Photo-identification Analysis of White-beaked Dolphins off South west and North east England 2007-2014

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Project details

This report was commissioned by Natural England to get an understanding of the distribution of white-beaked dolphins *Lagenorhynchus albirostris* in English inshore waters. The work was undertaken by Marinelife under contract by Natural England, using data previously collected from photo identification projects, where surveys have been undertaken between the years 2007 – 2014.

The analysis utilises several years of photo-identification studies collated by Marinelife, from both=their on-going targeted photo-identification and other survey work; photo-identification images collected by participating volunteers; and also compares against other white-beaked dolphin catalogues around the UK and other parts of Europe. The analysis seeks to better understand the fidelity of individual dolphins to specific parts of the south west and north east of English inshore waters; to estimate relative abundance of populations utilising the inshore waters; and establish ranges and distributions within the relevant regions.

Acknowledgements

Marinelife would like to thank everyone who submitted images for the catalogue, and acknowledge financial support from Natural England that assisted in the collection of data and production of the catalogue. Some of the Marinelife survey effort in the south west, which contributed to this work was part funded by the EU (INTERREG IV A) under the Channel Integrated Approach for Marine Resource Management (CHARM) Phase 3 Project.

1 Summary

In a recent reanalysis of SCANS II data (Hammond et al. 2013) the estimated population size of white-beaked dolphins *Lagenorhynchus albirostris* for the whole of the Celtic and Greater North Sea to be 15,895 (CV=0.29 95% CI = 9,107- 27,743), and more specifically in the UK EEZ to be 11,694 (CV=0.30; 95%CI = 6,578 – 20,790). A single management unit (IAMMWG 2015) across the UK is considered appropriate to represent the full range of the species, but it is also accepted that this species usually occurs on the continental shelf (i.e. in waters <200m depth) (Reid et al 2003). For conservation purposes, there is still a need to identify critical habitats such as feeding, breeding and nursery areas, and areas where animals are known to persistently occur and this project aimed to investigate persistent use of white-beaked dolphins in two areas in the UK; first across the south west of England (with most sightings in Lyme Bay) at the southern periphery of the species range, and the north east coast of England with most sightings in the Farnes Deeps and Northumberland coast.

South west England

From ~150 small boat surveys off south west England, photo-id images were obtained on 27 dates between August 2007 and December 2014, with 33 white-beaked dolphin groups totalling ~271 individual animals. The final Marinelife catalogue for Lyme Bay, south west England covering the period August 2007 – January 2015 comprised 142 sightings of 62 identifiable animals.

50% of animals were re-sighted on one or more occasions, with two individuals sighted on seven occasions. 32% of animals were sighted in multiple years, with three animals sighted in four different years. New individuals were regularly encountered (exponential increase) from 2008 to 2012, though from 2013 very few new individuals were encountered. The core centre of distribution of photo-id animals is in the deeper waters of western-central Lyme Bay, which covers areas both within Devon and adjacent offshore waters beyond the 12nm limit. Across the sample years, this work provides an estimate of population size of adults and well grown juveniles of white beaked dolphins in the Western Channel in two ways:(1) a (crude) estimate of ~80 individuals based on marking rates (fin and body damage); and (2) a maximum estimate of 131 individuals (range 99-211, 95% CL), using the Chapman modification of the Lincoln-Peterson method. No matches were found between animals in south west England catalogue and those for the relatively large catalogue for Iceland, and smaller Northumberland (this study), Dogger Bank and Scotland catalogues.

North east England

Photo-id images were obtained on 18 dates (surveys) between September 2010 and October 2014, from 20 white-beaked dolphin groups totalling 390 individual animals. The final Marinelife catalogue for north east England covers the period August 2007 – January 2015 comprised 86 sightings of 77 animals.

11% of animals were re-sighted on one or more occasions, with the maximum being three occasions. Six of the eight re-sightings were in different years. No animals were seen in more than two different years, with the maximum period between captures being across three different years. The number of new animals being added to the catalogue is continually increasing at a steady rate. Sightings were concentrated in the deeper waters of the Farne Deeps and inshore waters between Whitley Bay and Amble. Offshore UK waters recorded the highest number of individuals (73% of all animals sighted), though the highest number of re-sighted animals were recorded in Northumberland waters. A crude minimum estimate of population size of adults/well grown juveniles was ~150 but there were insufficient recaptures to make an absolute abundance estimate for white-beaked dolphins using this area. No matches were found between animals in this catalogue and those for Iceland, south west England, the Dogger Bank and Scotland.

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2 Introduction

The white-beaked dolphin is a widespread species in cooler shelf waters off eastern England, but is considered rare in the English Channel (Reid et al 2003). A population estimate of 7,856 white-beaked dolphins was made in July 1994 for the North Sea and English Channel (Hammond et al 1995) with a further estimate in the same area of 10,562 individuals in 2005 reported in SCANS II (Hammond et at. 2008). In January 2015, JNCC published a report developed by the Inter Agency Marine Mammal Working Group (IAMMWG. 2015)[1], to define Management Units for the cetacean species which frequent UK waters. A single management unit across the UK EEZ has been considered appropriate for the single population of white beaked dolphins, whose range extends into wider European waters, but is expected to remain mainly within waters <200m (Reid et al 2003).

In a more recent reanalysis of SCANS II (al, et al. 2013) the estimated population abundance was considered for the whole of the Celtic and Greater North Sea and assessed to be 15,895 (CV=0.29 95% CI = 9,107- 27,743), and more specifically in the UK EEZ to be 11,694 (CV=0.30; 95%CI = 6,578 – 20,790) with the majority of animals being in the northern part of the unit. These areas are not necessary directly comparable to previous assessments, but the species is considered vulnerable to climate change and there is evidence for a contraction in range northwards in UK waters due to warming sea temperatures (MacLeod et al 2005).

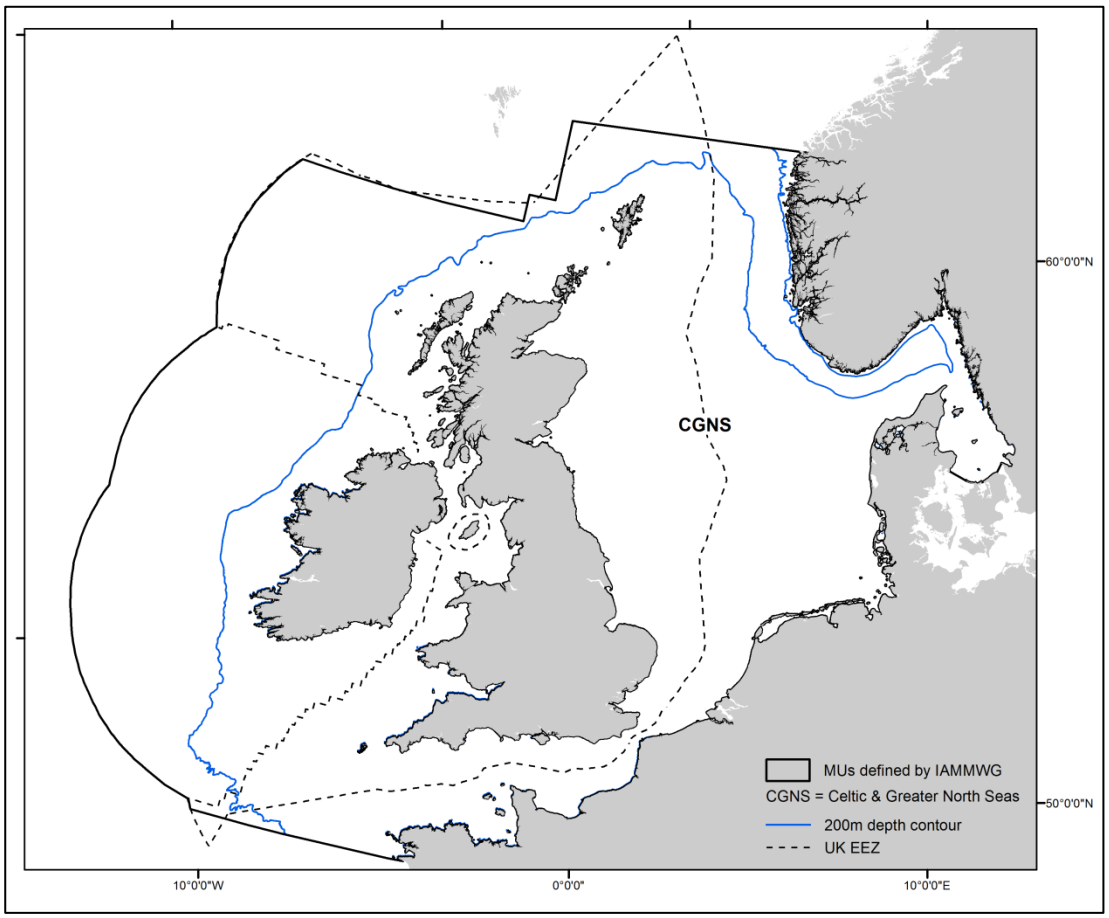

Figure 1 IAMMWG Management Unit for white beaked dolphin

[1] Management Units for cetaceans in UK waters http://jncc.defra.gov.uk/pdf/Report_547_webv2.pdf

