

Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2011-2013





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COMMISSIONED REPORT

Commissioned Report No. 797

**Site Condition Monitoring of bottlenose
dolphins within the Moray Firth Special Area
of Conservation: 2011-2013**

For further information on this report please contact:

Morven Carruthers
Scottish Natural Heritage
Great Glen House
INVERNESS
IV3 8NW
Telephone: 01463 725000
E-mail: morven.carruthers@snh.gov.uk

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COMMISSIONED REPORT

Summary

Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2011-2013

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Background

The Moray Firth Special Area of Conservation (SAC) was designated in 2005 under the European Habitats Directive (92/43/EEC) for bottlenose dolphins (*Tursiops truncatus*). This SAC extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast, and includes areas that are regularly used by the population of bottlenose dolphins occurring along the east coast of Scotland. As a result of this designation, Scottish Natural Heritage (SNH) has a responsibility to report on the condition of bottlenose dolphins within the Moray Firth SAC every six years.

Since 1989, this population of bottlenose dolphins has been the focus of an intensive research programme, carried out by the University of Aberdeen in collaboration with the Sea Mammal Research Unit at the University of St Andrews. In 2004, SNH entered into a Memorandum of Agreement with the University of Aberdeen to support these photo-identification studies and use the data to report on the condition of the site. This report presents the results from the fourth round of SNH funded surveys, together with the results of similar surveys made in 2011 and 2012 that were carried out with support from the Department of Energy and Climate Change (DECC), Scottish Government, Oil & Gas UK and Collaborative Offshore Wind Research Into the Environment (UK) (COWRIE). This is an interim report to provide updates on the monitoring programme in the three years since the last report. The next full site condition monitoring report is due in 2018.

Main findings

- Mark-recapture analysis of photographs collected during photo-identification surveys indicated that an estimated 102 individual dolphins used the SAC during the summer of 2011, 112 in 2012 and 94 in 2013.
- Despite inter-annual variability, the number of dolphins using the SAC between 1990 and 2013 appears to be stable.
- Passive acoustic monitoring from 2011 to 2013 highlighted that there was some inter-annual and seasonal variation in the amount of time dolphins spent at sample sites within

the SAC. However, dolphins were present at two long-term monitoring sites in the SAC on almost all days during the summer.

- Subject to available data we aim to update estimates of overall population size for the full site condition monitoring report due in 2018. These data will also be used to assess any changes in the proportion of the total population using the SAC.
- The quality of data available for completing the Site Attribute Table is high for attribute 1.1.1, medium for attribute 1.1.2 and low for attribute 1.1.3. As a result of this and in light of the limited years of data collected since the last full assessment, we recommend that no change is made to the condition status as a result of this report.

For further information on this project contact:

Morven Carruthers, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.

Tel: 01463 725000 or morven.carruthers@snh.gov.uk

For further information on the SNH Research & Technical Support Programme contact:

Knowledge & Information Unit, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.

Tel: 01463 725000 or research@snh.gov.uk

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1. INTRODUCTION

The Moray Firth Special Area of Conservation (SAC) was designated in 2005 under the European Habitats Directive (92/43/EEC) for bottlenose dolphins (*Tursiops truncatus*). The SAC extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast (Figure 1), and includes areas that are regularly used by the population of bottlenose dolphins occurring along the east coast of Scotland.

Since 1989, this population of bottlenose dolphins has been the focus of an intensive research programme, carried out by the University of Aberdeen in collaboration with the Sea Mammal Research Unit at the University of St Andrews. Research has been conducted throughout the known range of this population, but the core programme has consisted of boat-based photo-identification studies within the Moray Firth SAC. As a result, these studies have provided information on abundance, distribution and behaviour patterns that have supported the development and management of the SAC.

Scottish Natural Heritage (SNH) has a responsibility to report on the condition of bottlenose dolphins within the Moray Firth SAC every six years. In 2003, SNH contracted the Universities of Aberdeen and St Andrews to review existing information on the distribution and abundance of this population of bottlenose dolphins, and to explore the different options for monitoring bottlenose dolphins within the SAC (Thompson *et al.*, 2004). Subsequently, SNH entered into a Memorandum of Agreement with the University of Aberdeen to support these photo-identification studies and use these data to fulfil SNH's requirement to report on the condition of the site.

During the period 1990-2000 there appeared to have been a decline in the extent to which this population was using the SAC, and an apparent range expansion (Wilson *et al.*, 2004). Data from the first reporting cycle (2002-2004) (Thompson *et al.*, 2006) confirmed that a high proportion (75-80%) of the east coast of Scotland population still used the SAC during summer, and suggested that there may have been a slight increase in summer abundance within the SAC post-2000. On the basis of these findings, the condition status in 2006 was considered to be "Unfavourable (recovering)".

An internal report covering 2005 to 2007 identified significant inter-annual variation in the indicators being monitored, and acknowledged that it remained unclear to what extent this resulted from sampling variation or genuine biologically significant changes. In light of this uncertainty and the limited amount of data collected since the previous report, no change was made to the condition status (Thompson *et al.*, 2009).

The last reporting cycle (2008 to 2010) analysed data from 1990 to 2010 and concluded that despite inter-annual variability the number of dolphins using the SAC had remained stable. Additional data suggested that there was no evidence of a decline in the population of dolphins on the east coast of Scotland, and there was an over 99% probability that this population is stable or increasing. However, the proportion of the east coast of Scotland bottlenose dolphin population that uses the SAC has declined, most probably due to an overall increase in population size (Cheney *et al.*, 2012). Yet >50% of the population used the SAC at some point in any one year (Cheney *et al.*, 2014) and intensive surveys in 2006 and 2007 over the entire east coast showed that >80% of well-marked dolphins in this population have been photographed in the SAC (Cheney *et al.*, 2013). On this basis, the condition status in 2012 was considered to be "Favourable (recovered)".

This report presents the results from the fourth round of SNH funded surveys, together with the results of similar surveys made in 2011 and 2012 that were carried out with support from DECC, Scottish Government, Oil & Gas UK and COWRIE. We also present data from passive acoustic monitoring studies to support efforts to monitor the level of use that

dolphins make of the SAC. This is an interim report to provide updates on the monitoring programme over the last three years. These data will be incorporated into a revised assessment of the condition of this bottlenose dolphin population with further survey and monitoring data from 2014 to 2016 for the next full site condition monitoring report due in 2018.

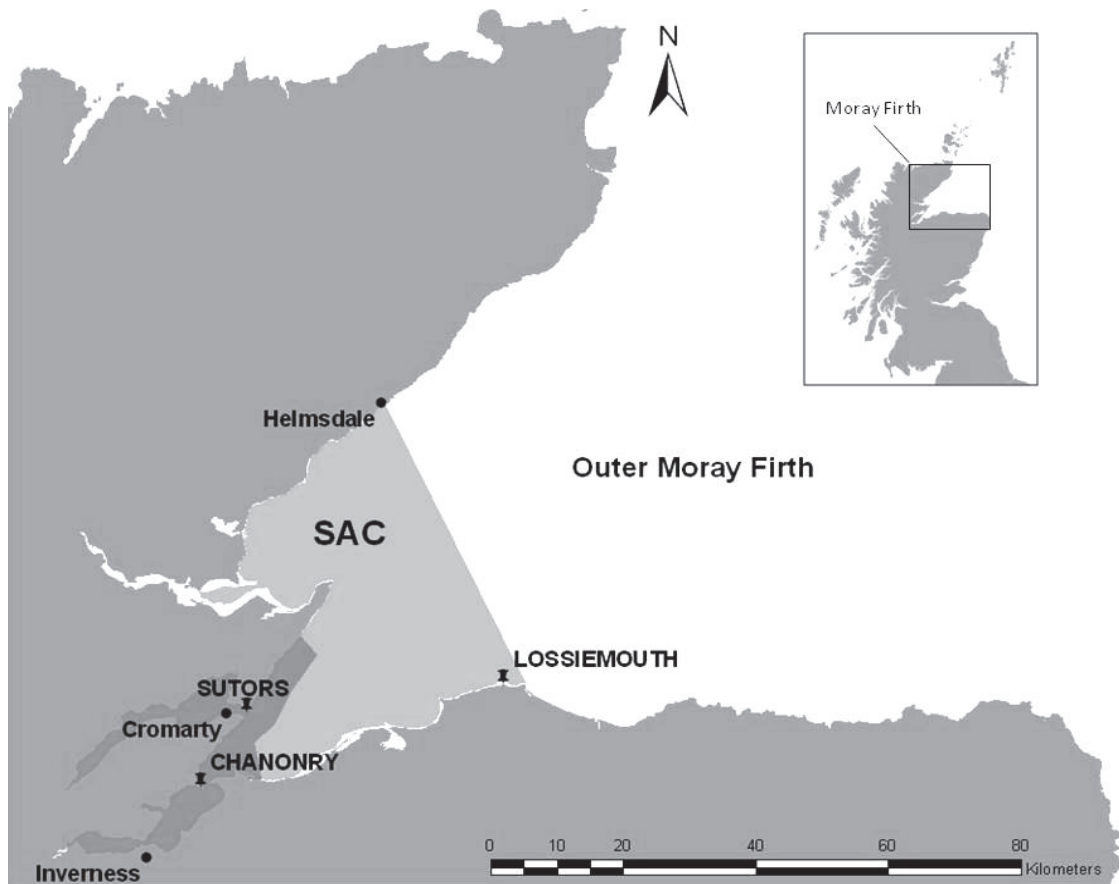


Figure 1. A map showing the location of the Moray Firth and the boundaries of the Moray Firth SAC (grey), core study area (dark grey) and locations of POD deployments at three sample sites (pins).

