excellent baseline from previous studies in the area provides opportunities to reduce uncertainty over spatial and temporal scale of displacement and potential for habituation.
Grey seal	**Low priority** species for monitoring at Moray Firth sites • No local SAC population • Although some displacement from foraging areas is predicted, local breeding sites are small • It is anticipated that monitoring of impacts on grey seals will be focused around Firth of Forth developments due to the existence of larger population sizes, local SACs and existing research infrastructure.
Minke whale	**Low priority** species for monitoring at Moray Firth sites • Some displacement predicted, but low and variable numbers of animals mean that there is low power to detect impacts • These animals are part of a large mobile population, meaning that any monitoring should be conducted at a broader scale or at other sites (e.g. Dogger Bank) which hold larger numbers of animals.

ANNEX 2. *Key questions that could be addressed through wind farm monitoring programme as presented in earlier consultation documents.*

Harbour seal	*Short-term* 1) To what extent are foraging harbour seals displaced by piling activity compared to worst-case scenarios in the Moray Firth Seal Assessment Framework that used proxy data from harbour porpoises? 2) If displaced during piling, do seals return to foraging areas between piling events; how does this reduce worst-case assumptions that seals are excluded from foraging areas year-round throughout construction? *Medium-term* 3) Does individual condition or reproduction at local sites decline during construction years as predicted under worst case scenarios? *Long-term* 4) Does construction noise cause PTS? 5) Do long-term survival or reproduction rates vary in relation either to variation in noise exposure or variation in hearing thresholds? 6) What are the long-term trends in abundance within the Moray Firth seal management unit in relation to other UK and European populations? 7) Do increases in vessel activity pose any additional threats to harbour seals?
Bottlenose dolphin	*Short-term* 8) Does the occurrence of bottlenose dolphins along the southern Moray Firth coast vary in relation to levels of offshore piling activity? *Medium- and long-term* 9) Are there changes in the vital rates of bottlenose dolphins using the SAC? 10) Are there changes in the numbers of bottlenose dolphins using the SAC, or the use of different parts of their overall range, in response to different wind farm construction programmes along the East coast of Scotland?
Harbour porpoise	*Short-term* 11) Can data from Horns Rev II be used as a proxy for the levels of displacement from piling at other sites? 12) How soon do porpoises return to affected areas once piling ends? *Medium-term* 13) Do porpoises become habituated or learn to tolerate piling noise during a prolonged construction period? *Long-term* 14) Are there long-term increases or decreases in porpoise density within the operational wind farm sites?

ANNEX 3. *Reproductive histories of female harbour seals seen with pups in Loch Fleet 2014-2016 (navy box with white tick = seen with pup, light blue box = seen without pup, white box = not seen).*

IDNO	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	✓	✓	✓	✓	✓	✓		✓	✓		
2	✓	✓		✓	✓		✓	✓	✓		
4	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	✓	✓	✓	✓	✓		✓	✓	✓	✓	
8	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	✓	✓	✓	✓	✓	✓	✓	✓		✓	
13	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
14	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17	✓	✓	✓	✓	✓	✓	✓		✓		
20	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
23	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
27		✓	✓	✓	✓	✓	✓		✓		
28	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
30	✓	✓	✓		✓						✓
33	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
35	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
42	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
46	✓	✓	✓		✓			✓	✓		✓
52	✓	✓	✓								
53			✓								✓
56							✓	✓			✓
59		✓	✓	✓		✓	✓	✓	✓	✓	✓
61		✓	✓	✓	✓		✓	✓	✓	✓	✓
62		✓	✓		✓	✓	✓		✓	✓	
63		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
70			✓						✓	✓	✓
75				✓	✓		✓	✓	✓	✓	✓
76			✓		✓	✓		✓			✓
77				✓	✓	✓	✓	✓	✓		
78				✓	✓		✓	✓	✓	✓	
81			✓	✓	✓		✓	✓	✓	✓	✓
84						✓	✓	✓	✓		
93								✓	✓	✓	✓
101			✓	✓	✓	✓	✓	✓	✓	✓	✓
103			✓	✓	✓	✓	✓	✓	✓	✓	✓
105			✓	✓	✓	✓	✓	✓	✓	✓	
127	✓		✓		✓	✓	✓	✓	✓	✓	✓
129						✓	✓				