The large extent of areas used by individual white-beaked dolphins is a large area but there is a need to identify critical habitats such as feeding, breeding and nursery areas, and areas where animals are known to persistently occur.

1.1 National Policy Relevance

Biodiversity 2020 [2] is the English part of the UK's post-2010 Biodiversity Framework, which replaced the Biodiversity Action Plan (BAP) process. There are various outcomes from B2020, one of which concerns species, with an ambition to halt species decline and prevent further human induced extinctions. The focus species in B2020 come from the Section 41 list from the 2006 NERC Act, and this list includes the white-beaked dolphin.

The programme led by Natural England provides a vision and a number of actions to achieve by 2020 to prevent further degradation to wildlife. Those specific to the white-beaked dolphin include: (1) conduct research into the effects of anthropogenic noise; (2) Instigate a cetacean monitoring programme sensitive to changes in distribution, population size, migration and productivity / recruitment; (3) Identify any sites of particular importance, which this report helps to inform; and (4) conduct research into effects of nature tourism and wildlife watching to determine best practice, to manage activity and avoid harassment, disturbance and risk of collision.

In addition, all cetaceans are listed under Annex IV of the Habitats Directive, for which Articles 12 and 16 of the Habitats Directive, aim to establish a system of strict protection for species found across the UK territory within and outside of SAC designation. The overall aim for these species is to ensure the maintenance or restoration of "favourable conservation Status", which is considered through the Article 17 condition reporting process to the EU.

The EU guidance[3] (EU 2007) on the strict protection of species summarises a species will be considered favourable when:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitats and;
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future and;
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long- term basis.

Although the majority of white-beaked dolphins are known to be located north of the English border in Scottish waters, this project provides useful context for understanding any changes in the distribution of the species, particularly in Lyme Bay, at the most southern limit in the known range of the species for the UK management unit (IAMMWG 2015).

1.2 Partnership Working

Since 2009, Marinelife has worked in partnership with Natural England and a range of other organisations to further knowledge of the ecology and status of white-beaked and other dolphin species in English waters to inform conservation efforts. Specific projects with Natural England include (i) Winter surveys and status report review of a newly found white-beaked dolphin population in Lyme Bay (B. T. Brereton et al. 2009); (ii) Establishment of the North East Cetacean Project (NECP), winter surveys, collation and analysis of historical of sightings data and status report for north east England focussed on Northumberland and the Farne Deeps (Brereton el al.

[2] https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services

[3] http://ec.europa.eu/environment/nature/conservation/species/guidance/pdf/guidance_en.pdf

2010); (iii) Further winter surveys, collation and analysis of recent NECP data and updated status report for the Farne Deeps and surrounding Northumberland waters (Brereton el al 2013); and (iv) Photo-identification study of bottlenose dolphins off south west England.

Over the period, Marinelife has undertaken photo-identification on white-beaked dolphin in both Lyme Bay and the North East of England, through an extensive programme of dedicated surveys with experienced voluntary and paid surveyors, and continued collation of data from public sources. In 2014, a partnership project was established with Natural England to catalogue and analyse this information, with the aim of generating new data to inform on the population size, group structures, fidelity and mobility of white-beaked dolphins off the coasts of Northumberland in north east England and in Lyme Bay in off south west England.

Specific objectives of the project were:

1. Process all remaining Marinelife images & collate available data from others;
2. Update catalogues of white-beaked dolphin individuals for SW & NE England;
3. Create excel databases of captures and recaptures for individuals and groups for both regions;
4. Obtain and look for matches with other catalogues, including those from western and eastern Scotland and Iceland and;
5. Produce a short report describing for each region: catalogues, minimum population size (based on recaptures), mobility, site fidelity with distribution maps showing captures and recaptures, and areas of high site fidelity. Also to complete a comparative analysis of regional populations.

3 Methods

2.1 Data sources

Four main photo-identification sources were collated:

Lyme Bay, South-west England

1) Photos taken on Marinelife effort-related small boat surveys in the western English Channel 2007- 2014 (B. T. Brereton et al. 2012)(n=123 photo-id sightings).
2) Photos collated from a variety of observers at sea, through Marinelife's casual sightings scheme in south west waters 2007-2014 (Brereton et al . 2009)(n=18 sightings).

Northumberland, North-east England North east England

1) Photos taken on NECP/Northern Experience Wildlife Tours pelagics, 2009-present (n=86 sightings)
2) Photos collated from a variety of observers at sea, through Marinelife's NECP project, 2009-present (n=2 sightings)

2.2 Cataloguing images

Each image was linked to a database containing the survey date, photographer, time and position of the sighting and group size. Images of recaptures were graded with a quality rating based on the focus, angle, and size of the fin within the image (Würsig 1990); (Zaeschmar et al . 2014). Only image captures of high quality were used to catalogue new individuals. Recognisable individuals were identified according to whether they exhibited permanent (e.g., nicks, notches, damaged fins, or diagnostic fin shape) or temporary (e.g. depigmentation, skin lesions, scars, scratches, tooth rakes) features on their dorsal fins and bodies.

To identify individuals from photographs, a previously adopted classification (Tscherter *unpublished*, Bertulli *unpublished*) was utilised, and adapted to provide a greater level of detail for further analyses of the population:

For Level 1 (**primary categories**) a description of animal photo-id features, and the presence of any of the following distinguishable photo-ID features were recorded for each individual captured:
1) Dorsal edge marks, e.g. nicks and indentations;
2) Dorsal fin scratches/rake marks;
3) Dorsal fin skin marks;
4) Distinct dorsal fin shape;
5) Body scratches/rake marks;
6) Body skin marks; and
7) Distinctive body saddle pattern.

A "-1" was entered for features 5-7 if the body of the animal was not visible to assess. The zone of the distinct markings, the area or areas on the body of the animal where the features were present, were recorded, comprising L1, L2, L3, L4, R1, R2, R3 and R4 (Figure 2).

For individuals with dorsal fin photo-ID features, a second level of classification was completed to describe the dorsal marks present. Level 2 (**secondary categories**) (finer-scale detail) dorsal mark descriptors comprised one or more of the following; Leading edge, Trailing edge, Tip, Base, Middle, Single nick, Multiple nicks (2 or more).

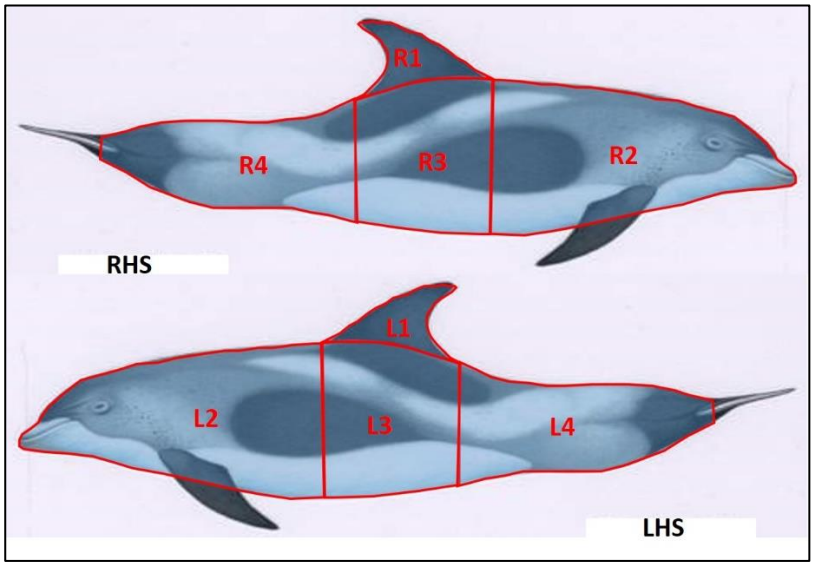

Figure 2: Position of zones of distinct markings. RHS = Right-hand side, LHS = Left-hand side.