2. METHODS

Detailed discussion of the different options for monitoring bottlenose dolphins in the Moray Firth SAC can be found in Thompson *et al.* (2004). Following this work, it was decided that the main requirement was to estimate the number of dolphins using the SAC. Given this, it was recommended that mark-recapture analysis of photo-identification data was the most appropriate method for estimating the abundance of this well-marked population of coastal dolphins. However, there still remained a number of different sampling options that could provide estimates of this kind. In particular, given the large size of the SAC, it was recommended that sampling be restricted to a core study area that can be used as a proxy for the SAC. Furthermore, because of the need for good weather conditions for boat-based photo-identification work, it was recommended that surveys be restricted to the summer period, when earlier year-round studies had also indicated that abundance within the Moray Firth SAC was highest (Wilson *et al.*, 1997). The resulting survey strategy was therefore based on Option A in Thompson *et al.* (2004), and further details of the protocols are given below.

2.1 Survey protocols

Surveys focused on the core study area (dark grey area in Figure 1). All surveys were made from an MCA certified 5.8 m Rigid Inflatable Boat, working from Cromarty Harbour. Survey effort was spread through the period May to September, but restricted to days with low sea state (< Beaufort 3), to maximise sighting probability, and good light conditions to maximise photographic quality. Survey routes were chosen to maximise sighting probability whilst also providing reasonably wide coverage of the core study area. Occasional surveys also covered other areas within the SAC and outside the SAC along the south coast of the Moray Firth. However, here we only present data from surveys and encounters with dolphins within the SAC. Surveys were made with a minimum crew of two, including an appropriately qualified skipper and at least one of the personnel named on the Animal Scientific Licence (Licence #13292 in 2013) granted to the University of Aberdeen by SNH.

Throughout the survey, the survey route was recorded automatically from the boat's GPS, and later downloaded to a GIS. Whenever a group of dolphins was encountered, the position and time was noted, a waypoint entered on the GPS log, and an estimate made of the size of the group (Wilson *et al.*, 1997). The boat was then carefully manoeuvred at slow speed around the dolphins to allow dorsal fin photographs to be taken with a Canon 7D and a 70-200mm lens. In doing so, every effort was made to minimise disturbance to the group, and to obtain pictures that were of sufficient quality for subsequent mark-recapture analyses. In particular, it was important to ensure that: dorsal fins were parallel to the camera; the whole fin was in the picture; the height of the fin image was >10% of the field of view; and that pictures were taken such that there was an equal probability of photographing different members of the group. The encounter was ended either when all dolphins had been photographed or when the survey vessel lost contact with the group. At this point, the end time and location were noted and another GPS waypoint taken.

2.2 Photographic analysis

Following the survey, the survey and each encounter within it were allocated unique "Trip" and "Encounter" numbers. Photographs were downloaded to a PC, and the pictures from each encounter were stored in individual folders. All pictures were then backed up to DVD before renaming the original image files with a name that included the trip number (see Annex I).

All the pictures taken on each encounter were then graded for photographic quality according to the criteria in Figure 2, adapted from Wilson *et al.* (1999). Subsequent analyses were restricted to the subset of high quality (Grade 3.1, 3.2 & 3.3) pictures to avoid biasing

mark-recapture estimates of abundance (see Wilson *et al.*, 1999). Analyses were also restricted to the subset of animals bearing distinctive marks, i.e. those with nicks in their dorsal fin. Each of these dorsal fin pictures was initially matched against the existing catalogue (see Annex II) by one experienced project team member. At the end of the season, each of these matches was then confirmed by a second experienced person.

Confirmed sightings of the different well-marked dolphins (i.e. animals with dorsal fin nicks that could be identified from either the left or right side) were then recorded in an Access database, linking that sighting with information on which side of the dolphin had been photographed, and the trip and encounter information (see Annex I). Estimates of group size were recorded as the larger of the field estimate of the number of animals seen in each encounter and the number of animals subsequently identified from grade 3 pictures. In addition, we used all grade 3 pictures to estimate θ , the proportion of animals that were well-marked. For each trip, we recorded the number of photographed individuals that were well-marked, and the number of individuals not well-marked (i.e. no dorsal fin nicks), and recorded this information in a separate database table (see Annex I).

Quality Grading Criteria

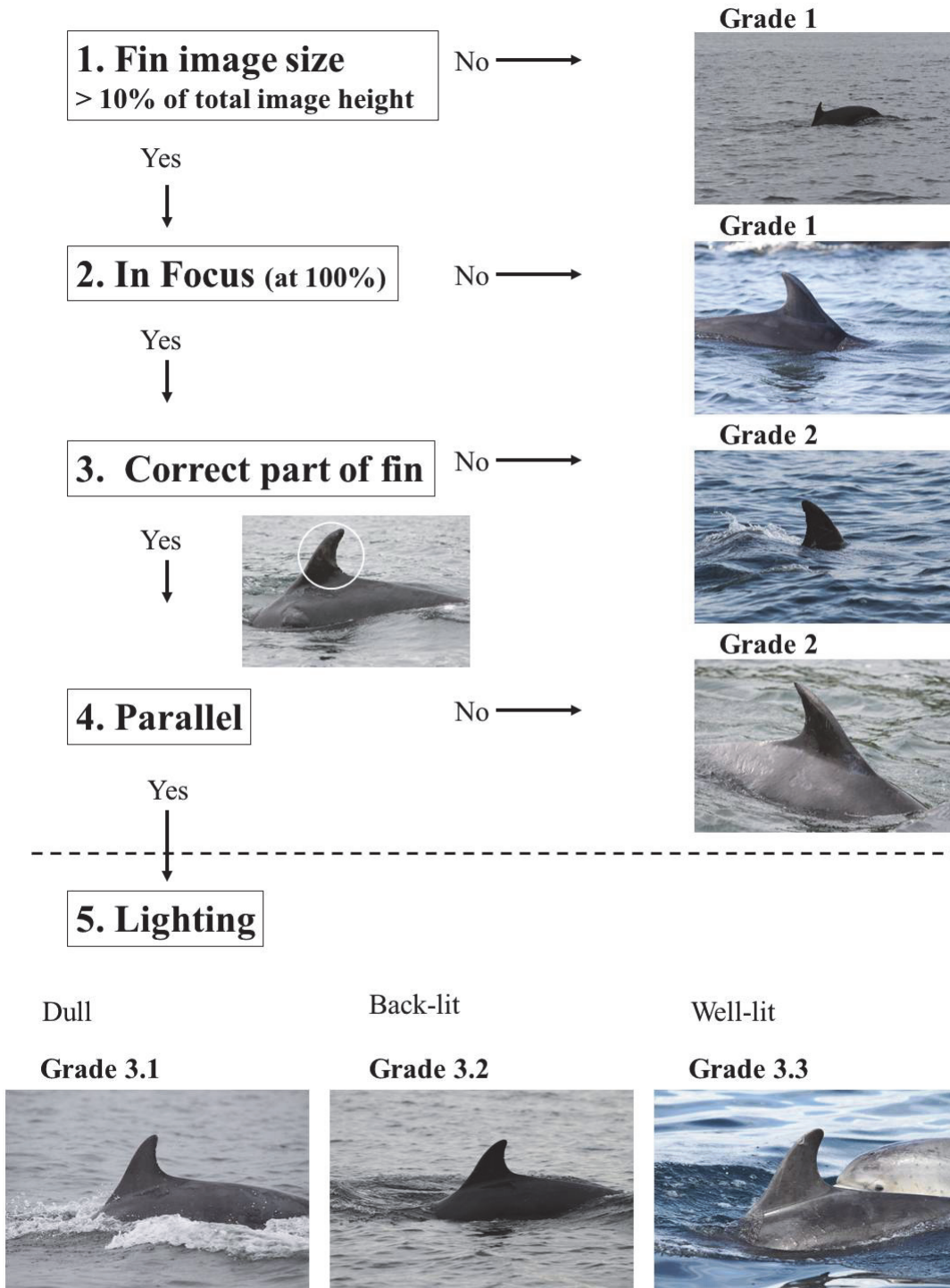


Figure 2. Schematic showing the criteria used to quality grade the photographs taken during photo-identification surveys. Only sightings confirmed from pictures of grade 3.1, 3.2 or 3.3 were used in mark-recapture analyses to estimate abundance.

2.3 Mark-recapture analysis

Annual abundance was estimated using a modification of the approach developed by Wilson *et al.* (1999). Previously, estimates were derived separately for left and right sides, but this led to high sampling variation in some years. Here, we based estimates on well-marked individuals with nicked dorsal fins that could be identified from both sides, and produced a single capture history combining left and right sides for each year. Based upon comparisons in Wilson *et al.* (1999) we used the Chao *et al.* (1992) M_{th} model, implemented in the program CAPTURE (Rexstad and Burnham, 1991), to estimate the number of well-marked individuals for each year.

