The status of short-beaked common dolphin, *Delphinus delphis*, population in SW Wales

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Abstract

The shorth-beaked common dolphin (*Delphinus delphis*) is one of the most abundant cetaceans in the North-East Atlantic Ocean. The methodology of Photo_identification is one of the established tools for the research of marine mammals. However, there are only six photo-ID studies on the individuals of short beaked common dolphin due to their low mark ratio, gregarious nature, and pelagic distribution. The principal aims of this study was to study the population of common dolphin in the Celtic Deep and to determine the distribution of this species, during the months of June and July 2018. To achieve these aims, a photo-ID catalogue of the individuals sighted was assembled. During the project, 51 individuals of common dolphin were documented in the photo-ID catalogue. Different species were also sight in the study area; however, any interaction was observed between the common dolphin and the other species. In other studies, it has been documented how the individuals of common dolphin can show preference between social groups. For this study, an analysis (HWI) was tested for the six individuals of common dolphin that were recognised in different sightings. However, the data sample was not big enough to find any social group preference between the individuals. It has been observed how the distribution of *D.delphis* can be influence by different environmental factors. In this project, a Geograpical Information System (QGis) was used to investigate the influence of the environmental parameters, such as bathymetry and sea surface temperature (SST) in the distribution of common dolphins. The results showed a significant correlation between depth and the presence or absence of common dolphin and for the SST, the data was not significantly different to carry the analysis. Furthermore, fishing boats and plastic debris were found during the surveys, which suggests that this species is affected by different threats in the study area.

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Declaration

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Candidate: Beatriz Tintore

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Statement 1:

This dissertation is being submitted in partial fulfilment of the requirements for the degree of Master of Marine Biology.

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This dissertation is the result of my own independent work/investigation except where otherwise stared.

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1. Introduction

A major challenge for conservation management of marine mammals is that they are highly mobile and that the abundance and distribution of cetacean populations may change over time. To be able to determine which are the management actions for the conservation of the species, it is necessary to study the spatial and temporal variation in cetacean abundance. For some species, different individuals can be identified by natural markings which helps in the study of the ecology, behaviour, distribution, and abundance of the population (Würsig & Jefferson, 1990; Urian et al., 2015). Photographs increase the capacity for the researcher to use natural marks to identify individual cetaceans.

In this study, photographic identification from the population of short-beaked common dolphins *Delphinus delphis* were analysed in the geographical area of the Celtic Deep, located in the southern Irish Sea between Ireland and Pembrokeshire, SW Wales.

For the identification of individuals of short-beaked common dolphins, researchers have used pigmentation patterns and long term natural markings on the dorsal fins (King et al., 2013).

1.1. Photo- identification

Photo-ID was developed to obtain quantitative population parameters such as abundance and survival rates (Urian et al., 2015). However, this method is less commonly applied to gregarious species that aggregate in large and dispersed groups which may thus result in imprecise estimates (Hupman et al., 2018). Photographs increase the capacity for the researcher to use natural marks to identify individual cetaceans. There are different features used to identify the individual depending on the species: notch patterns in fluke edges, nicks and notches in the edges of dorsal (Figure 1.1), the shape of dorsal ridges, pigmentation patterns, or callosity patterns and scars (Neumann et al., 2002; Figure 1.2).

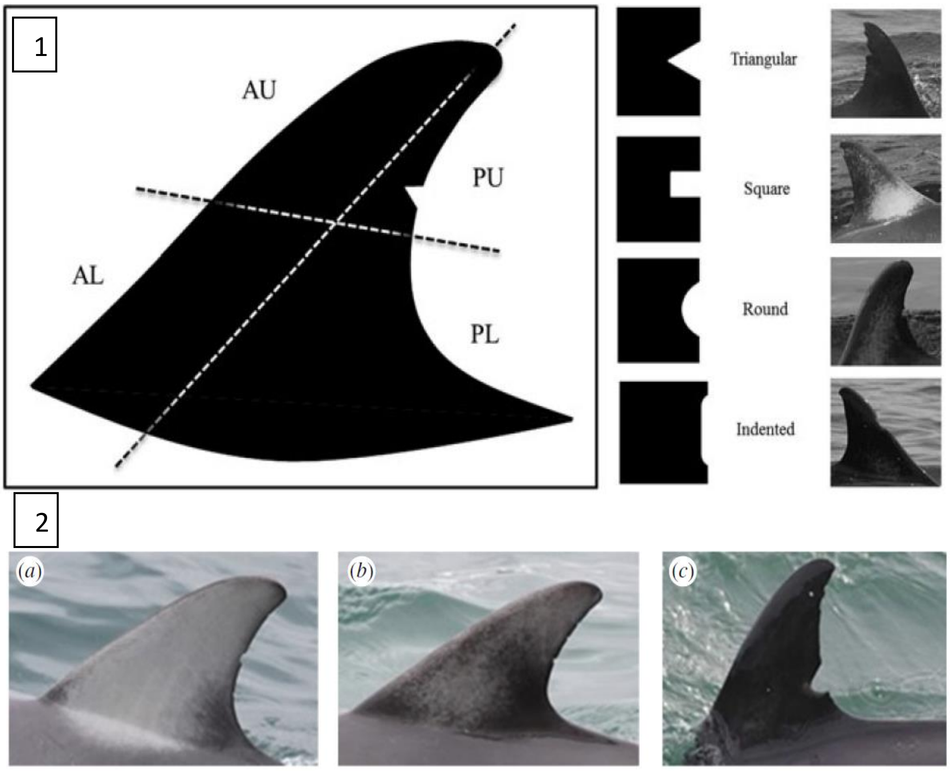


Figure 1.1. Layout system to identify the position (Anterior upper (AU), anterior lower (AL) and posterior upper (PU) and lower (PL)) and shapes of dorsal edges marks in the common dolphin (Bamford & Robinson, 2016). **Figure 1.2**. Example of differences in the dorsal fin of three different individuals of common dolphin (*D. delphis*). (a) Pale common dolphin dorsal fin; (b) Intermediate coloration; and (c) almost black common dolphin dorsal fin (Mason et al., 2016).

However, not all marked animals have the same probability of being identified which can result from different factors: the difficulty in detecting significant features due to photographic quality, variability in their distinctiveness, as not all animals have the same level of distinctiveness in their features, and variation in the behaviour of the individuals which may also affect detectability (Hupman et al., 2018).

Also, studies of the social structure of delphinids struggle with the high mobility of these animals, and for most of the delphinids, the lack of features to identify age and sex (Wells et al., 1987).

Pelagic species, like the short-beaked common dolphin, can be difficult to identify as they are poorly marked and are found in oceanic environments. Most of the studies published for this species relate to abundance estimates, in which the methodology involves counts from line transect surveys rather than the identification of individuals (Hupman et al., 2018).

This technique has been widely applied to most populations of species such as bottlenose dolphin because of their relatively high mark ratio, manageable population size, and inshore accessibility. In contrast, there are only six photo-ID studies on the individuals of short beaked common dolphin (Hupman, 2016). The limited number of photo-ID studies for this species is due to their low mark ratio, gregarious nature, and pelagic distribution.