Each animal was then graded for its degree of marking/distinctiveness. Grade categories comprised; Very distinctive, Distinctive, Slightly distinctive, or Not distinctive, for both the dorsal fin and body. This categorisation is subjective to a degree; consequently three independent researchers assessed each image in each catalogue. Where there was disagreement (<10% of the time), the majority selection was used, and where necessary an expert judgement was made by the lead author for consistency.

Best right and left side images of individuals were compiled into a catalogue that included notes on mark type and similar animals, table of the months and regional locations of photographic captures, map of captures, number of sightings and associations with other animals.

Separate catalogues were compiled for north east and south west England.

2.3 Site and regional fidelity

The site fidelity patterns of individually identified dolphins were determined based on (A) their re-sighting rate and presence across seasons (following (Moller et al . 2002), both within and between regions of the western English Channel and north east England; and (B) the level of association between individual animals (mixing of individuals between groups). Two types of association were identified, primary association where individuals were seen directly with other animals and secondary association where individuals were seen with other animals in the group, where primary animals were present.

The regions of survey for the south west project included parts of four English counties out to the 12 nautical mile limit: south Cornwall, south Devon, Dorset and Northumberland; and surrounding offshore UK waters (beyond 12nm).

2.4 Mapping sightings

Capture events of individual dolphins (sightings and re-sightings) were plotted in a geographic information system (GIS) created in ARC Map 9.3.1. (See Figure 7 below for map of successful photo id captures).

2.5 Population size

Two approaches were considered to assess population size. For method 1, a crude estimate for population size for each region was made based on the number of individuals identified, correcting for both the average number of animals in groups that were not identifiable (marking rate) and the average number of identifiable animals likely missed in each group (number not photographed divided by the marking rate).

For south west England, as there were sufficient re-sightings data, method 2 was also utilised to estimate absolute abundance using the Chapman modification of the Lincoln-Petersen mark-recapture model (Chapman 1951), a more sophisticated and widely used approach (e.g. (Currey R.J.C. 2007) (Balmer et al. 2008)). In the model the number of animals that are captured (photographed), marked, and released is represented by n_1. On a second capture event, the total number of animals captured is given by n_2, and the number of previously-marked animals is represented by m_2.

$$N_c = \left[\frac{(n_1 + 1)(n_2 + 1)}{(m_2 + 1)} \right] - 1$$

(where **Nc** is really "**Nc-hat**", the estimated population size versus the true size)

The variance of the Chapman-modified estimate of population size is:

$$\text{var}(N_c) = \frac{(n_1 + 1)(n_2 + 1)(n_1 - m_2)(n_2 - m_2)}{(m_2 + 1)^2 (m_2 + 2)}$$

The variance can be used to approximate a 95% confidence interval for the population estimate using the following equation:

$$N_c \pm 1.965 \sqrt{\text{var}(N_c)}$$

Because of the low levels of sampling effort within seasons, data was pooled across years to construct two time periods and to derive an estimate of abundance for all years combined. These were 2007-2010 (n=37 individuals sighted) and 2011-2014 (n=38). We considered survey work conducted 2007-2010 as the first four-year capture period, and the survey work 2011-2014 as the second four-year capture period.

The abundance estimate and confidence intervals were corrected by the mark rate.

Note that the model makes a number of assumptions:

1) The population is sampled only twice. Once, initially to mark a subset and again later to count the number of recaptures.
2) The population must be closed during the sampling period.
3) Each individual in the population has an equal probability of being captured.
4) The mark used to identify the individual does not harm the animal or reduce the likelihood of its being captured again in the second session.

2.6 Matches with other catalogues

Both the MARINElife South West (n= 62 individuals captured in between 2007-2014) and North East Cetacean Project (NECP) (n= 77 individuals captured between 2010-2014) photo-identification catalogues were compared for any matches in the individuals captured. Photo-identification catalogues were obtained from the following sources:

- Faxaflói Bay, Iceland (n= 440 individuals captured between 2002-2013 per Chiara Bertulli, University of Iceland);
- Skjalfandi Bay, Iceland (n= 303 individuals captured between 2002-2013 per Chiara Bertulli, University of Iceland),
- Scotland (n= 6 individuals captured between 2001-2003 per Caroline Weir);
- Dogger Bank, North Sea (n=6 animals captured in 2011 NECP Dogger Bank photo-identification catalogue using images provided by Anna Cucknell – IFAW/ Marine Conservation Research)

It should be noted that all of the catalogues only represent a small % of the estimated numbers in the populations which could be present in their associated regions.

4 Results

3.1 South West England

3.1.1. Photo-identification catalogue

From ~150 small boat surveys off south west England, photo-id images were obtained on 27 dates between August 2007 and December 2014, with 33 white-beaked dolphin groups totalling ~271 individual animals. The final Marinelife catalogue for Lyme Bay, south west England covering the period August 2007 – January 2015 comprised 142 sightings of 62 identifiable animals.

See Figure 5 below for the distribution of photo id captures, and Figure 7 for the effort corrected relative abundance over the survey area.

3.1.2 Photo-identification characteristics of white-beaked dolphins

Analysis of white-beaked dolphin group data (Table 2), indicated that on average 76% of individuals encountered were photographed. Of those photographed, on average, 80% were identifiable from photos. Minimum and maximum values showed that both these rates varied considerably between groups.

Table 1: Photo-identification data collated from white-beaked dolphin groups in Lyme Bay (n=33)

	Avg.	SD	Min.	Max.
No. animals per group	8	5	2	20
No. individuals photographed per group	6	3	1	14
% no. individuals photographed per group	76	28	9	100
No. individuals photographed without recognisable fins or body marks per group*	1	1	0	6
% no. individuals photographed without recognisable fins or body marks per group*	26	30	0	100
No. individuals photographed with recognisable fin damage and/or body markings per group*	4	3	1	11
% no. indiv. photographed with recognisable fin damage and/or body markings per group*	80	24	25	100
No. recognisable fins per group*	4	3	0	10
% no. recognisable fins per group*	66	32	0	100
No. individuals photographed with very distinctive dorsal fins per group	1	1	0	4

* Not accounting for the marking rate

Analysis of individual photo-identification sightings data showed that around 62% of white-beaked dolphin individuals have visible nicks on dorsal fins, whilst 80% have distinctive body markings that are visible from 'above water' photography, with ~60% of these located around the dorsal fin area (Table 3). Just over a third of animals photographed had multiple nicks in dorsal fins, whilst nicks were most frequently encountered (present in 63% of animals) along the trailing edge. 85% of animals with distinctive/very distinctive dorsal fins were re-sighted.

Table 2: Photo-identification characteristics of individual White-beaked Dolphins off South west England (n=62)

	Capture		**Recaptures**		
	No.	**% of all individuals**	**No.**	**% of all with feature**	**% of all individuals**
Dorsal fin					
No. with nicks	39	62	25	64	40
Leading Edge	20	32	10	50	16
Trailing Edge	39	63	25	64	40
Tip	26	42	14	54	23
Base	14	23	10	71	16
Middle	10	16	5	50	8
Single Nick	16	26	9	56	15
Multiple Nicks (2 or more)	22	35	16	73	26
Very Distinctive Dorsal Fin	9	15	6	67	10
Distinctive Dorsal Fin	11	18	11	100	18
Slightly Distinctive Dorsal Fin	29	47	10	34	16
Not Distinctive Dorsal Fin	13	21	4	31	6
Body					
Very Distinctive Body	5	9	4	80	7
Distinctive Body	26	47	15	58	25
Slightly Distinctive Body	23	42	11	48	18
Body marks visible near dorsal	34	62	20	59	33
Not Distinctive Body	1	2	0		
No. without dorsal nicks	11	18	3	27	5
Missing data	7	13	1	14	2

3.1.3 Sightings and re-sightings rates

50% of animals (n=31) were re-sighted on one or more occasions (Figure 3), with two individuals sighted on seven occasions. 32% of animals were sighted in multiple years, with three animals sighted in four different years.