Initially the proportion of well-marked animals (θ) was estimated separately for left and right sides for each trip, and an average value calculated for each year's set of surveys (Wilson *et al.*, 1999, Thompson *et al.*, 2006). However, inspection of our time series of data suggested that much of the variation in estimates of annual abundance appeared to be related to sampling variation related to our estimate of θ (Cheney *et al.*, 2012, Cheney *et al.*, 2014). To reduce these effects, Cheney *et al.* (2014) used all the available data from 1990 to 2010 to model θ . Using generalised linear mixed models (GLMMs) it was found that much of the variation in θ was accounted for by covariates relating to survey protocol, with the best model including the change in survey protocol in 2001 from a fixed survey route to more flexible surveys (Cheney *et al.*, 2014). This model provided two estimates of θ , one for 1990-2000 for the fixed survey route ($\theta_1 = 0.4720$, SE = 0.0345) and one for 2001-2010 for the flexible survey route ($\theta_2 = 0.5609$, SE = 0.0425), resulting in a step increase in θ coinciding with the change in survey protocol (Cheney *et al.*, 2014). There are two plausible causes for this change. One is that the population age-structure has changed in such a way that θ has increased. However, there is no evidence for this from the GLMMs. The other, more likely, explanation is that estimates of θ have changed as a result of changes in sampling. A priori, one might expect any sampling differences that affected the estimation of θ to also affect the estimate of well-marked animals. However, there was no increase in the mean estimate of the number of well-marked dolphins (1990-2000: 52 (SE = 5), 2001-2010: 53 (SE = 2)). Given the possibility that the change in the estimate of θ is a result of sampling bias, the higher capture probabilities and reduced capture heterogeneity in the second decade, and the absence of biological explanations for a step change in θ , we argue that the estimate of θ from the second decade probably reflects the proportion of well-marked animals in this population throughout the time series. Accordingly, θ_2 was used to inflate the annual mark-recapture estimates of well-marked animals (\hat{N}_t) for each year t 1990 to 2013 to estimate total annual abundance within the SAC ($N_{t\ total} = \hat{N}_t / \theta$). Assuming $N_{t\ total}$ is log normally distributed, the upper and lower 95% confidence intervals were estimated, by dividing and multiplying $N_{t\ total}$, respectively, by:

$$e^{1.96 \sqrt{\ln(1 + CV_{N_{t\ total}}^2)}}$$

$$\text{where: } CV_{N_{t\ total}}^2 = \frac{\text{var}(\hat{N}_t)}{\hat{N}_t^2} + \frac{\text{var}(\theta)}{\theta^2}$$

However, given that we cannot rule out the possibility of a step-change in θ , we also explore the consequences of applying θ_1 to annual abundance estimates from 1990-2000 and θ_2 to estimates from 2001-2013.

2.4 Usage of the SAC

We employed two methods to estimate the use of the SAC by the east coast of Scotland bottlenose dolphin population, using different approaches to quantify the amount of time dolphins spent within the SAC.

2.4.1 Encounter probability in the Sutors area

Although survey routes varied, all surveys passed through the Sutors of Cromarty (the headlands at the mouth of the Cromarty Firth). Therefore, as in previous condition monitoring reports, we used a simple index of usage of the SAC based upon the probability of encountering dolphins each time the survey boat passed through the Sutors area during the period May to September (Thompson *et al.*, 2006).

2.4.2 Passive acoustic monitoring

We also used passive acoustic monitoring to provide a more detailed assessment of usage of the SAC. CPODs were used to record changes in the presence or absence of dolphins at sample sites within the SAC. These devices incorporate a hydrophone, processor and digital timing system. The CPOD continuously detects from 20-160 kHz, logging time, centre frequency, sound pressure level and bandwidth of each cetacean echolocation click and can log detections for periods of up to 4 months. The manufacturer's software program was used to post-process the recovered data, detect characteristic click trains, and remove noises from other sources such as boat sonar (see www.chelonia.co.uk for details). Resulting data on the number of click trains recorded in each minute can be used to determine the presence or absence of target species in different time periods, or to identify the timing and duration of encounters with target species. We used version 1 CPODs to detect dolphin echolocation click trains, and processed all data using the manufacturer's software (version 2 train filter).

To evaluate trends in the use of sample areas within the SAC we used available acoustic data from a series of different studies that have been conducted by the University of Aberdeen since 2005 (see Bailey *et al.*, 2010, Thompson *et al.*, 2010, Thompson *et al.*, 2011). Sample sites and coverage varied between years, but data are available from 2011, 2012 and 2013 for three sample sites (Sutors, Chanonry and Lossiemouth) (Figure 1).

2.5 Dolphin population trends

In light of the limited amount of data collected since the last assessment a revised estimate of the total size of the east coast population will not be made until the next full reporting cycle. This will also permit these data to be used to assess any changes in the proportion of the total population using the SAC.

Available data sources were used to attempt to determine if there were any changes in crude birth rates or observed mortality within the population. The numbers of known calf births each year within the SAC and on the east coast from 1987 to 2013 were reviewed. Also, we summarised the number of known strandings from 1992 to 2013 on the east coast of Scotland from the Marine Mammal Stranding database created by the Scottish Marine Mammal Stranding Scheme (SRUC, 2014).

3. RESULTS

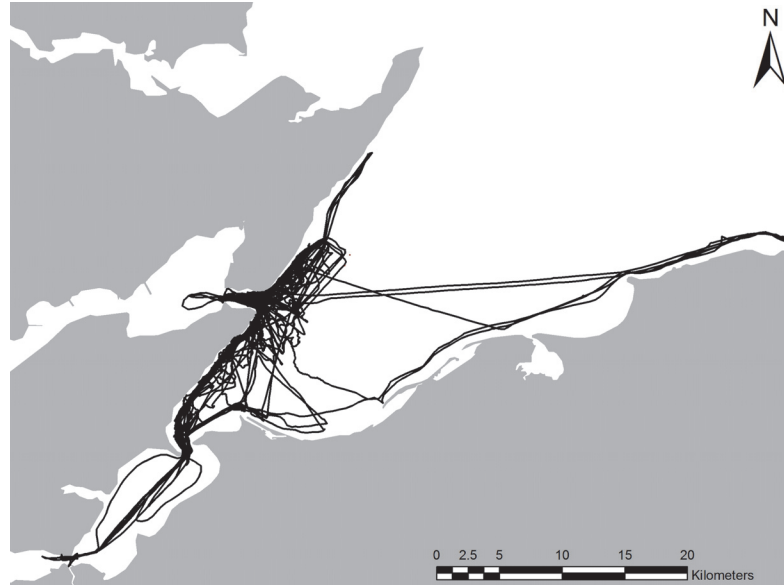
3.1 Survey details

In 2013, 22 photo-identification surveys were carried out within the SAC under contract from SNH. These surveys resulted in a total of 129 encounters with dolphin groups. Information on these surveys, and those made in 2011 and 2012 are presented in Table 1 and the survey routes for these three years are shown in Figure 3.

Table 1. Summary data on the number of photo-identification surveys conducted during the 2011 to 2013 reporting period.

Year	No. of surveys	Mean survey duration (hours)	No. of encounters	% of survey time with dolphins
2011	21	6.4	107	40
2012	19	6.3	119	45
2013	22	6.1	129	43

a) 2011



b) 2012



c) 2013

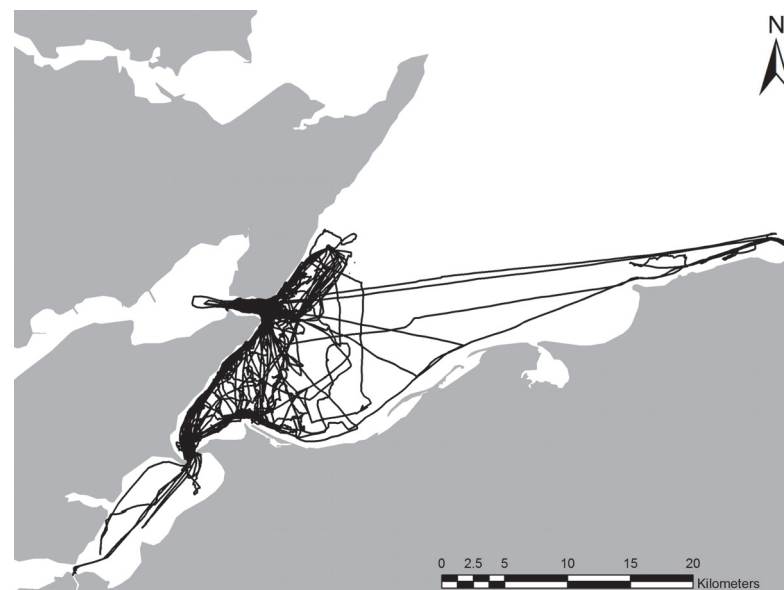


Figure 3. A map showing the areas covered by surveys in a) 2011 b) 2012 and c) 2013.

Although median group sizes were similar in 2011, 2012 and 2013 (7, 5 and 6 respectively), maximum group sizes were bigger in 2011 and 2012 (Figure 4), however, these differences were not significant (Kruskall-Wallis, $\chi^2 = 3.1398$, $df = 2$, $p=0.2081$).