1.2.The short-beaked common dolphin

The short-beaked common dolphin is a species of the genus *Delphinus*, and is a small cetacean generally found in temperate to tropical seas (Murphy et al., 2006). Until recently, it was unclear how many species belonged to the genus *Delphinus* since as many as 30 species have been proposed (Westgate, 2007). However, current evidence supports the existence of only two different species, the short-beaked common dolphin (*Delphinus delphis*) and the long-beaked common dolphin (*Delphinus capensis*). The short-beaked common dolphin was first identified in 1738 by Artedi, and described in 1758 (Linnæus, 1758).

1.2.1. Distribution and Abundance

Delphinid distributions are often related to prey availability. In some cases, the locations where dolphins occur are close to dense human populations, posing an increased risk of exposure to anthropogenic threats (Mason, Salgado Kent, Donnelly, Weir, & Bilgmann, 2016).

The common dolphin has a worldwide distribution in both hemispheres in oceanic and shelf-edge waters of tropical, subtropical and temperate seas (Evans et al., 2003).

This species can be found from nearshore waters to thousands of kilometres offshore the Atlantic and Pacific Ocean, and in enclosed seas such as the Okhotsk Sea, the Sea of Japan, the Black Sea and the Mediterranean Sea, where separate subpopulations have been found (Bearzi et al., 2003; Evans & Hinter, 2012; Hammond et al., 2008; Figure 1.3).

In Australian waters, short-beaked common dolphins show site fidelity along the southern Australian coast (Mason et al., 2016). In the Pacific Ocean, the species is widely distributed (Danil & Chivers., 2007).

Common dolphins are widely distributed in the North Atlantic Ocean where it is one of the most abundant species of cetaceans. In the North-east Atlantic, the common dolphin is mostly distributed off the west coasts of Britain and Ireland, in or adjacent to continental shelf waters, with a higher distribution in the Celtic Sea and western approaches to the Channel, as well as off southern and western Ireland (Reid et al., 2003).

In the Mediterranean Sea, the short-beaked common dolphin has faced a significant decrease in abundance and distribution (Bearzi et al., 2003). In the coastal waters of Greece, a local population of this species has suffered a decline of the population from around 150 individuals in 1996 to only around 15 individuals in 2007, thought to be due to a reduction in prey availability from overfishing (Genov et al., 2011).

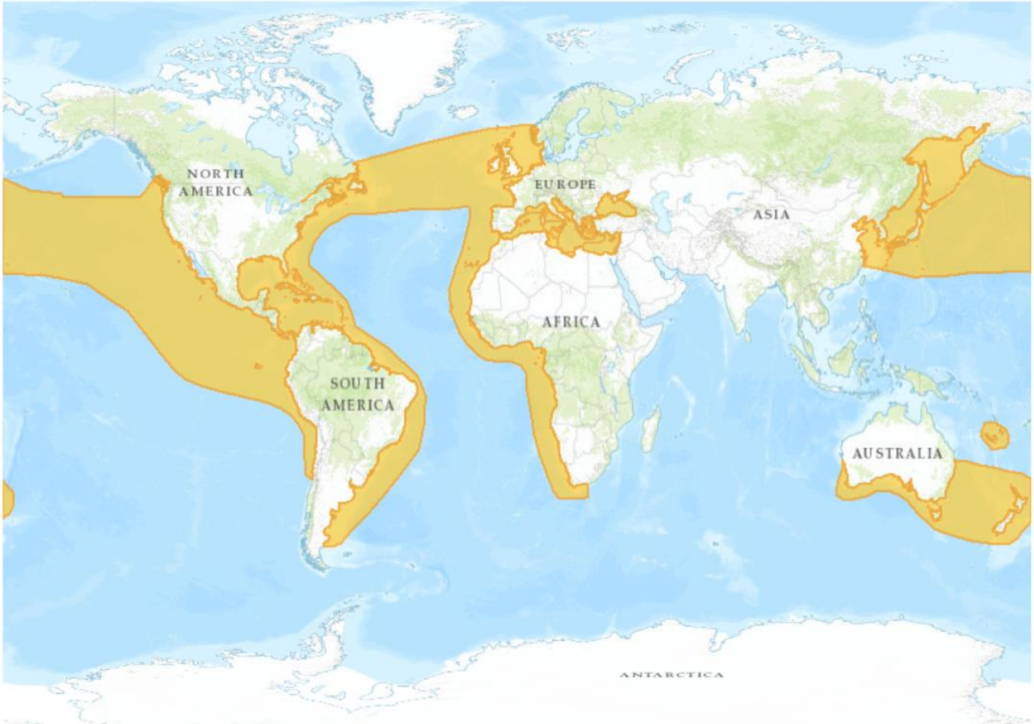


Figure 1.3. Worldwide distribution map of short-beaked common dolphin (*D. delphis*) (Hammond et al., 2008).

The short-beaked common dolphin is abundant in many parts of the world: in the Pacific Ocean, 2,963,000 individuals were estimated for the eastern tropical Pacific with 352.000 individuals on the US west coast (Amaha, 1994).

In the Atlantic Ocean, the estimated mean abundance in European continental shelf waters was 56.221 individuals in 2005, with 273,000 individuals in offshore waters (Cañadas, et al., 2009; Hammond., 2013). The highest densities of this species were in the west of Ireland and in coastal waters of Portugal, Spain and SW France (Hammond., 2013). In 1993, in the west of the Bay of Biscay. 62,000 common dolphins were estimated in the albacore tuna driftnet fishery (Hammond et al., 2008). In the Western Mediterranean Sea, the abundance of common dolphins has been estimated at 19,400 between 2000 and 2004. However, this species has experienced a significant decline of the population in the Mediterranean Sea during the last 30-40 years. The abundance of short-beaked common dolphin is unknown in the Black Sea (Cañadas & Hammond, 2008)

1.2.2. Biology and Ecology

Variation

The coloration of common dolphin varies within different populations across the world. However, the typical coloration pattern of the common dolphin is a shading of black, yellow, grey and white (Figure 3). The dorsal surface of this species at the spinal field has a dark coloration fading out to grey and white in the border patch, and also has a significant brown-yellow underlined with a white line is in the thoracic patch behind the eye (Norris, 2017).

Figure 1.4. Individual of short-beaked common dolphin in SW Wales (Beatriz Tintore).

In the Pacific Ocean, differences were found between the size of the different individuals (Danil & Chivers, 2007) which contrasts with the results found in the study by Murphy et al. (2013), with an apparent latitudinal cline in the NE Atlantic in the size of male of common dolphin. The results tested that, at higher latitudes, common dolphin males are slightly larger in total body length by comparison to individuals from populations off the NW coast of Spain. In the Pacific Ocean, the common dolphin presents differences in size between individuals from the populations of the North

Pacific and the Central Pacific Ocean. Individuals from the Central Pacific are significantly larger in length, both at birth and when adult (Danil & Chivers, 2007).

Life History

The species of common dolphins shows slight sexual dimorphism (Murphy et al., 2006; Murphy, Pinn, & Jepson, 2013). The body length of the common dolphin varies in different regions but has an overall range between 155-233 cm (González et al., 1999). There is a lack of information of the life span of this species. However, the oldest individual of this species documented in the NE Atlantic was a 28-year-old male (Murphy et al., 2005).

The average age of sexual maturity was estimated at 11.9 years in males and ranged from 195 to 233 cm in length and 8 to 28 years in age. Female body lengths ranged from 91 to 239 cm and the maximum estimated age was 30 years (Murphy et al., 2009). In the NE Atlantic this species exhibits reproductive seasonality. A unimodal calving/mating period extends from April to September, with a higher active period in July and August (Murphy et al., 2013).