IDNO	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
149			✓	✓	✓	✓	✓	✓	✓	✓	✓
158			✓	✓	✓		✓		✓	✓	✓
164			✓		✓	✓		✓	✓	✓	
167				✓	✓	✓	✓	✓	✓	✓	✓
172				✓	✓		✓	✓	✓	✓	
174						✓	✓	✓	✓	✓	✓
180			✓		✓		✓		✓		✓
181			✓		✓	✓	✓	✓	✓	✓	✓
184						✓	✓		✓	✓	✓
222			✓					✓			
223					✓	✓	✓	✓	✓	✓	✓
224				✓	✓	✓	✓	✓	✓	✓	✓
242							✓	✓	✓	✓	✓
243								✓	✓	✓	
244									✓	✓	
246									✓	✓	✓
247									✓	✓	
250									✓	✓	✓
251										✓	
252									✓	✓	✓
254									✓		
262											✓
268									✓	✓	✓
269										✓	✓
273									✓	✓	✓
276										✓	✓
278									✓	✓	✓
283										✓	✓
285									✓	✓	
289											✓
294										✓	✓
295										✓	✓
300											✓
313											✓
314										✓	✓
326											✓
330											✓
337											✓
339											✓
431										✓	

ANNEX 4. *Sighting histories of all well-marked harbour seal individuals seen in Loch Fleet 2014-2016 (male = 1, female = 2, unknown sex = 3).*

IDNO	SEX	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	2											
2	2											
4	2											
5	2											
7	2											
8	2											
10	2											
12	2											
13	2											
14	2											
16	2											
17	2											
20	2											
23	2											
27	2											
28	2											
30	2											
33	2											
35	2											
42	2											
46	2											
52	2											
53	2											
56	2											
59	2											
61	2											
62	2											
63	2											
67	2											
70	2											
72	1											
73	1											
75	2											
76	2											
77	2											
78	2											
80	2											
81	2											
82	1											
83	2											
84	2											

IDNO	SEX	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
86	1	■	■	■	■	■	■	■	■	■	■	■
90	1	■	■	■	■	■	■	■		■	■	■
92	1	■	■	■	■	■	■	■	■	■		
93	2	■	■	■	■	■	■	■	■	■	■	■
95	1	■	■	■	■	■	■	■	■	■		
99	1	■	■	■	■	■				■	■	■
100	2		■	■	■		■		■	■		■
101	2	■	■	■	■	■	■	■	■	■	■	■
103	2	■	■	■	■	■	■	■	■	■	■	■
104	1		■	■	■	■	■	■	■	■		
105	2	■	■	■	■	■	■	■	■	■	■	■
107	3	■	■	■	■						■	
109	1	■	■	■	■	■	■	■	■	■	■	■
118	2	■	■	■	■	■	■	■	■	■	■	■
120	1	■	■	■	■	■	■		■	■	■	■
122	1	■	■	■	■	■	■	■	■	■	■	■
127	2	■	■	■	■	■	■	■	■	■	■	■
128	1	■	■	■	■	■	■	■	■	■		
129	2		■			■	■	■		■		
132	1	■	■	■	■	■	■	■	■	■	■	■
139	2	■	■	■				■			■	
141	1		■		■							■
149	2	■	■	■	■	■	■	■	■	■	■	■
158	2	■	■	■	■	■	■	■	■	■	■	■
161	1	■	■	■	■	■	■	■	■	■	■	■
164	2	■	■	■	■	■	■	■	■	■	■	
165	1	■	■	■	■	■	■	■	■	■	■	■
167	2	■	■	■	■	■	■	■	■	■	■	■
168	2	■		■	■	■	■	■	■		■	■
169	1	■	■	■	■	■	■	■	■	■	■	■
172	2	■	■	■	■	■	■	■	■	■	■	■
174	2			■	■	■	■	■	■	■	■	■
176	1	■		■	■	■	■	■	■	■		
178	1			■	■	■	■	■	■	■	■	■
180	2			■		■		■		■		■
181	2	■	■	■	■	■	■	■	■	■	■	■
184	2			■	■	■	■	■	■	■	■	■
186	2	■		■		■		■			■	
187	1			■		■	■	■	■	■	■	■
189	1	■	■	■	■	■	■	■	■	■		
190	1	■	■	■	■	■	■	■	■	■	■	■
191	1			■	■	■	■	■	■	■	■	■
202	1		■	■	■	■	■	■	■	■	■	■
207	1				■	■	■	■	■	■	■	■

IDNO	SEX	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
211	1											
216	2											
219	1											
222	2											
223	2											
224	2											
229	1											
230	1											
234	1											
242	2											
243	2											
244	2											
245	2											
246	2											
247	2											
248	2											
249	1											
250	2											
251	2											
252	2											
253	2											
254	2											
255	2											
256	1											
257	1											
258	1											
259	2											
260	1											
262	2											
263	1											
264	1											
265	1											
267	1											
268	2											
269	2											
270	1											
271	1											
272	1											
273	2											
274	1											
275	1											
276	2											
277	1											
278	2											