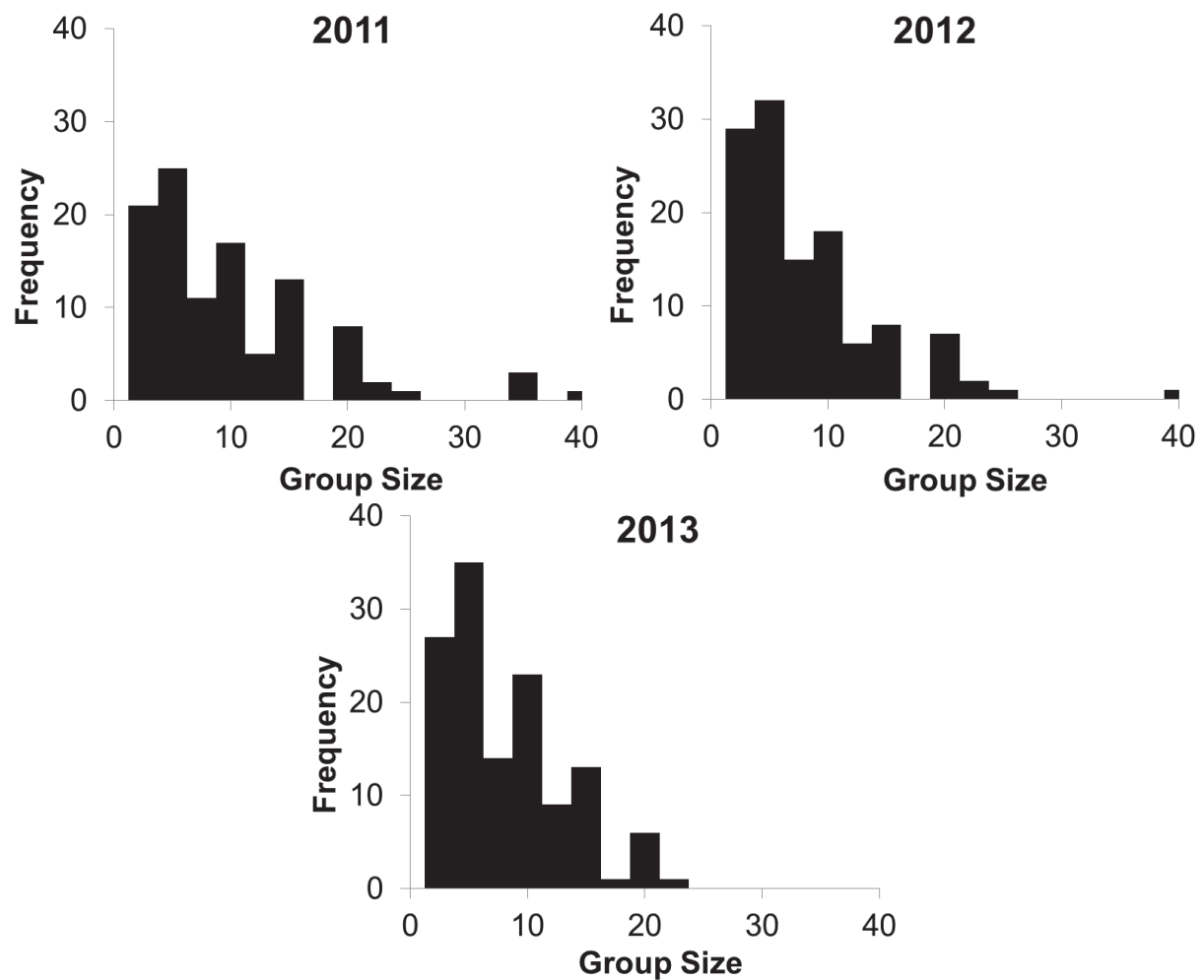
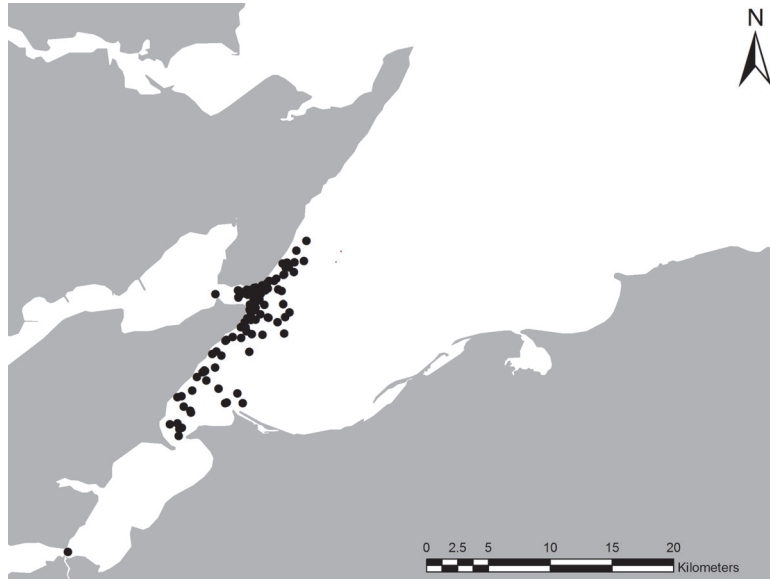


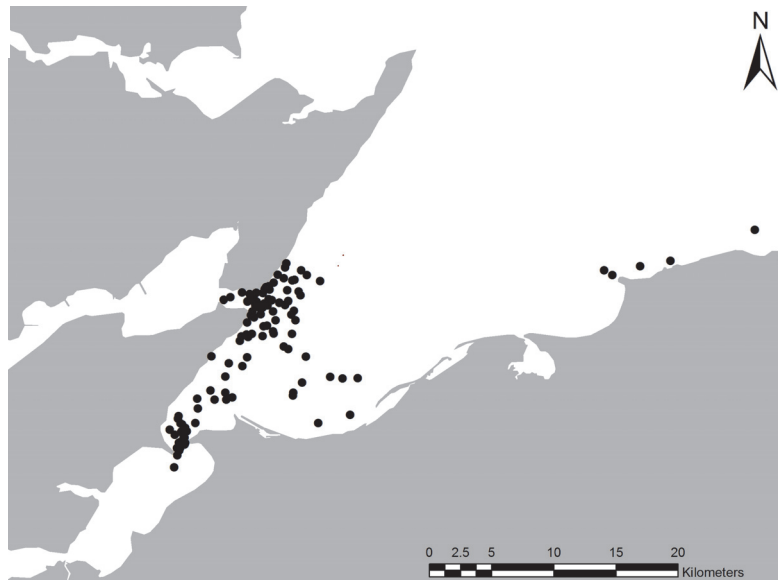
Figure 4. Frequency distribution of different estimated dolphin group sizes encountered during photo-identification surveys in 2011, 2012 and 2013.

The locations of encounters with dolphins in each year, based upon the position of the survey boat at the start of each encounter, are given in Figures 5a, b & c.

a) 2011



b) 2012



c) 2013

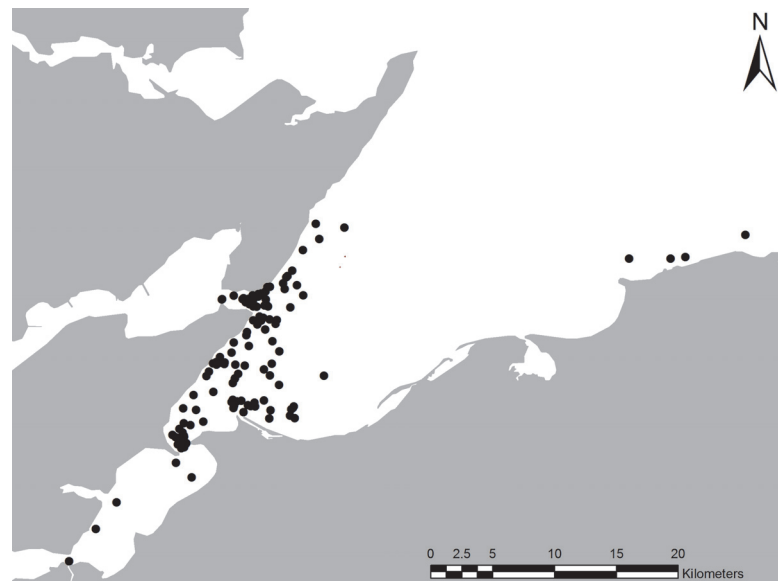


Figure 5. A map showing the location of encounters with groups of dolphins during surveys conducted in a) 2011 b) 2012 and c) 2013.

3.2 Estimate of the number of dolphins using the SAC

High quality pictures were obtained from at least 52 well-marked individuals during the 2013 surveys. The mark-recapture estimate of the total number of well-marked individuals was 53 (95% confidence interval (CI): 53-59). This estimate was inflated by the GLMM modelled proportion of well-marked individuals, θ_2 (0.5609). The resulting estimate of the number of dolphins using the SAC in the summer of 2013 was 94 (95% CI: 81-110). Equivalent estimates for 2011 and 2012 are presented in Table 2.

Table 2. Dolphin population data from the mark-recapture analysis using the M_{th} model including the number of well-marked individuals identified in grade 3 pictures (minimum number), the estimated number of well-marked individuals from CAPTURE (N -hat), the total number of dolphins estimated in the SAC (Total abundance) with 95% confidence intervals and the proportion of well-marked individuals (θ_2).

Year	Minimum Number	\hat{N}	95% CI	θ_2	Total abundance	95% CI
2011	52	57	54-68	0.5609	102	84-123
2012	59	63	61-73	0.5609	112	94-134
2013	52	53	53-59	0.5609	94	81-110

3.3 Trends in the number of dolphins using the SAC

Annual estimates of the number of dolphins using the SAC in summer show considerable variability from year to year (Figure 6). However, there is no significant linear trend in these annual estimates ($F_{1,22} = 0.046$, $p = 0.8312$).

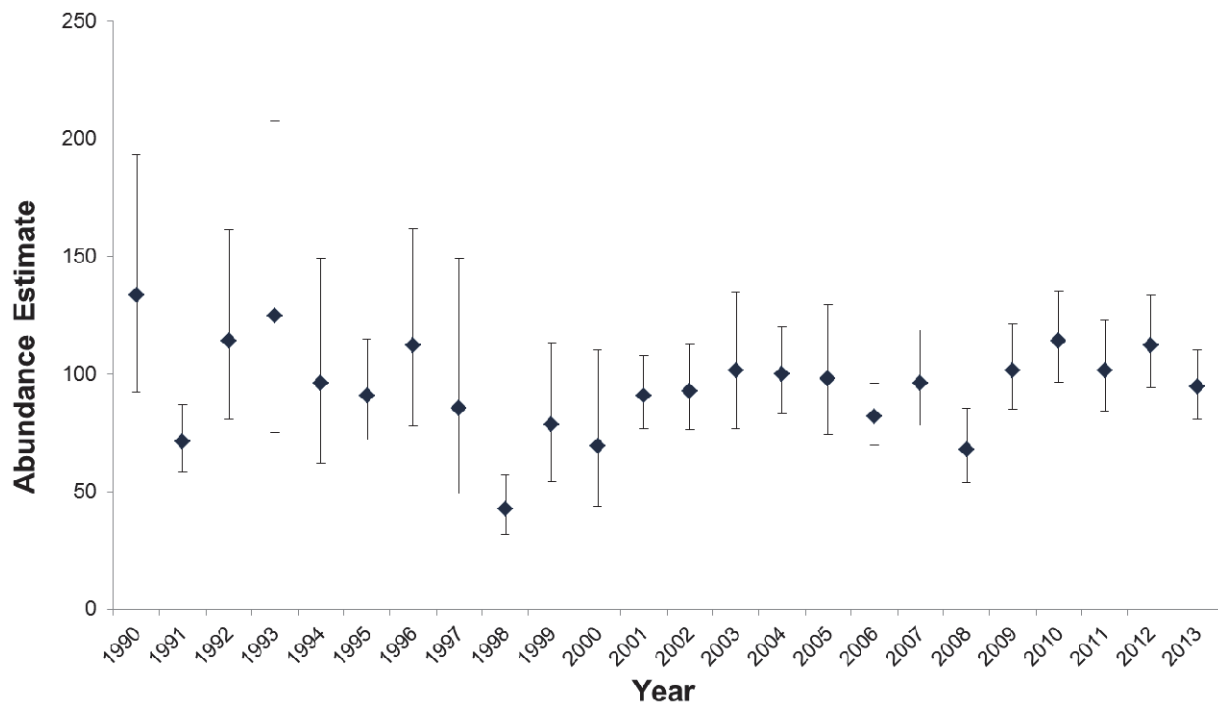


Figure 6. Annual estimates of the number of dolphins using the Moray Firth Special Area of Conservation from 1990 to 2013 with 95% confidence intervals.