Behaviour

Common dolphins are found in a wide range of group sizes from the low tens to schools of 5,000 or more (Murphy et al., 2013). This species has a social fluid structure with evidence of segregation in age and sex classes, especially in winter (Möller et al., 2011; Murphy et al., 2013).

Cañadas et al. (2009) reported an average group size of 15 ± 2.2 individuals with a significant increasing trend with depth, from 8.0 ± 1.44 animals in waters less than 400 metres depth to 18.6 ± 2.76 animals in depths exceeding 2,000 metres.

Even though some researchers reported a significant frequency of interactions between species, there are other which documented that the frequency of association is influenced by; predation pressure and prey distribution (Quérouil et al., 2008).

The species of common dolphin has been observed in association with other species of cetaceans and avian species around SW Wales, most frequently associated with the northern gannet (*Morus bassanus*) (Evans, 1982). For example, in the Mediterranean Sea, individuals of common dolphin have been documented in synchronized swimming, and aggressive or playful interactions with other species such as striped dolphins (*Stenella coeruleoalba*) and/or Risso's dolphin (*Grampus griseus*) (Frantzis & Herzing, 2002). In New Zealand, and during feeding activities, the short-beaked common dolphin showed interaction with different species of mysticetes like Bryde's whales (*Balaenoptera edeni*), sei whale (*Balaenoptera borealis*) or minke whales (*Balaenoptera acutorostrata*). This species also showed interaction with species of seabirds such as shearwaters (*Puffinus griseus*), and Australasian gannets (*Morus serratos*) (Neumann & Orams, 2010).

Ecology

The species tends to be present along or seaward of the 200 metres contour although it will also come seasonally onto the continental shelf, being present in waters of 50-100 metres. Its distribution has been correlated with prominent undersea topography (Evans et al., 2003).

The migratory patterns or movements of the common dolphin are not clear, but it is highly mobile and capable of significant dispersal, with examples of hundreds of kilometres travelled in association with the movements of their prey (Gallo-Reynoso, 1991).

Feeding & Diet

The common dolphin feeds mainly on shoals of fish, and its diet varies according to the distribution and abundance of prey individuals (Evans & Hintner, 2012). Species such as anchovies and sardines are often significant components of the diet (Santos et al., 2004; Murphy et al., 2009). There are several feeding strategies described, including high-speed pursuits, and tail slaps, and "kerplunking", which consists of rapid tail movement on the surface. Different strategies are associated with cooperative feeding, which allows the dolphin to exploit shoaling prey with a lower energy consumption. There appears to be a division of labour amongst the group, with some dolphins crowding the fish towards shore, while others patrol offshore in order to keep the fish school from escaping (Möller et al., 2011; Evans & Hinter, 2012). Cooperative feeding strategies include "carouselling", consisting of a wall formation of the group with synchronous diving, and bubble cloud production (Murphy et al., 2013).

The short-beaked common dolphin in the North Atlantic ocean tends to engage in surface chases of pelagic fish, deep pursuits of pelagic fish, or deep pursuits of demersal fish (Evans, 1982).

Conservation Pressures

The short-beaked common dolphin shows a wide distribution in the North-east Atlantic Ocean and is significantly impacted by a wide variety of threats and pressures (Murphy et al., 2013).

In the Celtic Seas and Bay of Biscay/Iberian Peninsula areas, fishery bycatch was the most significant threat to the common dolphin. However, other threats to consider in the area include contaminants, prey reduction, underwater noise and collisions with shipping (Murphy et al., 2018).

In the Atlantic Ocean, PCBs are the main pollutant of concern due to their high bio-accumulative rates in the food web and their resistance to degradation (Murphy et al., 2018).

Another of the main concerns in the Atlantic Ocean is the continued accumulation of debris in the marine environment. Of this marine debris, 60-80% constitute fragments of plastic which will not biodegrade but, instead, will break into small pieces, forming microplastics, fragments of plastics smaller than 5 mm (Barnes et al., 2009). The marine fauna is affected by this plastic when ingested or entangled in which it can cause blockage in the stomach or intestines, or drowning, suffocation or strangulation (Baulch & Perry, 2014).

1.3. North-eastern Atlantic Ocean

Distribution & Abundance

One of the most abundant offshore cetacean species in the North-east Atlantic is the short beaked common dolphin (Reid et al., 2003; Murphy et al., 2013). This species is abundant and widely distributed in deep waters from the north of the Iberian Peninsula to the Faroe Islands (Evans et al., 2003; Reid et al., 2003). Cañadas et al. (2009) suggested that short-beaked common dolphins were most frequently found at depths of 400-1000 m, and in water temperatures above 15ºC, although they noted that SST data were not available in all the waters surveyed.

There is an estimation of a population of around 120.000 short-beaked common dolphins in separate but overlapping areas to the south-west of Britain (Hammond et al., 2013; Macleod et al., 2008).

The distribution of this species on the UK continental shelf may be related to high primary productivity, the waters of the continental shelf being influenced by the deep waters of the Atlantic and the effects of land (Baines & Evans, 2012). The species is common in the western half of the English Channel and the southern Irish Sea, and further north in the Sea of Hebrides and southern part of the Minch. It is also common in the south and west of Ireland but rare in the central and southern North Sea (Evans et al., 2003; Reid et al., 2003; Figure 1.5.) .

In Welsh waters, this species is most abundant in the southern end of the Irish Sea, with a clearly defined area over the Celtic Deep, offshore to the west of Pembrokeshire and around the islands of Skomer, Skokholm, Grassholm, and the Smalls (Baines & Evans, 2012; Figure 1.5.). Common dolphins have been sighted in the area in every month of the year, but sighting rates indicate that the species is most abundant during summer. The proportion of juveniles is highest in the months of July and August, which overlaps with when group sizes are also highest, which suggests a coalition of different post-breeding family groups (Baines & Evans, 2012).