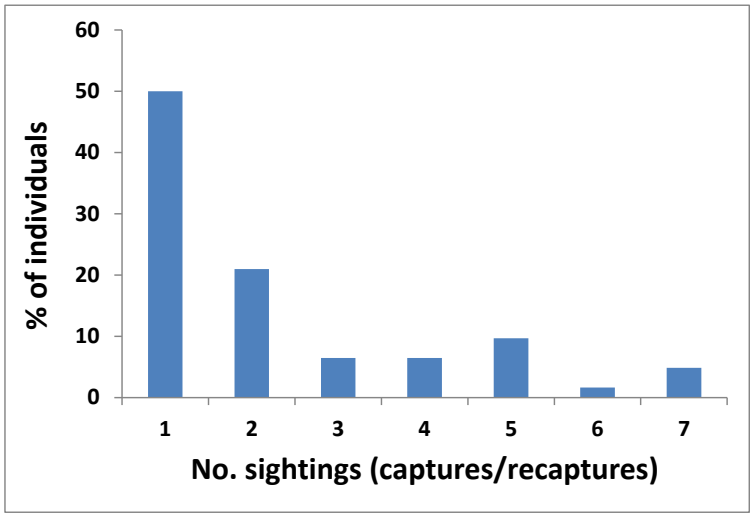

Figure 3: Bar chart showing the range of capture recaptures off south west England with 50% of individuals encountered more than once between 2007 and 2014

New individuals were regularly encountered (exponential increase) from 2008 to 2012, though since 2013 very few new individuals have been encountered (Figure 4).

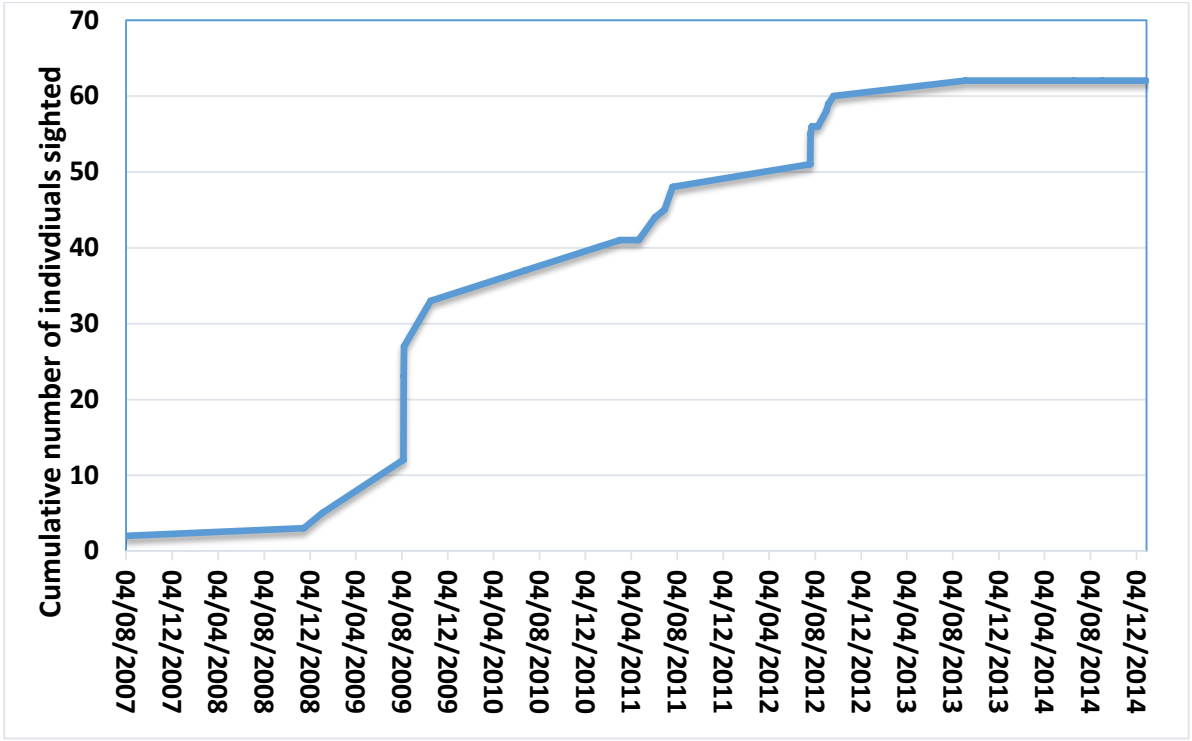

Figure 4: Discovery curve of identified white-beaked dolphins off south-west England 2007-2014

3.1.4 Temporal distribution of catalogue sightings

Recording effort was uneven between years, reflected in the temporal distribution of sightings (Table 4). Photo-identification sightings were made in ten different months across all years, though 90% of captures and recaptures were made between May and October (Table 5).

Table 3: Variation in number of photo-identification sightings off south west England between years.

	No. groups	No. individuals	No photo sightings
2007	1	2	2
2008	1	1	1
2009	10	31	46
2010	1	7	7
2011	5	14	20
2012	11	27	54
2013	1	4	4
2014	3	7	8

Table 4: Number of captures and recaptures by month (pooled across all years) for south west England.

	Jan.	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec.
No. individuals	2	5	1	13	27	25	20	13	1	4
No. sightings	2	5	1	14	42	33	25	15	1	4

3.1.5 Distribution of sightings

Figure 5 shows that the core centre of distribution of photo-id animals is in the deeper waters of western-central Lyme Bay, which covers areas both within Devon and adjacent waters beyond the 12nm limit (offshore UK waters). Very few sightings were made in adjacent Cornish and Dorset waters. For the wider context of sightings and effort see Figure 7 which demonstrates the effort corrected relevant abundance from all the surveys in the region.

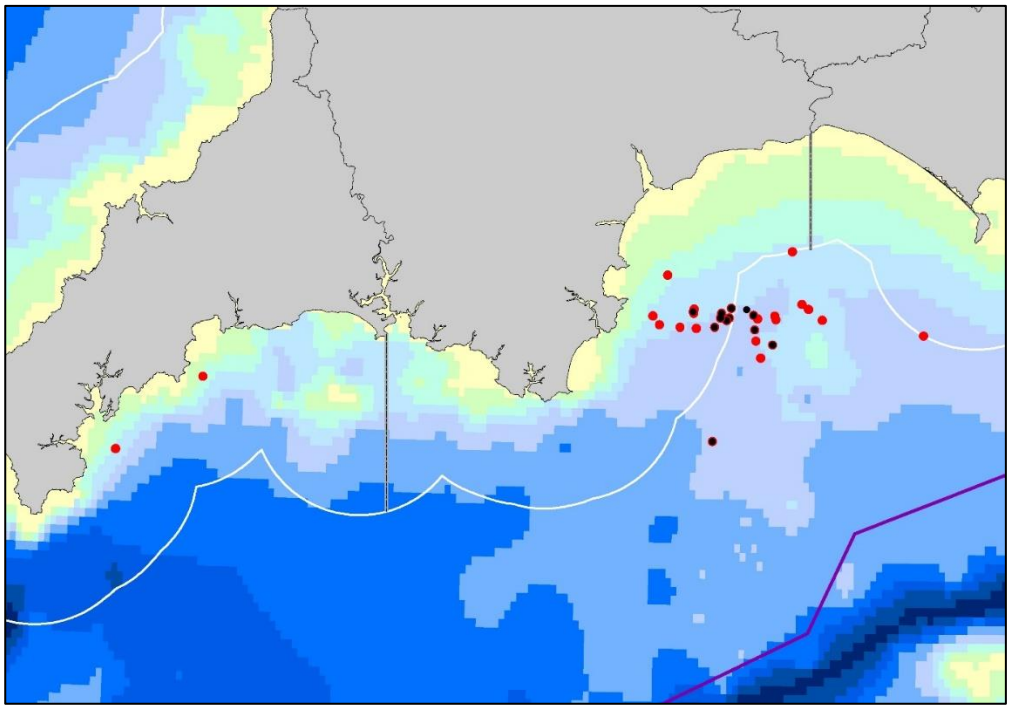

Figure 5: Location map of photo-id animals.