Applying the two different estimates of θ to data from the first and second decades of surveys also resulted in no significant linear trend ($F_{1,22} = 3.858$, $p = 0.06227$).

The estimates in Figure 6 represent variations in the abundance of dolphins within the Moray Firth SAC. As such, this may represent changes either in the overall population size, and/or the proportion of the population that entered the Moray Firth each year during the survey period.

3.4 Usage of the SAC

Survey effort in different areas of the SAC varied between surveys and years. However, the Sutors area was visited during every survey, and the probability of encountering groups of dolphins within this area averaged 0.79 over the whole reporting period (Table 3), identical to that reported for 2008 to 2010 (Cheney *et al.*, 2012).

Table 3. Estimates of the usage of the SAC based upon the probability of encountering groups of dolphins within the Sutors area.

Year	Total number of trips	Proportion of trips encountering dolphins in the Sutors area
2011	21	0.81
2012	19	0.89
2013	22	0.68
Total	62	0.79

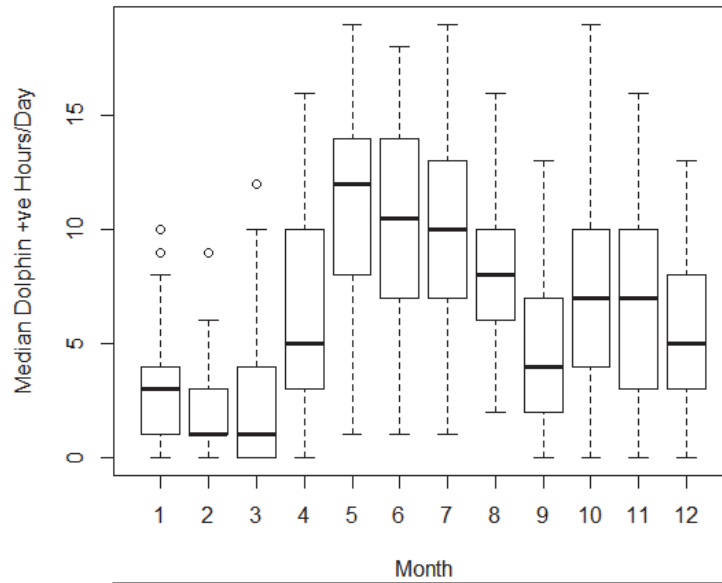
Data on seasonal changes in the detection of dolphins by CPODs moored at sample sites in the Sutors, Chanonry and Lossiemouth areas during 2011 to 2013 are presented in Table 4 and Figure 7. Data are included only for those months in which data are available for 10 or more days and early failure of equipment meant that coverage was not available in all months (i.e. Sutors for March and December 2012 and January to March 2013; Chanonry for April, September and October 2011 and January to March 2013; Lossiemouth for January and February 2013; see Table 4 for the full number of days sampled each month). Nevertheless, these data indicate that although dolphin occurrence tends to be highest during the May to September photo-identification survey period, dolphins are also present in these areas at other times of year (Table 4). For example, at Sutors dolphins were detected on average between 5 and 7 hours per day during October to December (inter-quartile ranges = 3 to 10), compared to summer medians of 4 to 12 hours per day (inter-quartile ranges = 6 to 14) (Figure 7a and Table 4).

To investigate annual changes in the detection of dolphins by CPODs moored at sample sites in the Sutors, Chanonry and Lossiemouth areas, only summer data (May to September) from 2011 to 2013 were used for consistency with the summer photo-identification data (as above, there was no CPOD data available for Chanonry in September 2011) (Table 5 and Figure 8). Dolphins regularly spend more time in the Sutors and Chanonry area than Lossiemouth (Table 5 and Figure 8). Although there is annual variation in the median number of hours per day dolphins spend in each of these areas (Table 5 and Figure 8) this was not significant for Sutors (Kruskal-Wallis Test, $\chi^2 = 5.4918$, $df = 2$, $p = 0.06$). However, there was a significant increase in the median hours per day dolphins were detected at Chanonry and Lossiemouth in 2013 (Kruskal-Wallis Test, $p < 0.05$). Also, if data were used from the entire year there was a difference at the Sutors with a higher median number of hours detected in 2012 (median = 8, inter-quartile range = 4 to 11) (Kruskal-Wallis Test, $\chi^2 = 18.5351$, $df = 2$, $p < 0.0001$).

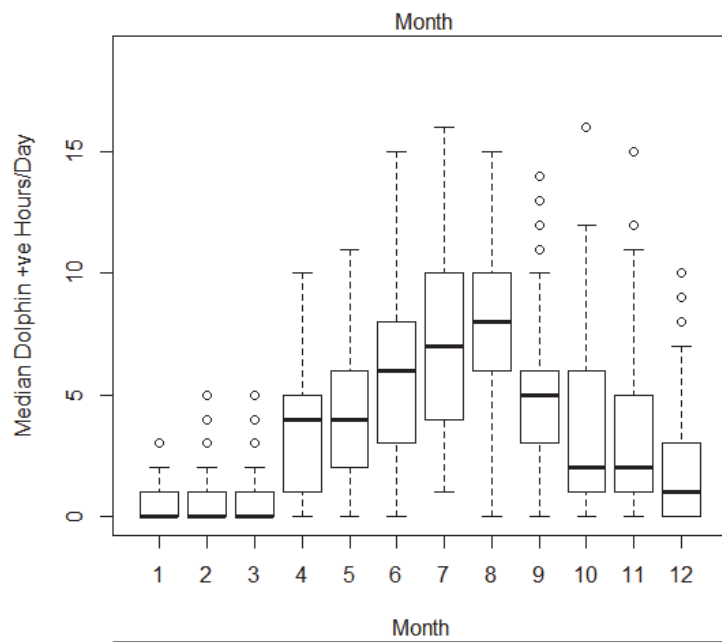
Table 4. The percentage of days on which dolphins were detected on CPODs at the Sutors, Chanonry and Lossiemouth sites each month from 2011 to 2013. Data are also presented on the median number of hours in which dolphins were detected each day during that period. (* CPOD data was unavailable in these months in some years)

2011 to 2013	No. days sampled	% days dolphins detected	Median hrs/day detected	Inter-quartile range
Sutors				
January*	62	85.5	3	1-4
February*	42	78.6	1	1-3
March*	31	61.3	1	0-4
April	71	90.1	5	3-10
May	93	100	12	8-14
June	90	100	10.5	7-15
July	90	100	10	7-13
August	92	100	8	6-10
September	90	91.1	4	2-6.75
October	92	94.6	7	4-10
November	77	98.7	7	3-10
December*	62	91.9	5	3-7.75
Chanonry				
January*	62	32.2	0	0-1
February*	57	36.8	0	0-1
March*	62	45.2	0	0-1
April*	59	88.1	4	1-5
May	90	92.2	4	2-6
June	90	97.8	6	3-8
July	92	100	7	4-10
August	81	98.8	8	6-10
September*	60	95.0	5	3-6
October*	62	75.8	2	1-6
November	81	77.7	2	1-5
December	90	61.1	1	0-3
Lossiemouth				
January*	62	45.2	0	0-1
February*	57	66.7	1	0-2
March	61	73.8	2	0-3
April	90	75.6	2	1-3
May	93	76.3	1	1-2
June	90	80.0	2	1-3
July	91	68.1	1	0-2
August	92	77.2	1	1-2.25
September	90	63.3	1	0-2
October	93	40.9	0	0-1
November	78	61.5	1	0-2
December	85	57.6	1	0-1