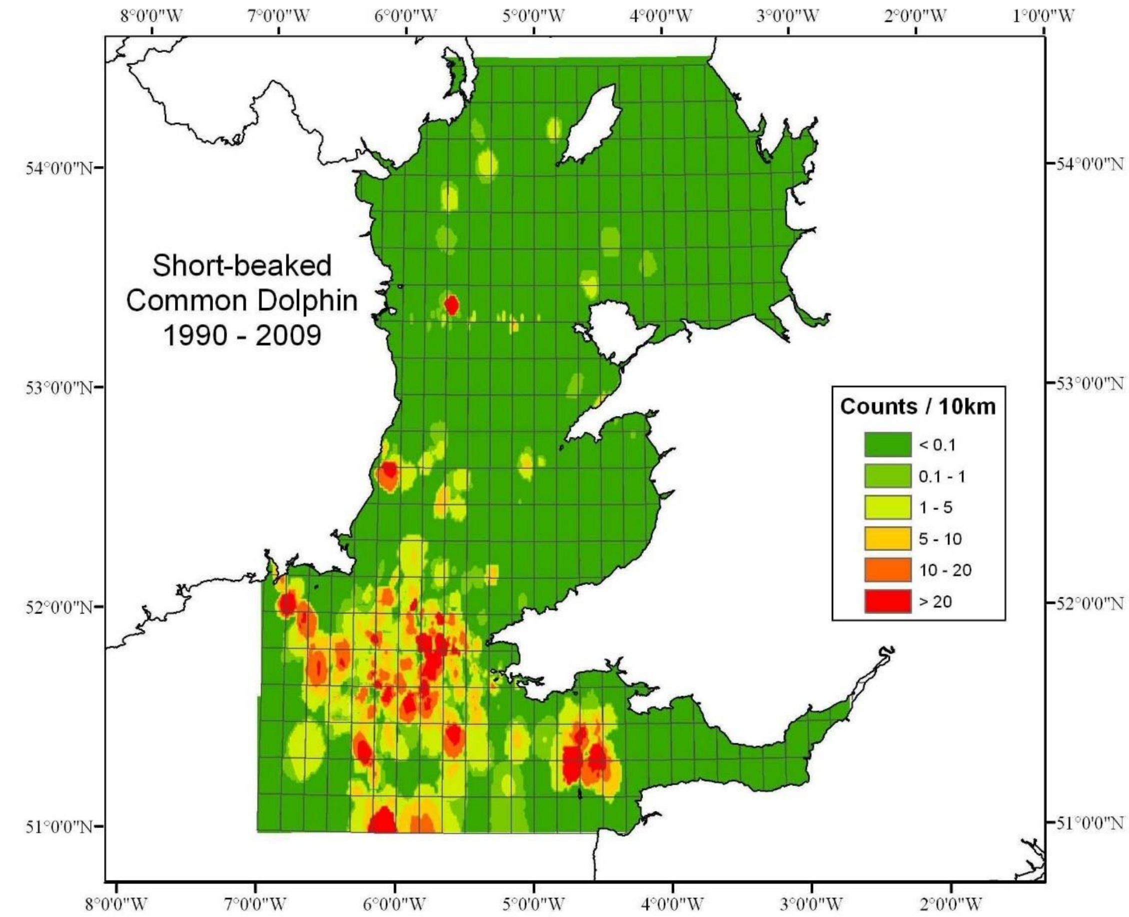


Figure 1.5. Distribution of Short-beaked common dolphin in Northeast Atlantic Ocean (Baines & Evans, 2012)

1.4.Objectives and Hypotheses

The purpose of this project was to study the population of short-beaked common dolphins in the study area of the Celtic Deep. To accomplish this, surveys were undertaken and a photo-ID catalogue of the dorsal fin of the common dolphin was assembled, which allowed to:

- Record, document and report numbers of short-beaked common dolphins in the study area.
- Record all environmental and physical factors (state of the sea (Beaufort scale), depth, time of day, tidal state, and sea surface temperature) for every sighting in order to study the preference of habitat.
- Record all behavioural activities of the common dolphin for each sighting in the study area.

From these objectives, the following hypotheses were developed:

1) The short-beaked common dolphin will show no preference to remain within particular social groups.
2) There is no variation in group size according to activity.
3) A positive relationship will exist between the sightings of common dolphin and sea surface temperature.
4) A positive correlation will occur between the sightings of common dolphin and bathymetry.

2. Study Area

The Celtic Sea extends from the south of Ireland and the St George's Channel across the continental shelf, with the Bristol Channel and the English Channel as its eastern limits (Pingree et al., 1976). This area is affected by the North Atlantic Oscillation (NAO) which plays a significant role in climatic parameters such as the state of wind and temperature among others, which may have an effect on the abundance of plankton in the continental shelf waters of the Celtic Sea (Beaugrand et al., 2002).

The project was conducted out of St. Justinians (51°52'N, 5°18'W), located in the Pembrokeshire Coast National Park in the community of St. Davids on the southwest coast of Wales. The study area was limited to St. Bride's Bay out to the Island of Grassholm (51° 43′ 52″ N 5° 28′ 47″ W) and the Smalls lighthouse, (51° 43′ 16″N 5° 40′ 11″W). The study area also encompassed Ramsey Island (51° 51′ 42″ N 5° 20′ 34″ W) and the Bishops and Clerks Islets (51° 52′ 12″N 5° 23′ 42″ W) (Figure 2.1).

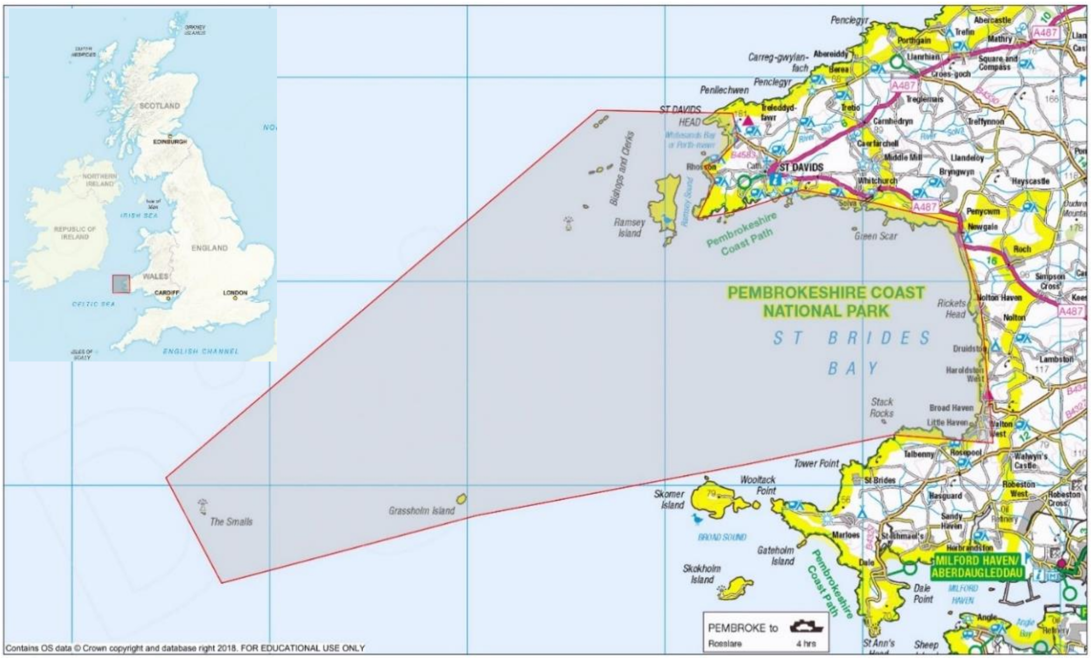


Figure 2.1. Map of the study area located in Pembrokeshire Coast National Park and the St. Brides Bay in SW Wales (Digimap, 2018).

Since 1990, eighteen species of cetaceans have been recorded in Welsh waters, of which five species are regular in the area: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*), common dolphin (*Delphinus delphis*) and minke whale (*Balaenoptera acutorostrata*) (Evans and Baines, 2012). In July 1994, the estimated population of short-beaked common dolphin in the Celtic Deep was 75.449 individuals (Hammond et al., 2008). The other thirteen species which are more rarely recorded include: fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), humpback whale (*Megaptera novaengliae*), northern bottlenose whale *(Hyperoodon ampullatus*), pygmy sperm whale (*Kogia breviceps*), Sowerby's beaked whale (*Mesoplodon bidens*), Cuvier's beaked whale (*Ziphius cavirostris*), long-finned pilot whale (*Globicephala melas*), Blainville's beaked whale (*Mesoplodom densirostris*), killer whale (*Orciuns orca*), white-beaked dolphin (*Lagenorhynchus albirostris*), striped dolphin (*Stenella coeruleoalba*) and Atlantic white-sided dolphin (*Lagenorhynchus acutus*) (Evans and Baines, 2012). Different species of birds have also been recorded in the study area interacting with cetacean species. The northern gannet (*Morus bassanus*) has a significant colony on the Isle of Grassholm, with 36,011 breeding pairs (Falcon Boats). Other species breeding on this and neighbouring islands include Atlantic puffin (*Fratercula arctica*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), and kittiwake (*Rissa tridactyla*).