IDNO	SEX	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
279	1							■	■	■	■	■
280	1							■	■	■	■	■
282	1							■	■		■	■
283	2							■	■	■	■	■
284	1							■	■	■	■	■
285	2							■	■	■	■	■
286	1							■	■	■	■	■
287	2							■	■	■	■	■
288	2							■	■	■	■	■
289	2							■	■	■	■	■
290	2							■	■	■	■	■
291	1							■	■	■	■	■
292	1							■	■		■	
293	1							■	■	■	■	■
294	2							■	■	■	■	■
295	2							■	■	■	■	■
296	1							■	■	■		
297	1							■	■	■	■	■
298	1							■	■	■	■	■
299	1							■	■	■	■	■
300	2						■		■	■	■	■
301	1								■	■	■	■
302	1								■	■	■	■
303	1								■	■	■	■
304	1								■	■	■	■
305	2								■	■	■	■
306	2								■	■	■	■
307	1								■	■	■	■
308	1								■	■	■	■
309	1								■	■	■	■
310	2								■	■	■	■
311	2								■	■	■	■
312	1								■	■	■	■
313	2								■	■	■	■
314	2						■		■	■	■	■
315	1								■	■	■	■
316	1								■	■	■	■
317	2								■	■	■	
318	1								■	■	■	■
319	1								■	■	■	■
321	1									■		
322	1									■	■	■
324	1								■		■	
325	1								■	■	■	■

IDNO	SEX	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
326	2							■		■		■
327	3									■	■	■
328	1									■	■	■
329	1									■		
330	2									■	■	■
331	1									■	■	■
332	2									■		■
333	1								■	■	■	■
334	1									■	■	■
335	1								■	■	■	■
336	1								■	■	■	■
337	2								■	■	■	■
338	1									■	■	■
339	2									■	■	■
340	2									■	■	■
341	2									■	■	■
342	1								■	■	■	
376	1										■	■
379	2									■		■
380	1											■
382	2									■		■
385	2											■
386	2										■	■
387	2											■
388	2										■	■
389	2										■	■
390	2										■	■
391	1											■
394	2								■		■	
396	1									■	■	■
397	2									■	■	■
420	2										■	■
429	2									■	■	■
430	1										■	■
431	2										■	■
432	2										■	■
433	1										■	■
434	3										■	■
435	2										■	■
449	1									■		■
454	3											■
455	3											■
456	3											■
458	2											■

IDNO	SEX	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
459	1											
460	3											
461	3											
462	2											
463	3											
464	1											
466	3											
467	2											
468	3											
469	1											
470	1											
471	1											
472	3											
473	1											
474	3											
475	1											
476	1											
477	3											
478	3											

ANNEX 5. *Summary information, sightings histories and movements to 31st March 2017 of the 57 harbour seals captured and tagged in Loch Fleet during September 2014, February 2015 and February/March 2017.*

ANNEX 6. *Summary information of the 28 harbour seals captured but not tagged in Loch Fleet during September 2014, February 2015 and February/March 2017.*

ID #	Date Captured	Flipper Tag #	Sex	Weight (kg)	Length (cm)	Girth (cm)	Comments
46	05/03/2017	58599	Female	-	-	-	Captured but not retained. Flipper tag found tangled in net
385	23/02/2015	00533	Female	27.0	95.0	76.0	
386	23/02/2015	00542	Female	27.6	104.0	73.0	
387	25/02/2015	00532	Female	26.0	103.0	76.0	
388	25/02/2015	00546	Female	27.4	103.0	72.0	
389	25/02/2015	00547	Female	29.0	102.0	80.0	
390	27/02/2015	00549	Female	21.8	98.0	76.0	
479	15/02/2017	D033	Female	28.2	92.0	78.0	
482	18/02/2017	D047	Female	38.2	113.0	82.0	
486	04/03/2017	D061	Female	31.8	112.0	79.0	
73	04/03/2017	D067	Male	92.2	156.0	111.0	
120	19/02/2017	D051	Male	103.6	154.0	121.0	
122	06/03/2017	D073	Male	101.0	149.0	118.0	
202	04/03/2017	D065	Male	94.8	146.0	118.0	
291	19/02/2017	D053	Male	79.8	144.0	108.0	
308	04/03/2017	D063	Male	72.2	141.0	104.0	
309	18/02/2017	D046	Male	80.8	140.0	113.0	
321	28/09/2014	00524	Male	36.4	105.0	84.0	
391	27/02/2015	00552	Male	28.6	99.0	75.0	
459	04/03/2017	D062	Male	51.4	125.0	93.5	
470	15/02/2017	D034	Male	44.2	117.0	89.0	
473	18/02/2017	D048	Male	36.4	109.0	80.5	
476	04/03/2017	D060	Male	43.4	113.0	90.5	
480	18/02/2017	D042	Male	51.2	127.0	90.5	
481	18/02/2017	D044	Male	43.4	119.0	80.0	
483	19/02/2017	D049	Male	41.0	119.0	87.0	
484	19/02/2017	D056	Male	42.4	105.0	85.0	
485	19/02/2017	D059	Male	39.8	118.0	82.0	