a) Sutors



b) Chanonry



c) Lossiemouth

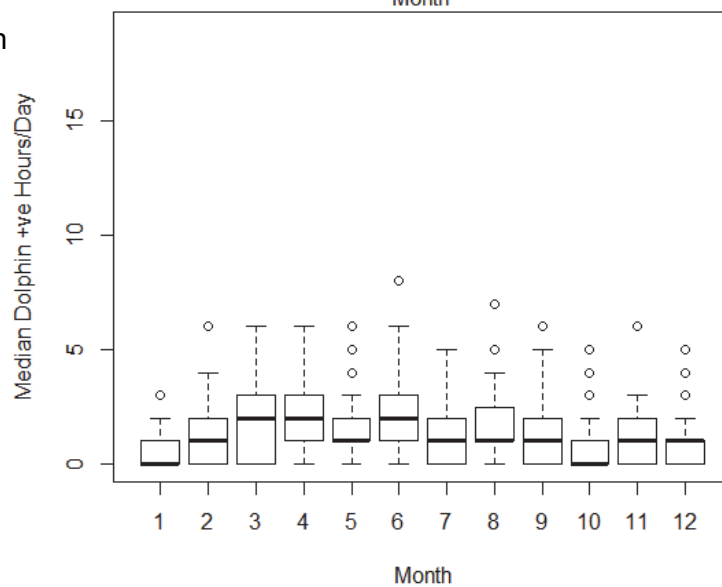
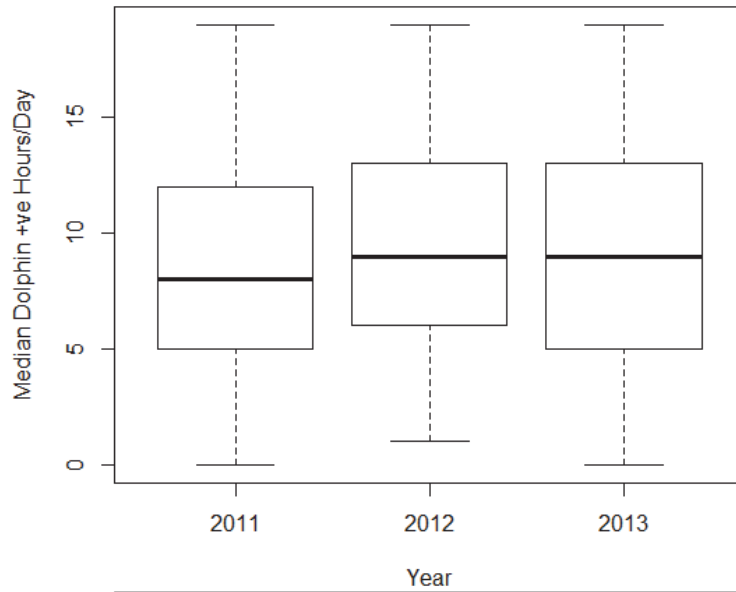
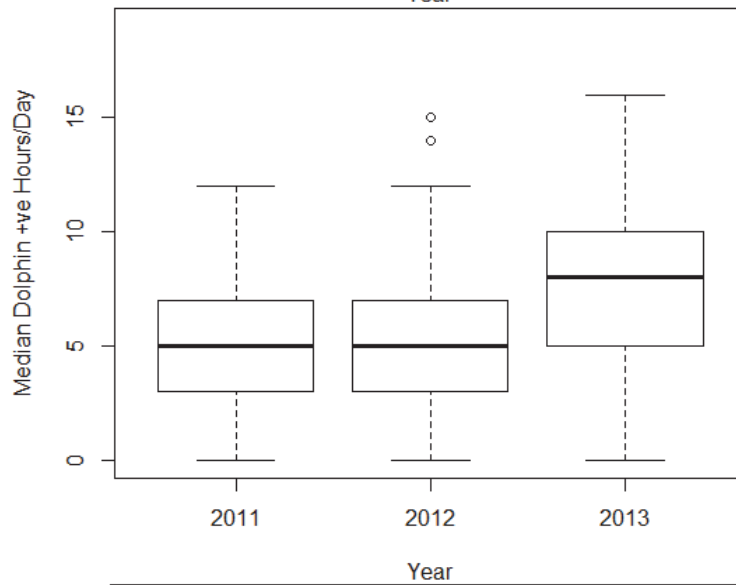


Figure 7. Seasonal variation in the median number of hours/day (+/- inter-quartile ranges) that dolphins were detected on CPODs moored in the Sutors, Chanonry and Lossiemouth sample sites from 2011 to 2013.

a) Sutors



b) Chanonry



c) Lossiemouth

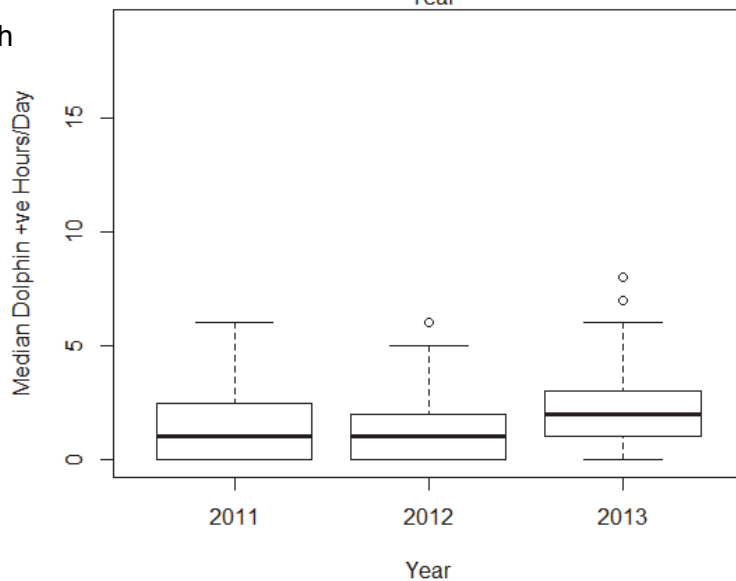


Figure 8. Annual variation in the median number of hours/day (+/- inter-quartile ranges) that dolphins were detected on CPODs moored at the Sutors, Chanonry and Lossiemouth sites during the summers (May to September) of 2011 to 2013.

Table 5. Annual figures for the percentage of days on which dolphins were detected on CPODs at the Sutors, Chanonry and Lossiemouth sites during the summer (May to September). Data are also presented on the median number of hours in which dolphins were detected each day during that period. (* CPOD data was unavailable in September 2011 at Chanonry)

Year	No. days sampled	% days dolphins detected	Median hrs/day detected	Inter-quartile range
Sutors				
2011	152	96.0	8	5-12
2012	152	100	9	6-13
2013	151	98.7	9	5-13
Chanonry				
2011*	109	99.1	5	3-7
2012	152	94.7	5	3-7
2013	152	97.4	8	5-10
Lossiemouth				
2011	152	72.4	1	0-2.25
2012	152	68.4	1	0-2
2013	152	78.3	2	1-3

3.5 Dolphin population trends

In Cheney *et al.* (2012) the model developed by Corkrey *et al.* (2008) was used to incorporate additional data from areas outside the SAC and estimate the most likely trend in overall population size. This suggested that there was a >99% probability that the population was stable or increasing. Further years of data across the home range of this population are required to effectively update this analysis. However, this will only be possible as long as additional data from the ongoing collaborative studies across the known home range of this population are available (e.g. photo-identification data from the University of St Andrews Sea Mammal Research Unit from Tayside and Fife). Subject to available data we aim to update these estimates of overall population size in the next full site condition monitoring report. This will also permit these figures to subsequently be used to assess any changes in the proportion of the total population currently using the SAC.

Bottlenose dolphin calves can be identified in their first, second or third year of life (aged using foetal folds, vertical creases down the sides of calves from their position in the womb, which fade over time). However, only calves seen in echelon position (the calf is seen consistently surfacing alongside the mother's dorsal fin) with known females were included to avoid possible duplication. This resulted in total of 176 calves identified on the east coast of Scotland between 1989 and 2013 (Figure 9). The number of newborn calves ranged from zero to 20, with an average of seven calves born each year (se = 1). Although effort outside the SAC varied, in all but three years, the majority of new calves were first seen within the SAC (Figure 9). The potential increase in the number of calves is likely due in part to our change to digital photography where more photos are taken making it easier to link newborn calves to known females and the increase in photo-identification effort outside the SAC in recent years (Figure 9).

The Scottish Marine Mammal Stranding Scheme database (SRUC, 2014) notes that 56 bottlenose dolphins have stranded on the east coast of Scotland between 1992 and 2013 (Figure 10). The number of stranded individuals ranges from one to seven each year with an average of three (se = 0.35). The observed inter-annual variability could be a result of changes in mortality or search effort. Also, it is unknown if all of these stranded animals belong to the east coast of Scotland population. Since 1992 only 10 stranded animals (i.e.

19%) were matched to the University of Aberdeen east coast of Scotland bottlenose dolphin catalogue.

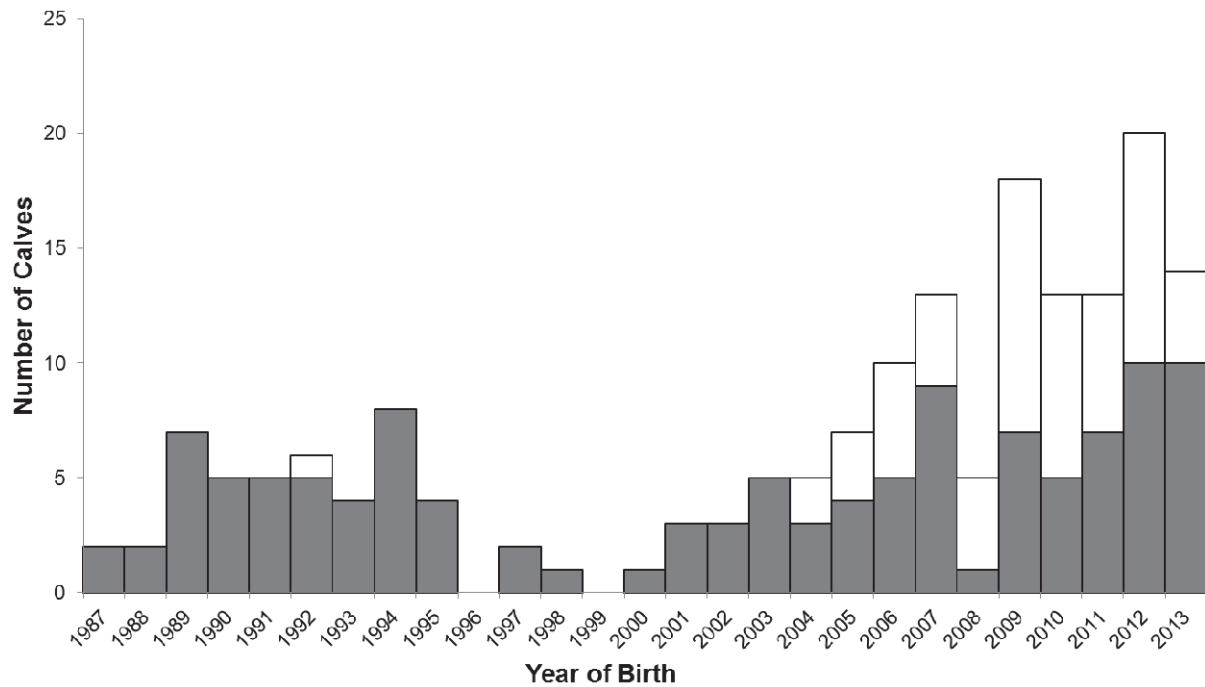


Figure 9. The number and estimated year of birth of calves observed with known females on the east coast of Scotland, including calves first identified in the SAC (grey bars) and outside the SAC (white bars).