3. Materials and Methods

3.1. Field Work

Figure 3.1. Falcon Boats boat "Atlantic Storm", 10 m open Humber Quinquari RIB, used for 14 of the surveys conducted during the project (photo by Falcon Boats).

The data used in this study were obtained from a total of 17 surveys conducted during the months of June and July 2018 with the collaboration of two different companies: Falcon Boats and Thousand Island Expeditions. Eleven of these surveys were in the month of June and the other six in July. The number of surveys was limited by the weather conditions and availability of the vessel. The survey area was situated over the Celtic Deep, southwest of Wales and southeast of Ireland (51° 46' 31.134" N, 5° 36' 13.8312" W).

The survey route ran from the pier at Saint Justinians in the Pembrokeshire Coast National Park to the Isle of Grassholm for observation of the colony of gannets, and as far as the Smalls lighthouse. During the transects, different data such as GPS coordinates, state of the sea, swell height, tides, when strong currents, and visibility, were collected every 15 minutes throughout the transect, as well as for every marked change in the environmental conditions, and every sighting.

The data collected during the sightings included start and end time of sighting, species, group size, presence of calves, behaviour, and association with birds. Behavioural observations were recorded according to the prominent behaviour of the whole group, and was categorised as: travelling (fast directed swimming), foraging (rapid movements, changing directions, diving behaviour, fishing), socialising (group staying in one general area, not showing obvious travelling movements or showing different aerial behaviour), and bow-riding (approaching the vessel to ride the bow or stern wave).

3.1.1. Photo-identification

A team of two or three observers and all the passengers that were on the vessel conducted the observations for the sightings. The principal researcher photographed as many individual dolphins as possible within the group. All photos used in this analysis were collected using a Canon EOS 7D (Mark II) and a telephoto zoom lens Tamron 70-300 mm (f/4-5.6). Photographs were taken from either side of the fin of the dolphin, attempting to photograph as much of the body as possible to identify possible distinctive notches on the body (Figure 3.2.). Where possible, photo-ID was continued until all the individuals were photographed. The group size was estimated visually by counting the number of individuals at the surface of the water, and underwater.

Figure 3.2. Example of an individual with a notch on the body and in the dorsal fin, individual 036_18_M_R_180628_011_atlanticstorm_BTI_007_1 (“Pino”) of the catalogue.

3.2. Data analysis

3.2.1. Photo-identification

Each image was first assessed to determine the photographic quality. If the image had sufficient quality to identify patterns or notches, the image was cropped. All the images were analysed and compared with previously identified fins. After analysing all the images, and if one of the fins analysed was new to the catalogue, the picture was renamed with the code for the catalogue;

NNN-YY_L_X_YYMMDD_EEE_boat_NNN_###_S

Where the ID alphanumeric code is:

NNN = progressive number (3 digits) from the first animal sighted.

YY = year (two digits) when the dolphin was first sighted.

L = location of the nick/notch; Top (T), High (H), Medium (M) or Low (L) (Table 1).

X = If the picture is of the left (L) or right (R) side of the animal.

YYMMDD = Year (two digits), month (two digits) and day (two digits) first were the individual was first sighted.

EEE = Encounter number (three digits).

Boat = Name of the vessel

NNN = Name of the photographer in upper case (Beatriz Tintore = BTI).

= Picture consecutive number.

S = consecutive number for the set starting from 1. If there are no sets within the encounters, this will always be 1.

Table 3.1. Example of different individuals of the catalogue with the nick/notches located at the top, high, medium or low position of the fin.

ID individual	Image
041_18_T_L_180628_011_atlanticstorm_BTI_015_1	
008_18_H_L_180606_002_atlanticstorm_BTI_015_1	
034_18_M_R_180628_011_atlanticstorm_BTI_004_1	
027_18_L_L_180625_009_atlanticstorm_BTI_021_3	

When the catalogue of the study area was finished, a comparison with pictures received from volunteers in other areas was made to analyse if there were any matches between the individuals in the different areas.

3.2.2. Abundance estimation

An estimate of abundance of the short-beaked common dolphin population in the area was made by comparing the number of individuals identified (well-marked) with the rest of the individuals – the estimated total number which was documented during the sighting, and those which were not well marked, or where the photographic quality was not good enough to identify the individuals.

Association analysis

The social structure of the dolphins was analysed using the Half-Weight Index (HWI). This index was appropriate as the principal methodology in this study of the population was photo-identification which is likely to underestimate the number of individuals which are re-sighted.

The HWI formula; $HWI=x/\{x+y_{ab}+0.5(y_a+y_b)\}$ (Bejder et al., 1998)

where x = is the number of groups where the individuals *a* and *b* were both present; y_{ab} = is zero in the present study as the individuals of dolphin needed to be photographed to be included in the analysis, and it cannot be supposed that the two individuals were in different groups at the same time; y_a = is the number of groups where individual *a* was present but not individual *b*; y_b = is the number of groups where individual *b* was present but individual *a* was not.

Behaviour

The variation among the number of encounters, and social group size in relation to the behaviour was analysed by calculating the average abundance of group size according to social group. Also, for those individuals that had more than one sighting, a comparison was made to analyse if there was any association between individuals showing the same behaviour when it is the same social group.

3.2.3. Population distribution

The distribution of individuals in the study area was represented using the software QGIS, which allowed one to have an idea of spatial preferences of this species within the study area.

The sightings of individuals of common dolphin were also compared with sightings of other species (minke whale, harbour porpoise, and Risso's dolphin) in the study area.

The distribution of the population may also be affected by different environmental factors. For this project, the effects of bathymetry, depth, anomalies, and roughness, and sea surface temperature (SST) on the distribution of the short-beaked common dolphin in the area were analysed by use of a general linear model with the software R-studio. This analysis tested the relationship between the presence or absence of common dolphins and the depth, anomalies, roughness or the SST.

3.2.4. Other analyses

During the surveys, plastic debris were collected in the study area which suggested that any common dolphin resident in the study area could be affected by their presence and could influence their distribution and survival rate.

For the analysis of the plastic debris in the study area, a count of the total number of plastic collected, type of plastic, and the date of recollection was documented.

3.2 Thesis rationale

With the data collected from the sightings of common dolphin, such as date and sighting location, number of individuals, sea surface temperature and depth, a long-term location for some of the individuals identified might be possible, providing data on movements and potential site fidelity.

4. Results

4.1. Effort and sightings

During the months of June and July, a total of 17 surveys, with 50 hours of effort, were conducted to study the population of short-beaked common dolphin in the Celtic Deep. All the transects were conducted between the pier of Saint Justinians to Grassholm Island and the Small lighthouse (Figure 4.1.).