ANNEX 7. *Reproductive histories of female bottlenose dolphins seen with new-born calves in the SAC between 2014 and 2016 (ticks = year a calf was born, green box = calf survived to at least age 3, red tick = calf died).*

IDNO	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
11		✓					✓			✓		✓		✓		
240				✓					✓			✓			✓	
433							✓							✓		✓
440			✓			✓			✓			✓		✓		
578			✓				✓				✓				✓	
580			✓							✓				✓		
800						✓			✓				✓			✓
809					✓						✓				✓	
820							✓				✓			✓		
866									✓				✓		✓	
872					✓							✓		✓		
880							✓				✓			✓		
913				✓			✓			✓				✓		
932						✓			✓		✓			✓		
969							✓				✓			✓		
973													✓		✓	
1018																✓
1023															✓	
1024															✓	
1027											✓				✓	
1028									✓					✓		
1030					✓			✓						✓		
1032													✓			✓
1068																✓
1084															✓	

ANNEX 8. *Sighting histories of all well-marked (dorsal fin nick) bottlenose dolphins seen in the SAC between 2014 and 2016 (male = 1, female = 2, unknown sex = 3). Sightings from 1990 to 2016 in the SAC once an individual received its first dorsal fin nick.*

IDNO	SEX	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	3	■		■		■	■	■	■		■		■	■	■	■	■	■	■	■	■	■	■	■	■	■		
11	2		■	■	■		■		■		■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■
23	1	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
30	2	■	■	■	■	■	■		■	■	■	■	■									■	■	■	■	■	■	■
31	2	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
52	2										■		■					■	■		■	■	■	■			■	■
79	2	■	■	■		■	■	■	■		■	■	■		■		■			■		■	■	■	■	■	■	
105	1														■	■	■	■	■	■	■	■	■	■	■	■	■	■
430	2														■	■	■	■	■	■	■	■	■	■	■		■	■
435	1					■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
573	1							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
578	2																	■	■	■	■	■	■	■	■	■	■	■
580	2													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
744	2										■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
745	2										■		■	■	■	■	■	■	■		■	■	■	■	■		■	■
748	1																					■	■	■	■	■	■	■
760	1											■	■	■	■	■	■	■	■	■	■	■		■	■		■	
800	2											■		■	■	■	■	■	■		■	■		■	■		■	■
809	2																						■	■	■	■	■	■
815	1														■	■	■	■	■	■	■	■	■	■	■	■	■	■
816	2												■						■				■				■	
817	1												■	■		■	■	■	■	■	■	■	■	■	■	■	■	■
820	2												■	■	■	■		■	■	■	■	■	■	■	■	■	■	■
856	3												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
866	2																		■	■	■	■	■	■	■	■	■	■
880	2													■	■								■	■	■		■	■
885	2													■		■	■	■			■	■	■	■	■	■	■	■

IDNO	SEX	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
904	3																	■	■	■	■	■	■	■	■	■	■	■
907	1													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
914	1													■	■		■	■	■		■	■	■	■	■	■	■	■
923	2														■	■	■	■	■	■	■	■	■	■	■	■	■	
965	2															■	■		■		■	■	■	■	■		■	
969	2															■	■	■	■	■	■	■	■	■	■	■	■	■
972	1																				■	■	■	■	■	■	■	■
989	1																								■	■	■	■
991	2																■	■	■	■	■	■	■	■	■	■	■	■
997	3																				■	■	■	■	■		■	■
1007	1																										■	■
1011	3																									■		
1012	3																									■		
1016	2																					■	■	■	■		■	
1022	1																				■	■	■	■	■	■	■	■
1023	2																							■	■	■	■	■
1025	1																				■	■	■	■	■	■	■	■
1027	2																					■	■	■	■	■	■	
1028	2																				■	■	■	■	■	■	■	■
1032	2																				■	■	■	■			■	■
1042	1																				■	■	■	■	■	■	■	■
1063	3																					■	■	■	■	■	■	
1084	2																							■	■		■	■
1086	2																								■	■	■	■
1110	2																							■	■	■	■	■
1125	3																										■	■
1130	2																						■	■	■	■	■	■
1141	1																									■	■	■
1178	3																										■	
1193	3																											■
1198	3																											■
1202	3																											■