A map of additional effort corrected sightings is provided in Figure 7 below. Red circles represent re-sighted animals; smaller black circles represent animals sighted once only. The white line represents the 12 nautical mile limit and for Cornwall, Devon and Dorset the boundary of south west waters. The purple line represents the southern limit of UK territorial waters in the Channel and is the limit of offshore UK waters.

Devon waters recorded the highest number of individuals (82% of all animals sighted), though the highest number of re-sighted animals were recorded in Lyme Bay in adjacent waters beyond the 12nm mile limit (offshore). There was considerable inter-change of individuals between the inshore and offshore waters within Lyme Bay, but these areas jointly represent the deeper regions of Lyme Bay, the distinction between inshore and offshore is administrative, rather than a physical difference and the whole area is roughly between 40 and 50m deep. (Table 5).

Table 5: Number of individual animals sighted and re-sighted by SW England region

		No. individuals re-sighted				
	No. individuals	All regions	Cornwall	Devon	Dorset	Offshore UK (SW)
Cornwall	5	5	0	5	1	5
Devon (mainly inshore Lyme Bay)	51	26	5	14	2	26
Dorset	2	2	0	2	0	2
Offshore (mainly offshore Lyme Bay) UK	37	26	5	26	2	28
All areas	62	31				

3.1.6 Population size

This work provides a crude estimate of population size of adults/well grown juveniles of white beaked dolphins in the Western Channel at approximately ~80 using method 1, whilst the Chapman modification of the Lincoln-Peterson method gave an estimate of 131 adult/well grown juvenile individuals (range 99-211, 95% CL).

3.1.7 Population structure and behaviour

Calves were recorded in at least 17% of groups, with feeding behaviour recorded in 50% of groups.

3.1.8 Associations

Animals mixed readily with each other in groups of different sizes. This is best illustrated with reference to WBD_001 which was recorded in both the first (August 2007) and last (December 2014) groups with catalogued animals. WBD_001 was recorded with every single animal sighted in the catalogue (bar one, i.e. with 98% of all animals) either directly with others (in the same group), or with animals that were subsequently seen in other groups with other animals. Group sizes with which this animal was recorded in ranged from three to twenty (Figure 6 below).

3.1.9 Matches with other catalogues

No matches were found between animals in South West England catalogue and those for the relatively large catalogue for Iceland, and smaller Northumberland (this study), Dogger Bank and Scotland catalogues although there were several similar looking animals, as might be expected when an increasing number of animal are catalogued.

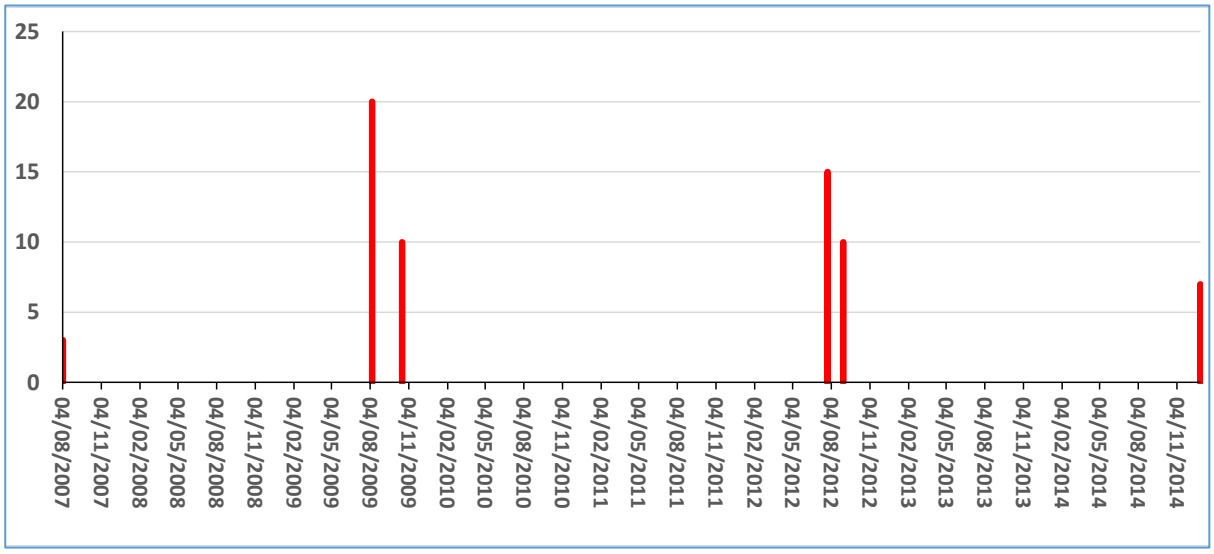

Figure 6: Group size (y axis) in which animal WBD_001 was recorded in, within six groups off south west England from 2007-2014.

3.1.10 Data representativity

The distribution of white-beaked dolphin photo sightings closely matches that from Marinelife effort related surveys collated through the Charm III project covering 1995-2012 (Brereton T.M 2012), with almost all sightings in central/western Lyme Bay despite widespread coverage over other parts of the English Channel (Figure 7). Casual sightings collated by Marinelife through Charm III (Brereton T.M 2012) show that animals range more widely, though again the main distribution was centred on Lyme Bay. Mean group size determined from effort related surveys through Charm III (Brereton T.M 2012) was eight animals, which is the same as that obtained in this study for groups with photographed animals. Maximum group size was 20 from effort related surveys and there was one report of a group of 200 from casual sightings (observer Colin Speedie) in the Charm III study, compared with 20 in this study.

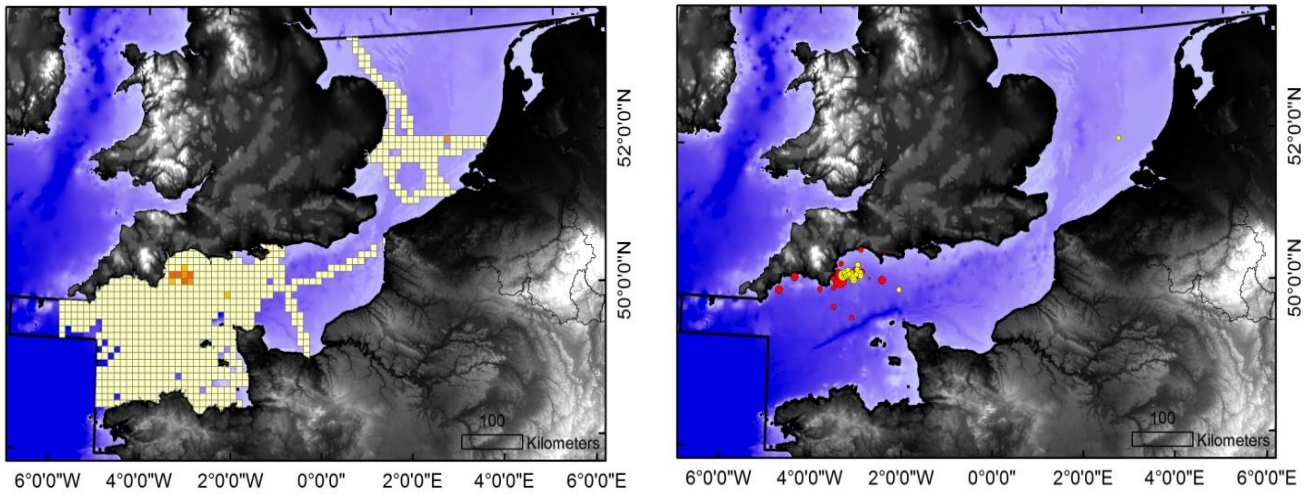

Figure 7: Effort corrected relative abundance at 10 km^2 scale (left side plot) and mapped sightings (right side plot) of white-beaked dolphin in the English Channel.