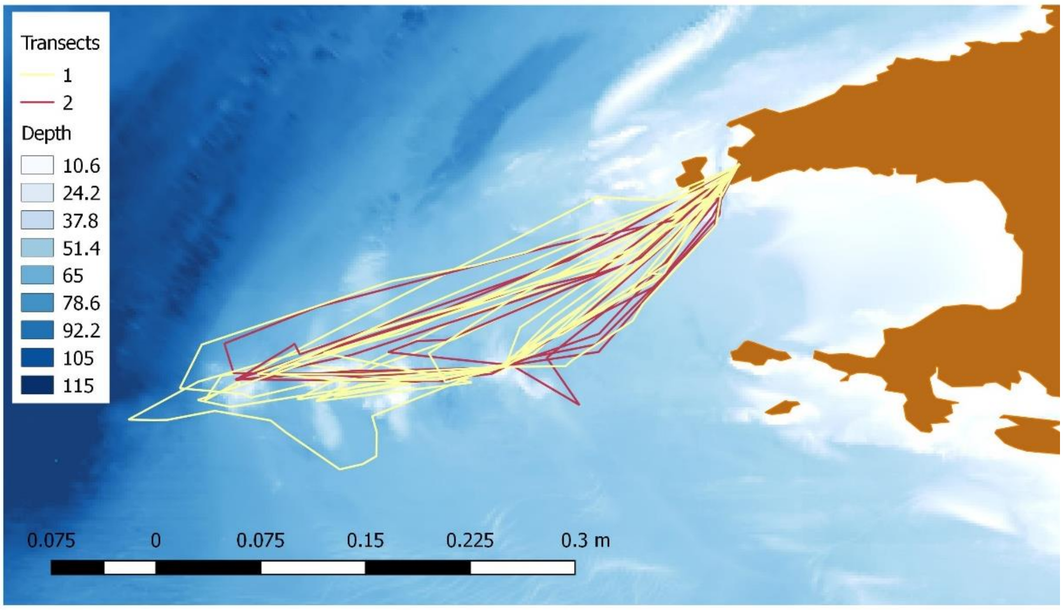


Figure 4.1. Map of the survey area from Saint Davids to the Smalls Lighthouse. The extension of the area depended on the sightings. The transects are represented according to the month of the survey (1: June; 2: July).

During the months of the survey, 15 sightings were documented, in which a total of 51 individuals of common dolphin were identified and added to the photo-ID catalogue. The sightings of common dolphin extended all over the study area showing a preference between depths of 50 – 60 metres.

In the month of June, 11 surveys were conducted in which 12 sightings of common dolphin occurred. With the data collected from the sightings during June, 44 different individuals of common dolphin were identified. Also, during the month of June, a total of 13 sightings of harbour porpoise (*Phocoena phocoena*), and minke whale (*Balaenoptera acutorostrata*) were documented, in which two of the sightings were of individuals of minke whale, and the other 11 were sightings of harbour porpoise.

On the other hand, in the month of July, six transects were conducted in which 3 sightings of common dolphin were documented. From the pictures collected in the sightings, a total of seven individuals were identified and added to the photo-ID catalogue. Also, during the month of July a total number of 10 sightings of other species were documented, in which nine of the sightings were of harbour porpoise (*Phocoena phocoena*), and one of the sightings of Risso's dolphin (*Grampus griseus*).

Table 4.1. Summary of the sightings of common dolphin and other species documented per date. The sightings of the species documented that were not short-beaked common dolphin, are represented by *sighting of one species, **sighting of two different species.

Survey #	Date	Boat	Sighting
1	04/06/2018	Atlantic Storm	
2	05/06/2018	Thousand Islands	001
3	06/06/2018	Atlantic Storm	002
4	08/06/2018	Thousand Islands	003
5	24/06/2018	Atlantic Storm	004, 005, 006 **
6	25/06/2018	Atlantic Storm	007, 008, 009 *
7	26/06/2018	Thousand Islands	*
8	27/06/2018	Atlantic Storm	010 *
9	28/06/2018	Atlantic Storm	011 *
10	29/06/2018	Atlantic Storm	*
11	30/06/2018	Atlantic Storm	012 *
12	12/07/2018	Atlantic Storm	013 *
13	16/07/2018	Atlantic Storm	*
14	20/07/2018	Atlantic Storm	*
15	21/07/2018	Atlantic Storm	*
16	22/07/2018	Atlantic Storm	014, 015 *
17	25/07/2018	Atlantic Storm	**

Even though a total of 23 sightings of species of cetaceans, besides common dolphin, were documented in the same area where sightings of common dolphin occurred (Figure 4.2.), no association, a co-ocurrence in the same location at the same time between those species was observed. As the sightings of minke whale *(*Balaenoptera acutorostrata*)*, risso's dolphin *(*Grampus griseus*)* or harbour porpoise *(*Phocoena phocoena*)* were not in the same time or place as the sightings of common dolphin. Also, although there is a significant breeding population of northern gannets (*Morus bassanus*) in Grassholm Island, there was no obvious association between this species of seabird and individuals of common dolphin during the surveying days. However, other boats did document behavioural interaction between those species when foraging.

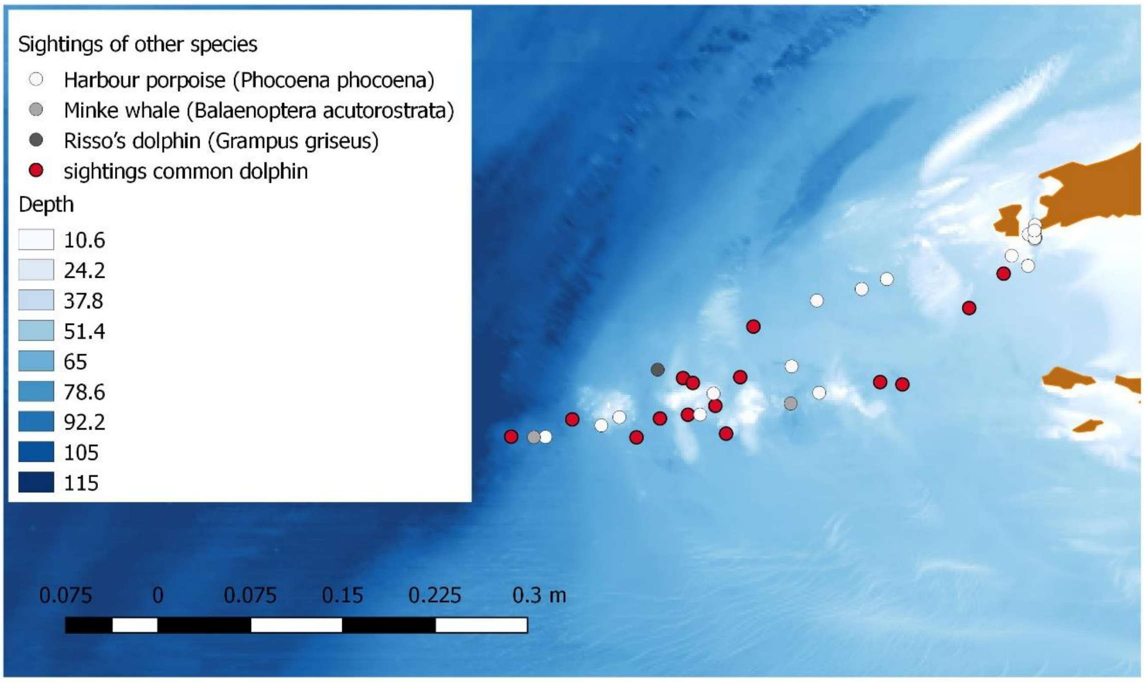


Figure 4.2. Map of the distribution of all the sightings in the study area during the period of the survey.