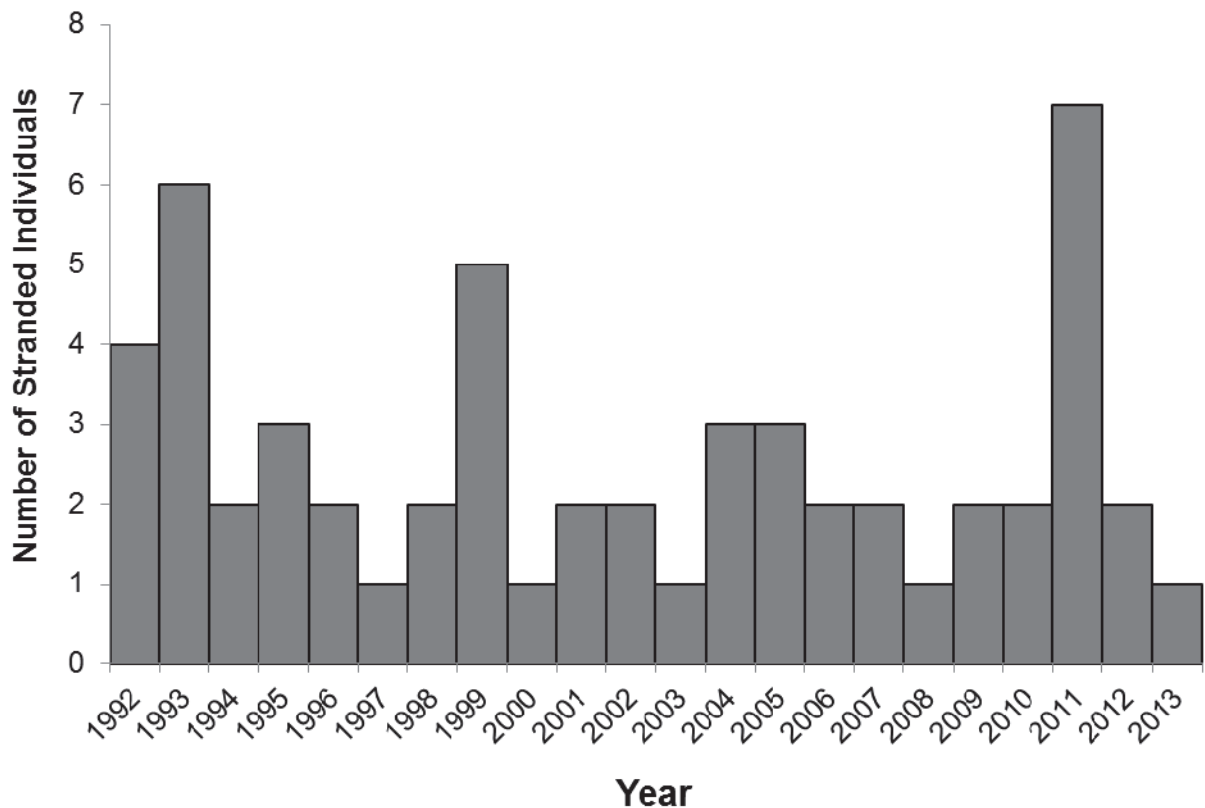


Figure 10. The number of stranded bottlenose dolphins found on the east coast of Scotland (Duncansby Head to the border with England) between 1992 and 2013 from the Scottish Marine Mammal Stranding Scheme.

4. DISCUSSION

Currently, there are three attributes and associated targets for the bottlenose dolphin feature of the Moray Firth SAC, as outlined in the Site Attribute Table (Annex II). The existing photo-identification monitoring programme focuses on providing data to monitor the first and second of these attributes (the number of individual dolphins using the SAC and frequency of occurrence of dolphins within the SAC). Additional data from related CPOD studies and analysis of changes in the use of the Sutors area, monitored on every photo-identification survey provide extra information to assess the second attribute. Reporting on the third site attribute (dolphin population trends) is outwith what can be done using data from the current photo-identification studies alone. However, it may be possible to revisit the Cheney *et al.* (2012) assessments of these attributes in the next reporting cycle, as long as additional data from ongoing studies including collaborative projects across the known home range of this population are available.

Because of the large size of the SAC, efforts to monitor changes in the number of dolphins using the SAC (Attribute 1.1.1) have been based on photo-identification surveys within a core study area in the inner Moray Firth. This has the advantage that sighting probability is higher in this intensively used area, and abundance estimates are therefore more precise. Furthermore, data collected during this monitoring programme can be more clearly related to the existing time series of data from this core study area (Thompson *et al.*, 2004). It remains possible that other individuals use other parts of the SAC, but are never recorded within the core study area in the inner Moray Firth. However, three lines of evidence still support our assumption that this core study area provides a good proxy for use of the whole SAC. First, during extensive visual and acoustic surveys conducted across the whole of the SAC in the summers of 2004 and 2005, 84% of dolphin encounters were within the core study area (Bailey and Thompson, 2009). Second, most remaining sightings were along the southern Moray Firth coast, and related photo-identification studies have shown that animals using these areas also use the core study area (Wilson *et al.*, 1999, Durban *et al.*, 2005). Thirdly, work completed as part of a Scottish Government and Scottish Natural Heritage funded project identified that in 2006 and 2007 over 80% of the well-marked dolphins seen on the southern coast of the outer Moray Firth were also identified within the SAC in those years. Only 11 well-marked individuals seen in this area in 2006 or 2007 were not seen in the SAC over this period, and only one has never been seen in the SAC (Thompson *et al.*, 2011).

Using data collected in the 2013 surveys, we estimated that 94 (95% CI: 81-110) different bottlenose dolphins used the SAC during the period May to September. Although, there is inter-annual variability in the number of dolphins in the SAC, results suggest there was no significant trend in abundance between 1990 and 2013.

The second site attribute is the frequency of occurrence of dolphins within the SAC (Attribute 1.1.2). In previous assessments we used a simple estimator that provided information on variation in the probability of sighting dolphins in the Sutors area (an area visited on every survey). Data from 2011 to 2013 confirms that dolphins continue to be encountered within this area at a high rate (on an average of 79% of visits to the area). The passive acoustic monitoring data from CPODs at three sample sites within the SAC suggest there is some inter-annual and seasonal variation in the amount of time spent in these areas each day. There was an increase in detections at the Sutors in 2012 and at Chanonry and Lossiemouth in 2013. However, at both Sutors and Chanonry dolphins were detected nearly every day during the summer in all years and for between 5 to 9 hours per day. Although dolphins were detected for fewer hours per day at Lossiemouth they were detected on the majority of days. Between 2011 and 2013, dolphins were detected in all months in all areas, although there was a general increase during the summer months. These data also suggest that dolphins may use certain areas of the SAC outside the summer months more than previously thought (Wilson *et al.*, 1997). For example, at the Sutors, dolphins were detected

on over 90% of days in April, October, November and December, only slightly less than in the summer, and for on average between 5 and 7 hours per day.

The third site attribute relates to overall trends in the east coast of Scotland dolphin population (Attribute 1.1.3). Monitoring to address this attribute requires photo-identification data to be collected both within and outside the SAC. Data from additional surveys outside the SAC were used in the previous reporting period to estimate population abundance (Cheney *et al.*, 2012). This suggested with a high probability, that this population is stable or increasing. As there are only three years of additional data collected since the last assessment, a further assessment of the total population size of the east coast population will not be repeated until the next reporting cycle. However, this will only be possible as long as additional data from the ongoing collaborative studies across the known home range of this population are available. This will also permit these figures to subsequently be used to assess any changes in the proportion of the total population currently using the SAC. No unusual observations in terms of the number of calves born or frequency of strandings within the population have been recorded.

In May 2005, the original condition monitoring assessment concluded that the current condition of the population was “Unfavourable (no change)”. Subsequent analysis of monitoring data from 2003 and 2004 indicated that there was a higher probability that targets 1.1.1 and 1.1.2 were being met, and this was reflected in a revision of the condition status to “Unfavourable (recovering)” (Thompson *et al.*, 2006). The internal report for 2005-2007 highlighted that there was significant inter-annual variation in the indicators being monitored, and it remained unclear to what extent this resulted from sampling variation or genuine biologically significant changes and therefore the condition status was not changed (Thompson *et al.*, 2009). The last report for 2008 to 2010 suggested that despite inter-annual variability, the number of dolphins using the SAC between 1990 and 2010 had remained stable; that there was a $\geq 99\%$ probability that the east coast of Scotland dolphin population is stable or increasing; and although the proportion of the dolphin population that use the SAC has declined, this is probably due to an overall increase in population size (Cheney *et al.*, 2012). All attributes for the bottlenose dolphin feature of the Moray Firth SAC were met, and the condition status was revised to “Favourable (recovered)”.