Data from Marinelife surveys and public sightings schemes, including all non-photographed animals (taken from Brereton et al. 2012). Relative abundance categories in squares are: none seen (white cells), <0.01 counted per km (light orange), 0.01-0.049 per km (orange), 0.05-0.49 (dark orange), 0.5-0.99 per km (light red), >1/km (red). Cetacean sightings categories: 1 (smallest circle), 2 - 9, 10 - 49, 50 - 99, 100 - 999, >1000 (largest circle). Yellow circles are sightings from MARINElife surveys, red circles are casual sightings submitted to MARINElife.

3.2 North east England

3.2.1 Photo-identification catalogue

Photo-id images were obtained on 18 dates (surveys) between September 2010 and October 2014, from 20 white-beaked dolphin groups totalling 390 individual animals. The final Marinelife catalogue for north east England covers the period August 2007 – January 2015 comprised 86 sightings of 77 animals.

3.2.2 Photo-identification characteristics of White-beaked Dolphins

Analysis of white-beaked dolphin group data (Table 6), indicated that on average 51% of individuals encountered were photographed. Of those photographed, on average, 80% were identifiable from photos. Minimum and maximum values showed that rates varied considerably between groups.

Table 6: Photo-identification data collected from White-beaked Dolphin groups (n=20) off north east England

	Avg.	SD	Min.	Max.
No. animals per group	20	26	3	100
No. individuals photographed per group	5	3	1	16
% no. individuals photographed per group	51	35	10	100
No. individuals photographed without recognisable fins or body marks per group*	1	1	0	3
% no. individuals photographed without recognisable fins or body marks per group*	14	22	0	75
No. individuals photographed with recognisable fin damage and/or body markings per group*	4	3	1	15
% no. indiv. photographed with recognisable fin damage and/or body markings per group*	86	22	25	100
No. recognisable fins per group*	4	3	1	14
% no. recognisable fins per group*	80	21	25	100
No. individuals photographed with very distinctive dorsal fin per group	2	2	0	9

* Not accounting for the marking rate

Analysis of individual photo-identification sightings data showed that around 87% of white-beaked dolphins individuals have visible nicks on dorsal fins, whilst 80% have distinctive marks visible from 'above water' photography, with ~60% of these around the dorsal fin area (Table 7). Body marks were obtained from 48% of individuals photographed.

Table 7: Photo-identification characteristics of individual white-beaked dolphins (n=77) off north east England

			Recaptures		
	No.	**% of all individuals**	**No.**	**% of all with feature**	**% of all individuals**
Dorsal fin					
No. with nicks	68	88	7	88	9
Leading Edge	10	13	2	25	3
Trailing Edge	62	81	7	88	9
Tip	32	42	5	63	6
Base	1	1	0	0	0
Middle	1	1	1	13	1
Single Nick	17	22	2	25	3

Multiple Nicks (2 or more)	50	65	6	75	8
Very Distinctive Dorsal Fin	33	43	3	38	4
Distinctive Dorsal Fin	25	32	4	50	5
Slightly Distinctive Dorsal Fin	15	19	0	0	0
Not Distinctive Dorsal Fin	6	8	1	13	1
Body					
Very Distinctive Body	4	11	1	17	22
Distinctive Body	18	47	4	67	89
Slightly Distinctive Body	13	34	1	17	22
Body marks visible near dorsal	13	38	0	0	0
Not Distinctive Body	3	8	0	0	0
No. without dorsal nicks	8	21	1	17	22
Missing data	39	51	2	25	33

3.2.3 Sightings and re-sightings rates

11% of animals (n=8) were re-sighted on one or more occasions (Figure 8), with the maximum being three occasions. Six of the eight re-sightings were in different years. No animals were seen in more than two different years, with the maximum period between captures being across three different years.

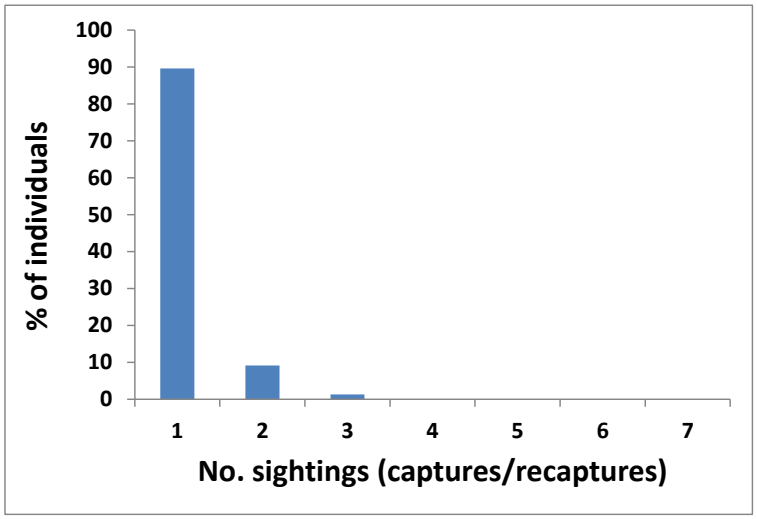

Figure 8: Bar chart showing the range of capture recaptures for north east England.

The number of new animals being added to the catalogue is increasing at a steady rate (Figure 9).

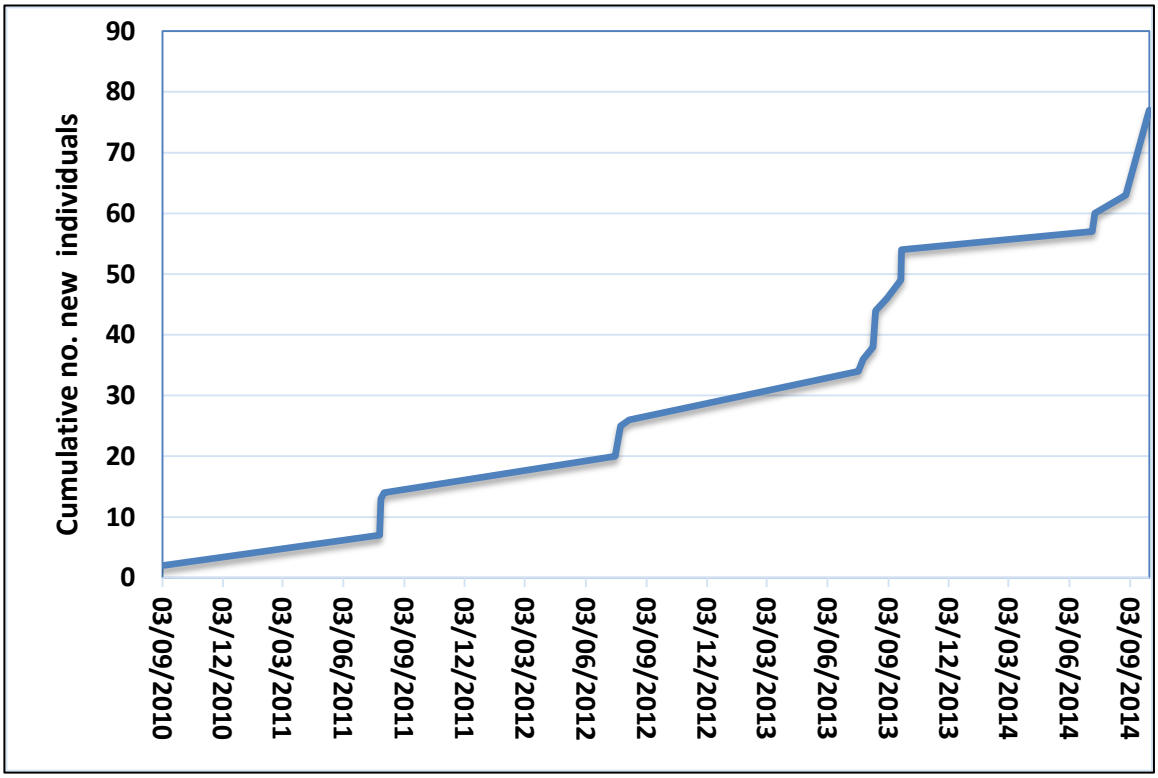

Figure 9: Discovery curve of identified white-beaked dolphins off the north east England 2010-2014

3.2.4 Temporal distribution of catalogue sightings

Recording effort was uneven between years, with a peak in sightings rates in 2013 (Table 8).