Harbour porpoises show a wide distribution in the study area but with a significant preference for "The Bitches and Whelps", a reef of rocks between Ramsey Island and Saint Davids. In this area, the tidal currents and seabed topography combine to create a foraging resource for different species. The species that were most frequent in the area during the surveying days were northern gannets and harbour porpoise.

Regarding the other two species sighted, there is no information whether a resident population of Risso's dolphin or minke whale exists, but they were occasional visitors to the area, and both companies have documented the presence of this species in past years.

4.2. Abundance estimation

As mentioned in the limitations, the total abundance of each sighting cannot be precise as there are different factors influencing the estimation of the total number of common dolphins for each sighting.

For every sighting, an estimation of the number of individuals was made during the survey, the number of individuals identified by photo-ID, and the number of individuals that was not identified because of poor quality of the picture or because the fin was not well-marked (Figure 4.3).

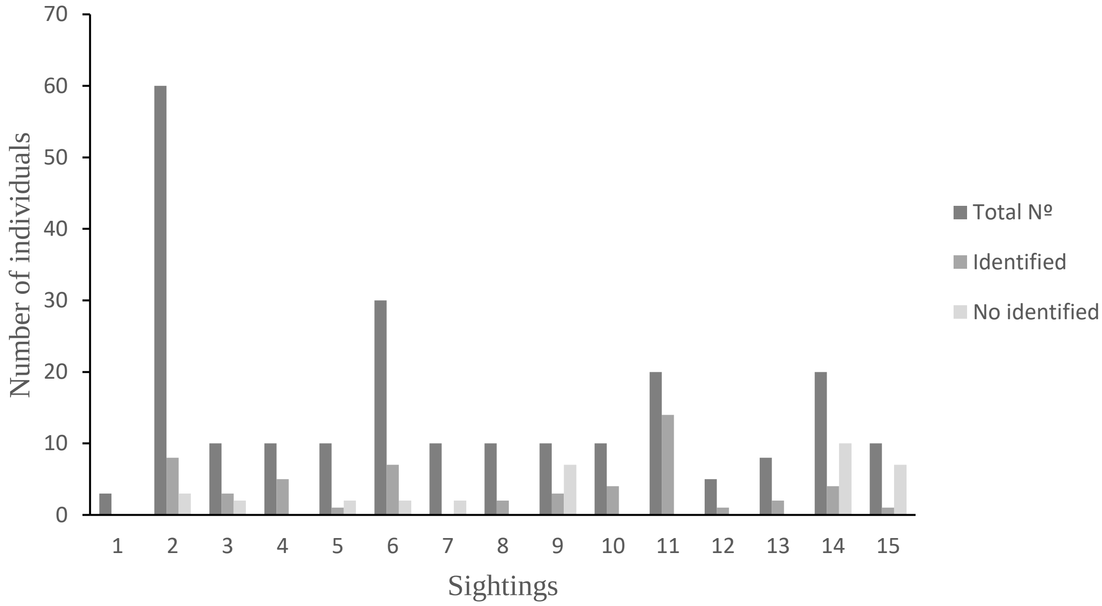


Figure 4.3. Representation of the estimation of the total number of individuals in comparison with the individuals identified by photo-ID and the number of identified individuals.

For each sighting, the percentage of individuals identified and not-identified is calculated in relation to the estimated total number. The first sighting shows a percentage of 0 for both identified and no-identified because no pictures were collected during the sighting as the individuals were at a significant distance of the vessel and the dolphins were showing travel behaviour. The highest percentage of individuals identified was given in sighting # 011 with 24 individuals recognised and 20 individuals sighted.

Table 4.2. Summary of the estimation of the total number of individuals per sighting in relation with the percentage of identified all the individuals, and no identified all the individuals.

Sighting	Total Num.	% ID	% No-ID
001	3	0	0
002	60	13.3	5
003	10	30	20
004	10	50	0
005	10	10	20
006	30	23.3	6.7
007	10	0	20
008	10	20	0
009	10	30	70
010	10	40	0
011	20	70	0
012	5	20	0
013	8	25	0
014	20	20	50
015	10	10	70

The 51 individuals identified in the study area were compared with pictures sent by volunteers from Swansea University in South Wales, Peter Evans who took pictures of encounters with common dolphins in Cardigan Bay, St George's Channel and a few miles north of Point Lynas, Anglesey, in North Wales, and pictures sent from a volunteer in the Menai Strait between Anglesey and Bangor in North Wales.

The pictures from Swansea University showed a total of six individuals which could be recognised as well-marked and the quality of the picture was good enough to do photo-ID. From the analysis, a match was found with the individual 035_18_H. This individual was recognised and added to the photo-ID catalogue in the Celtic Deep during one of the surveys conducted in the month of June. The match found is with an individual which photographed around Swansea Bay two years ago in September 2016.

SIGHTING HISTORY	Celtic Deep	Swansea
09/2016 (Swansea) 06/2018 (Celtic Deep)	 	 *CATALOGUE NAME:* 035_18_H *NICKNAME:* None *AGE CATEGORY:* Unknown *GENDER:* Unknown *LOCATION OF THE NICK/NOTCH:* High *FIRST TIME SEEN: 09/2016 (Swansea)* *NUMBER OF TIMES SEEN:* 2

Figure 4.4. Pictures of the fin of the individual 035 identified in the Celtic Deep and matched with a picture sent by a volunteer from the area of Swansea Bay in 2016.

The pictures obtained from Cardigan Bay, St George’s Channel, and Point Lynas, Anglesey showed a total of seven individuals that could be recognised, as the fins were well marked, and the photographic quality was good enough to recognise the features of the fin. From the analysis, no matches were found between the pictures from Anglesey, and the individuals identified and documented in the catalogue of the Celtic Deep.

Finally, the pictures obtained from the Menai Strait showed a total of five individuals that could be recognised, with a possible match between one of the fins from those pictures and the individual 017_18_L identified in the Celtic Deep, but the photographic quality was too low to be accepted as a match for the two fins (Figure 4.5).

SIGHTING HISTORY	Celtic Deep	Menai Strait
24/06/2018 25/06/2018 (Celtic Deep) 30/07/2018 (Menai Strait)	 	 *CATALOGUE NAME:* 017_18_L *NICKNAME:* Jose *AGE CATEGORY:* Unknown *GENDER:* Unknown *LOCATION OF THE NICK/NOTCH:* Low *FIRST TIME SEEN:* 24/06/2018 Celtic Deep *NUMBER OF TIMES SEEN:* 2 – 3

Figure 4.5. Pictures of the fin of the individual 017 identified in the Celtic Deep and picture of the possible matched fin sent by a volunteer from the Menai Strait in July 2018.

Association analysis

During the project, six of the 51 individuals documented in the photo-ID catalogue were identified in more than one sighting.

The individual 001_18_M (“David) (Figure 4.7.) was first identified on the 06th of June and then re-sighted the 24th of June and, as shown in figure 4.6, The locations of both sightings are close to each other, in the same area.