In summary, and building on the results of the last assessments, for this interim report the quality of data available for completing the Site Attribute Table is high for attribute 1.1.1, medium for attribute 1.1.2 and low for attribute 1.1.3. As a result of this and in light of the limited years of data collected since the last assessment, we recommend that no change is made to the condition status as a result of this report.

5. CONCLUSIONS

Estimates of abundance within the Moray Firth SAC have shown inter-annual variability over the last two decades; however, the number of dolphins using the SAC between 1990 and 2013 appears to be stable. As there are only three years of additional data since the last assessment, we aim to update estimates of overall population size and assess any changes in the proportion of the population using the SAC for the full site condition monitoring report due in 2018.

Passive acoustic monitoring shows that there is some inter-annual and seasonal variation in the amount of time spent at sample sites within the SAC, however, dolphins were present on most days between May and September at two long-term monitoring sites. These data also suggest dolphins may use certain areas of the SAC outside the summer months more than previously thought.

As a result of the interim nature of this report we recommend that no change is made to the condition status.

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ANNEX 1: EXAMPLE RAW DATA TABLES

This Appendix contains five tables of the raw data used in this project to produce estimates of the number of dolphins using the Moray Firth SAC. Full tables are provided in electronic format. Only the first few rows of each table are displayed to illustrate the format of each file. In all cases, “-99” is an identifier for no data.

- 1. Surveys** – containing basic information on the date and timing of surveys, with a unique “trip number” that links these data to those from any encounters with groups of dolphins during that survey.

TRIP_NO	DATE	TIMESTART	TIMEEND	NO. OF ENCOUNTERS	NO. OF PICTURES	NO. OF Q3 PICTURES
1416	03-May-11	08:40	13:26	2	1019	193
1417	25-May-11	07:28	12:34	5	585	98
1418	03-Jun-11	09:25	14:22	7	481	138
1420	08-Jun-11	09:43	13:20	2	211	34
1422	15-Jun-11	07:25	14:16	5	768	240
1423	20-Jun-11	10:12	16:36	12	655	138
1425	24-Jun-11	10:18	17:29	6	636	144
1427	01-Jul-11	08:40	16:35	8	842	234
1428	04-Jul-11	07:16	14:45	6	477	80
1430	08-Jul-11	09:18	16:10	0	0	0
1431	13-Jul-11	07:18	14:45	5	294	69
1433	18-Jul-11	12:12	16:06	3	492	70
1434	21-Jul-11	09:20	17:52	7	691	152
1436	27-Jul-11	08:10	17:27	3	291	80
1437	03-Aug-11	09:35	16:24	7	814	159

- 2. Encounters** – containing information on the location of the start of the encounter, estimates of group size, and a unique “encounter number” that links these data with any photographs and sightings of individually recognisable dolphins.

TRIP_NO	ENCOUNTER #	GROUP SIZE	START_LAT	START_LONG	YEAR
1416	2741	22	57.6889	-4.0084	2011
1416	2742	22	57.58901	-4.08163	2011
1417	2743	2	57.69446	-3.96895	2011
1417	2744	18	57.70102	-3.94621	2011
1417	2745	3	57.65468	-4.00325	2011
1417	2746	12	57.63303	-4.03821	2011
1417	2747	5	57.7254	-3.91638	2011
1418	2748	15	57.70593	-3.94402	2011
1418	2749	4	57.67381	-3.93832	2011
1418	2750	1	57.66982	-3.96749	2011
1418	2751	5	57.68276	-3.98379	2011
1418	2752	15	57.69287	-3.97581	2011
1418	2753	1	57.69113	-3.98466	2011
1418	2754	13	57.67498	-3.99195	2011
1420	2755	15	57.59134	-4.09813	2011

3. **Pictures** – containing information on all Grade 3 pictures and the confirmed ID numbers of any dolphins in that picture.

ENCOUNTER	FRAME	SIDE	Conf_ID
2741	AU11-1416-005	R	815
2741	AU11-1416-019	L	815
2741	AU11-1416-023	R	1110
2741	AU11-1416-024	R	1110
2741	AU11-1416-036	R	969
2741	AU11-1416-038	R	969
2741	AU11-1416-039	R	969
2741	AU11-1416-041	R	969
2741	AU11-1416-042	L	856
2741	AU11-1416-046	L	64
2741	AU11-1416-051	L	64
2741	AU11-1416-066	L	993
2741	AU11-1416-068	L	64
2741	AU11-1416-072	L	1086
2741	AU11-1416-098	L	969

4. **Inflation factor** – containing the number of well-marked and unmarked dolphins photographed on each trip, and the resulting estimate of θ .

Year	Trip	L_Marked	L_total	θ	R_Marked	R_total	θ
2011	1416	17	25	0.680	15	22	0.682
2011	1417	14	27	0.519	11	23	0.478
2011	1418	15	25	0.600	14	25	0.560
2011	1420	8	15	0.533	4	7	0.571
2011	1422	7	14	0.500	19	35	0.543
2011	1423	20	31	0.645	20	31	0.645
2011	1425	11	21	0.524	14	30	0.467
2011	1427	23	34	0.676	23	36	0.639
2011	1428	8	15	0.533	12	21	0.571
2011	1431	7	12	0.583	10	17	0.588
2011	1433	7	16	0.438	4	12	0.333
2011	1434	16	28	0.571	15	26	0.577
2011	1436	10	20	0.500	17	30	0.567
2011	1437	9	17	0.529	13	27	0.481
2011	1438	16	32	0.500	15	34	0.441

5. **Mark-recapture matrices** – containing the input matrices for programme CAPTURE that were used to provide estimates of abundance in each of the three reporting years. Each row represents one well-marked dolphin (with the ID number in the first column). Subsequent columns represent each survey in the year, with a 0 or 1 representing whether or not there was a confirmed sighting from a grade 3 picture for that individual, e.g. section from 2013

```
0001 0000000000100010000000
0011 0000000010000000010000
0023 0010110011011010011000
0030 1111011001000000000001
0031 0000001001001101010000
0049 0000000011100000000000
0079 0110011010010100001001
0105 1000011001000011001000
0129 0000000001010000000000
0430 0000000010000000010000
0435 0000000011000000000000
0573 0010000011011110011010
0578 1000010011000111101000
0580 1010000011000010011000
0744 0110001000001000001001
```

ANNEX 2: SITE ATTRIBUTE TABLE

Site	Reporting Category	Interest Feature	Interest level	Attribute	Target	Prescription	Result of Monitoring
Moray Firth	1 Mammals	1.1 Bottlenose dolphin (<i>Tursiops truncatus</i>)	SAC	1.1.1 Number of individual dolphins using the SAC	1.1.1 A stable or increasing number of dolphins using the SAC.	Apply photo-identification and mark-recapture extrapolation techniques to annual observations.	Between 1990 and 2013, annual estimates of the number of dolphins using the SAC ranged between 43 and 134. Although there is inter-annual variability in the number of dolphins using the SAC in these years there is no evidence of any linear trend.
				1.1.2 Frequency of occurrence of dolphins within the SAC	1.1.2 Maintain or increase the level of use of the SAC.	Determine the probability of occurrence of dolphin groups at sample sites within the SAC.	<p>Visual and passive acoustic monitoring data indicate that dolphins occur at sample sites within the SAC on most days between May to September.</p> <p>Despite inter-annual and seasonal variation, the data show broadly similar patterns of use by dolphins at sample sites over the reporting period, with relatively higher use of the Sutors and Chanonry sample sites compared with the stretch of coast at Lossiemouth.</p>
				1.1.3 Dolphin population trends	1.1.3 Maintain a stable or increasing bottlenose dolphin population.	<p>Evaluate trends in population size by updating Bayesian capture-recapture modelling using all available data.</p> <p>Evaluate other anecdotal data sources which may suggest changes in birth or mortality rates within the population.</p>	<p>In light of the limited amount of data collected since the last assessment we believe a further assessment of the total size of the east coast population should be attempted in the next reporting cycle.</p> <p>No unusual observations in terms of the number of calves born or frequency of strandings within the population have been recorded.</p>

ANNEX 3: PHOTO-IDENTIFICATION CATALOGUE

Example page of the electronic version of the photo-identification catalogue of all well-marked dolphins recorded in the SAC during the reporting period.

SINGERS

1



LEFT

1
5



RIGHT

1
5

SIMILAR DOLPHINS: none.

YEAR	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05	06	07	08	09	10	
SIGHTINGS																						
YEAR	2011	12	13	14	15																	
SIGHTINGS																						

ANNEX 4: GIS PROJECT

The GIS Project “snh 2013.mxd” contains GPS derived tracks of all surveys conducted by the University of Aberdeen as well as locations of all encounters with bottlenose dolphins during these surveys in the SAC between May and September in 2011, 2012 and 2013. The project should run from the CD if used on any PC running ArcMap, as long as the CD drive is designated as the E: drive.

Each survey track is provided as a .dbf and shapefile labelled with trip number and the date of the trip is included in the attribute table. Encounters are grouped by year and provided as an excel spreadsheet and shapefile for each year and in the attribute table there is information on each individual encounter. This information includes the encounter number, latitude and longitude of the start of each encounter, date, trip number and the number of dolphins in the encounter.

The ArcMap Project includes a map of Great Britain with the UKSACs. There are three layers, each containing all the individual survey trip trails conducted in 2011, 2012 and 2013 (e.g. 2013_Trips). There are also three other layers, each containing all the bottlenose dolphin encounters in 2011, 2012 and 2013 (e.g. 2013_Encounters). The survey tracks from each trip are found separately in the layers for each year (e.g. 1488_trail is a trip trail from 2013 within the 2013 layer).

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Policy and Advice Directorate, Great Glen House,
Leachkin Road, Inverness IV3 8NW
T: 01463 725000

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