Table 8: Variation in number of photo-identification sightings off north east England between years.

	No. groups	No. individuals	No photo sightings
2010	1	2	2
2011	3	12	14
2012	3	13	15
2013	9	32	32
2014	4	25	26

Photo-identification sightings were restricted to the period July to October (Table 9).

Table 9: Number of captures and re-captures by month (pooled across all years) off north east England

	Jan.	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec.
No. individuals					38	19	11	15		
No. sightings					40	20	11	15		

3.2.5 Distribution of sightings

Figure 10 shows that sightings were concentrated in the deeper waters of the Farne Deeps and inshore waters between Whitley Bay and Amble. No sightings were made in Tyneside waters.

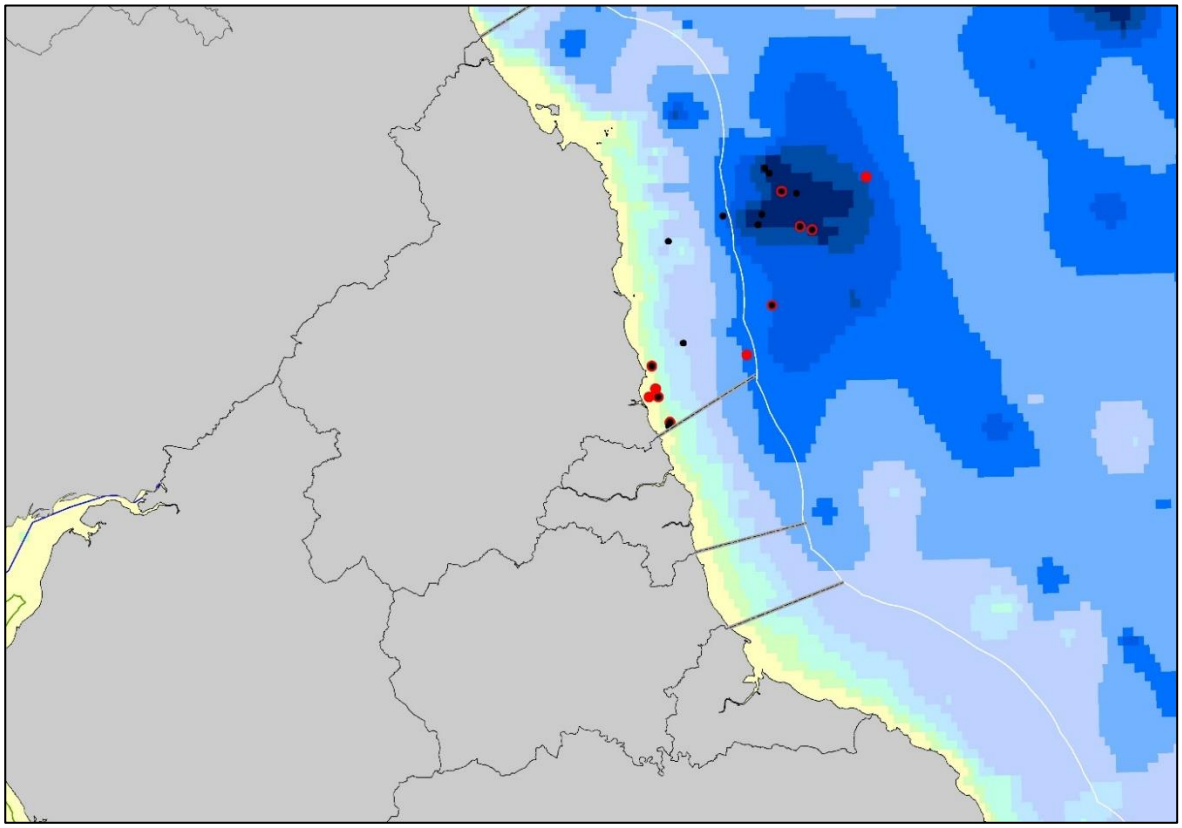

Figure 10: Location map of photo-id animals only. Red circles represent re-sighted animals, smaller black circles represent animals sighted once only. The white line represents the 12 nautical mile limit.

Offshore UK waters recorded the highest number of individuals (73% of all animals sighted), though the highest number of re-sighted animals were recorded in Northumberland waters (Table 10).

Table 10: Number of individual animals sighted and re-sighted off NE England.

		No. individuals re-sighted		
	No. individuals	All areas	Northumberland	Offshore UK
Northumberland	36	6	3	4
Offshore UK	45	5	4	1
All areas	77	8		

3.2.6 Population size

A crude minimum estimate of population size of adults/well grown juveniles was ~150 using method 1. There were insufficient recaptures to estimate abundance with method 2.

3.2.7 Population structure and behaviour

Calves were recorded in 15% of groups, with feeding behaviour recorded in 45% of groups.

3.2.8 Associations

Re-sighted animals were associated with an average of eight other photographed animals (range 5-16). Each animal re-sighted, was subsequently recorded in a different group size to the previous encounter, highlighting the considerable degree of mixing of animals between groups.

3.2.9 Matches with other catalogues

No matches were found between animals in this catalogue and those for Iceland, south west England, the Dogger Bank and Scotland.

3.2.10 Data representativity

The distribution of white-beaked dolphin groups with photo sightings reflects the species distribution determined through a more wide-ranging dataset of casual and effort related sightings obtained through the North East Cetacean Project (Brereton el al. 2010) (Brereton el al 2013); with relative high densities of sightings in coastal waters of southern Northumberland and the Farne Deeps (Figure 11).

Mean group size of white-beaked dolphins from all NECP surveys was 13 animals, compared with nine found for groups with photographed animals in this study. Maximum group size was 250 from NECP, compared with 100 in this study.

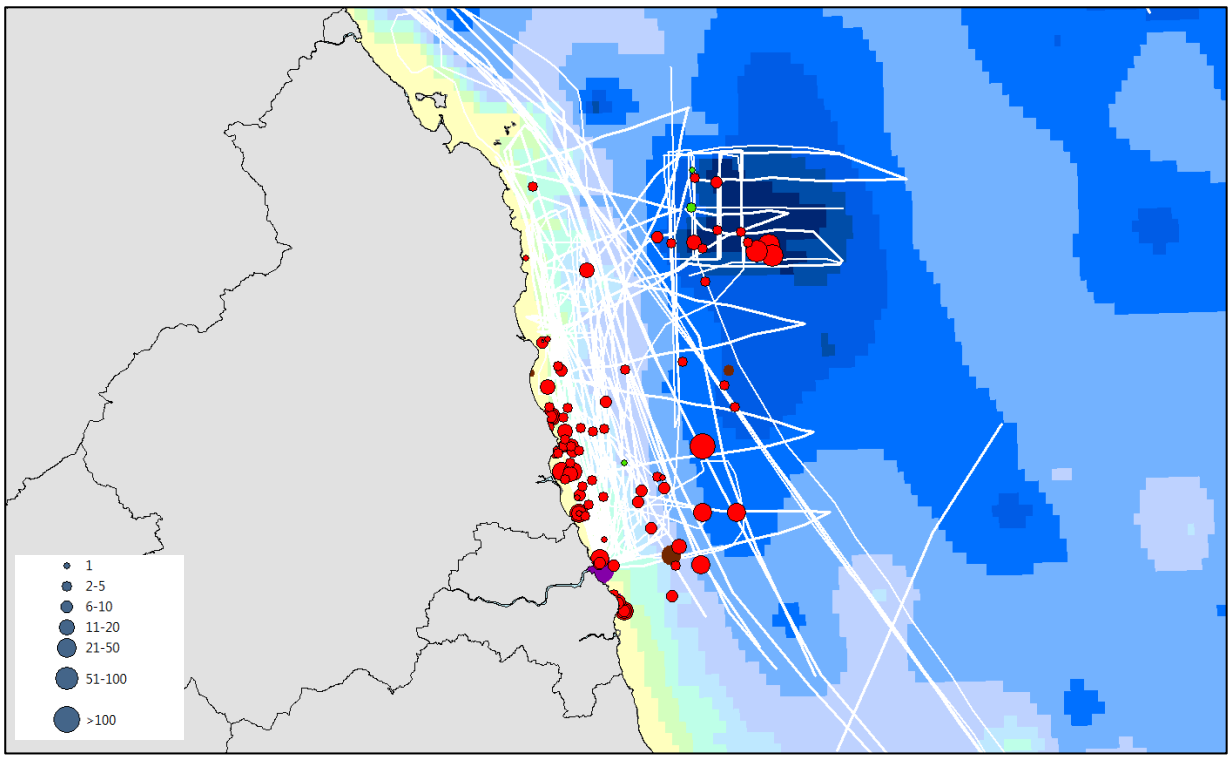

Figure 11: Seasonal distribution of white-beaked dolphins scaled to abundance off the Northumberland coast from casual and effort related sightings collated through the NECP 2010-2013.

White lines represent effort tracklines. Colour coding for seasonal sightings: Spring (green); Summer (red); Autumn (brown); Winter (black).

5 Discussion

4.1 Re-sightability of white-beaked dolphins from photo-identification

Our studies confirmed that white-beaked dolphins are not as readily identifiable as bottlenose dolphins through degree of damage to dorsal fins. However, we found that with good photographs a high proportion of animals were found to have distinctive dorsal fin damage and/or body markings to enable re-identification, supporting the merits of the approach used in this study. For example, 62% of individual photographed in south west England waters had visible nicks on dorsal fins, whilst the figure was 87% for animals off Northumberland.

4.2 Distribution, population size and population structure off south west England

Off south west England, photographed individuals were chiefly observed in a restricted area of central/western Lyme Bay. More wide-ranging Marinelife surveys have confirmed this area as a hotspot (B. T. Brereton et al. 2012) (See Figure 7) between years 2007 - 2014. Both the high recapture rates (50% of individuals) and the high degree of interchange of individuals between groups (e.g. WBD_LB_001 being associated directly or indirectly with 98% of animals identified) within Lyme Bay and the absence of matches with animals catalogued from other parts of England, Scotland and Iceland, all indicate that the population Lyme Bay shows a high degree of site fidelity.

Whilst Hammond (Hammond et al. 2013) report on no sightings of white beaked dolphins throughout the English Channel (SCANS II Block B), this was a broad scale assessment of the national population, whilst this work focuses more intensely on the site fidelity of specific areas. The likely most accurate method (method 2), gave an estimated total population size of ~130 adult/well grown juvenile individuals (range 99-211, 95% CL) over the period 2007-2014. The addition of calves would bring the estimate to around 140 animals. This would represent approximately 1% of the estimated number of animals occurring in the North Sea and English Channel from SCANS II (Hammond et al ., 2008).

Note however that the Chapman method may be biased high, as it assumes no recruitment or mortality from the population, over the eight year study period. The estimate is therefore for the whole period, rather than any one year.

No new animals have been identified since 2013 though there have continued to be re-sightings, suggesting a substantial proportion of the population using the area has already been discovered. Just under a fifth of groups contained calves and the high proportion of encounters of feeding animals (observed in 50% of groups), suggest the area is an important breeding, feeding and calving/nursery area, whilst sightings from this and wider Marinelife studies indicate year-round presence.

Published distribution data (Reid et al 2003) indicates that the population of white-beaked dolphins in Lyme Bay are separated from the nearest known main areas of distribution (central/northern North Sea). However, animals are occasionally / frequently seen in the eastern Channel and very occasionally in the Irish and Celtic Seas data (Marinelife pers comms, and Wildlife and Wetlands Trust consulting (WWT Consulting 2009)). It is not known whether these form the wider limits of the Lyme Bay population, as possibly suggested by the few recaptures of individuals from the Lyme Bay population in west Cornish waters.

4.3 Distribution, population size and population structure off north east England

Off Northumberland, white-beaked dolphin photo sightings were chiefly obtained in coastal waters off central southern Northumberland and in the Farne Deeps. Recapture rates were low (11%), and there was no evidence of a slowdown in the rate of new animals being identified. These data indicate that the areas of the North Sea sampled in this study form part of the range of a much larger population with an open structure; the limits of which have not yet been determined. This conclusion is not surprising, given that SCANS II surveys have detected a large and extensive population in the North Sea and that the area of suitable habitat is both continuous and extensive.

Given that almost 80 animals have already been identified, from 20 encounters chiefly over a three year period, it seems likely that many more individuals are likely to be identified with the current level of annual survey effort planned.

The presence of calves in 15% of groups and feeding behaviour in 45% demonstrate that the sampled waters form important habitat for the species, and a number of observations during other NECP surveys/pelagics have identified locations with very small calves present in groups (M. Kitching, *pers obs.)*

The number of animals identified would indicate that Northumberland and adjacent offshore UK waters, especially the Farne Deeps, provide feeding and nursery habitat for a significant and nationally important proportion (> 150 animals; >1% of the total) of the North Sea population.

4.4 Conservation implications

The findings of this report add to those already published to highlight that Lyme Bay supports a discrete population of white-beaked dolphin, with nationally important numbers higher than detected in broad scale national assessments. The lack of interchange between the Lyme Bay and NE suggests they are more sedentary, and less mobile, than in other areas of the UK, but more work is required to better understand the movements between Lyme Bay, the rest of the channel, and the Celtic and Irish Seas. It is also clear the area is important for feeding and calving.

Within the areas targeted for Marinelife survey work, areas off Northumberland (within the Coquet to St Mary's MCZ and adjacent to the Farnes East rMCZ) are persistently being highlighted as areas with higher numbers of White beaked dolphins than the surrounding areas.

4.5 Future research work

Further survey work would be useful in Lyme Bay and surrounding waters to get a more accurate estimate of the continuing population size and to build on understanding of the population structure and how it evolves year to year Marine life survey data indicate that ~15 day surveys per annum (assuming an 80% detection rate of groups per trip and mean of six individuals photographed per survey, thus yielding 72 capture events), would be sufficient to enable annual abundance to be monitored.

Nationally important numbers also utilise Northumberland and adjacent waters, and as above it would be useful to continue to survey the areas to gain more information on population size, site fidelity, and to better define the use of this "hotspot" area that supports returning animals. It would also be useful to assess whether the frequency of occurrence of groups with small calves is higher in these inshore areas than offshore.

A programme of targeted photo-identification surveys during the key occurrence period for white-beaked dolphin off Northumberland (July-September) is recommended to gather data allowing

refinement of the current population estimate, and to assess site fidelity further. Additionally, expansion of the North East Cetacean Project survey area would be also be useful to ensure that a wider area is being considered in relation to “hot spot” area in the NE to coastal waters south of the River Tyne, and off the coast of Yorkshire, should be undertaken to further define the wider geographic range of the population of white-beaked dolphin utilising key feeding/calving/nursery areas off Northumberland. A key component of this expansion should be surveys of the Dogger Bank during the winter months; some limited photo-identification data has been catalogued by Marinelife, so this is an area that requires more detailed study.

4.6 Comparison with other catalogues

As discussed within the Management Unit report (IAMMWG 2015), evidence suggests a distinction between individuals in Iceland and the UK. No matches were found between animals in south west England or the north east catalogue and those for Iceland, which has a significant number of animals within the catalogue. Some interchange was considered more likely between animals within the UK; however there were no matches between animals in the south west England catalogue and those of Northumberland (this study), Dogger Bank or Scotland. Although, there were several similar looking animals which might be expected when an increasing number of animal are catalogued.

Further survey is required to assess the degree of connectivity between regions. No matches were found between catalogues from other regions, though limited time was spent on this activity and also there are limited numbers of animals captured in other catalogues. With more than 2500 images to cross-check, it is highly possible matches were overlooked and there is a need for further more detailed investigation, and to continue to do this as all the catalogues grow. Furthermore, given the low proportion of Icelandic and North Sea animals photographed, it is not surprising not to get any recaptures between regions at this stage in the development of all the catalogues.

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