The individual 002_18_H (Figure 4.8.) was first documented on the 06th of June and re-sighted on three different occasions (08th of June, 24th of June, and 28th of June). However, this individual shows a wider distribution of sightings in the study area (Figure 4.6).

The individual 008_18_H (Figure 4.9.) was first identified on the 06th of June and re-sighted on the 28th of June, with the two sightings significantly distant from each other, with one of the sightings documented close to Ramsey Island and the other one around the area of the Smalls lighthouse.

The individual 012_18_H ("Bruja) (Figure 4.10.), and the individual 017_18_L ("Jose") (Figure 4.11.) were sighted on two consecutive days. The first sighting was on the 24th of June and the second one on the 25th of June. However, whereas "Bruja" was sighted in the first encounter on the 24th of June and then in the second encounter on the 25th of June, "Jose" was first sighted in the second encounter of the 24th of June and then the first encounter of the 25th of June. The two sightings of "Bruja" and "Jose" were distant from one another in the study area.

The individual 028_18_H (Figure 4.12.) was first documented on the 25th of June and re-sighted on the 12th of July and as Figure 4.6 shows, the sightings were very close to one another within the study area.

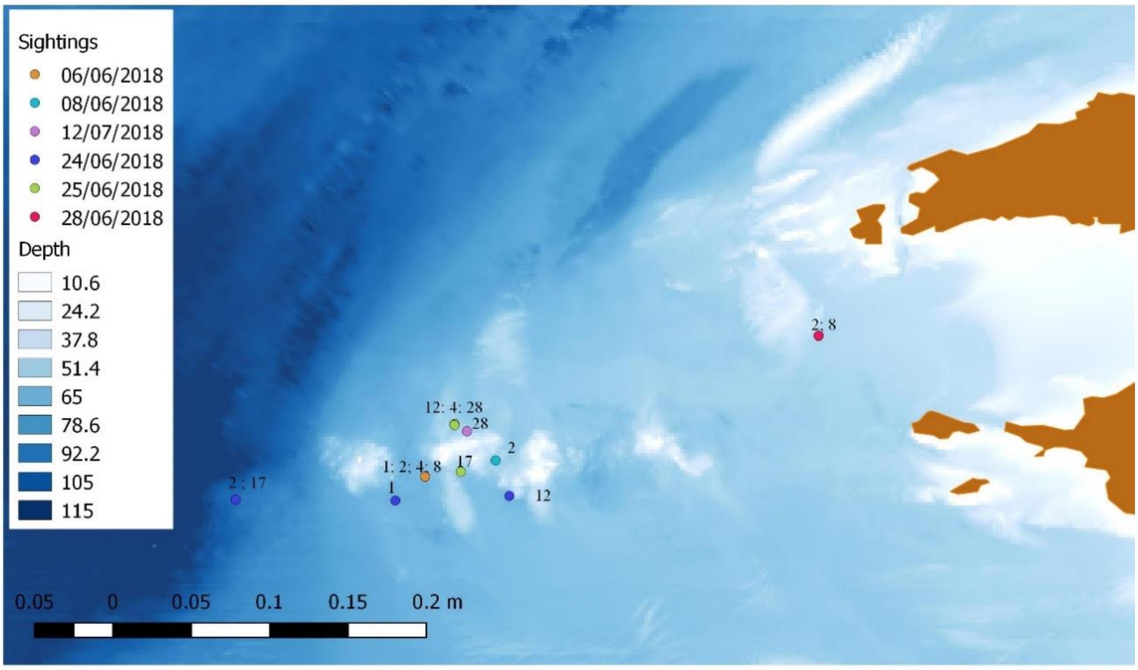


Figure 4.6. Map of the distribution of the sightings of the individuals 001, 002, 008, 012, 017, 028 on the different dates that were documented.

SIGHTING HISTORY

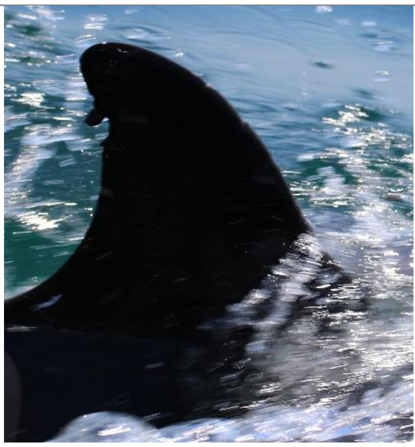
06/06/2018
24/06/2018

CATALOGUE NAME: 001_18_M
NICKNAME: David
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 2

Figure 4.7. Summary of the sightings of the individual 001_18_M

SIGHTING HISTORY

06/06/2018
08/06/2018
24/06/2018
28/06/2018



CATALOGUE NAME: 002_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 4

Figure 4.8. Summary of the sightings of the individual 002_18_H

SIGHTING HISTORY

06/06/2018
28/06/2018

CATALOGUE NAME: 008_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 2

Figure 4.9. Summary of the sightings of the individual 008_18_H

SIGHTING HISTORY

24/06/2018
25/06/2018

CATALOGUE NAME: 012_18_H
NICKNAME: "Bruja"
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 2

Figure 4.10. Summary of the sightings of the individual 012_18_H

SIGHTING HISTORY

24/06/2018
25/06/2018

CATALOGUE NAME: 017_18_L
NICKNAME: Jose
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 2

Figure 4.11. Summary of the sightings of the individual 017_18_L

SIGHTING HISTORY

25/06/2018
12/07/2018

CATALOGUE NAME: 028_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 25/06/2018
NUMBER OF TIMES SEEN: 2

Figure 4.12. Summary of the sightings of the individual 028_18_H

The results obtained from the analysis[1] of the preferences of social groups from the individuals re-sighted, showed the probabilities of an individual to be within the same group of individuals than other individuals.

[1] HWI=x/{x+y_{ab}+0.5(y_a+y_b)} (Bejder et al., 1998)

The most significant results obtained from the HWI, showed the higher preference for the same social group between the individuals 002_18_H and 008_18_H (HWI= 0.66), the individual 001_18_M and 008_18_H (HWI= 0.5), and finally, between the individual 012_18_H and 028_18_H (HWI= 0.5). The results obtained from the association between the other individuals, showed a low preference (HWI= 0.33) or a result of 0.

Table 4.3. Summary of the results obtained from the HWI for the different individuals.

	001	**002**	**008**	**012**	**017**	**028**
001		0.33	0.5	0	0	0
002			0.66	0	0.33	0
008				0	0	0
012					0	0.5
017						0
028						

Behaviour

In total, four different types of behaviours were documented during the sightings of common dolphins (Table 4.4). From the data collected of all sightings, bow-riding was the most common behaviour as the dolphins were generally coming to swim in the bow of the boat.

The behaviour shown in the different sightings of the individuals can be related to the social group preference. In this case, there is not enough data to determine a relationship between social group preference and behaviour.

Table 4.4. Summary of the data behaviour documented for each sighting and the estimated total number of individuals for each sighting.

Sighting	Total. Num	Behaviour
001	3	Travelling
002	60	Foraging
003	10	Foraging
004	10	socialising
005	10	Bow-riding
006	30	Bow-riding
007	10	Foraging
008	10	Bow-riding
009	10	Bow-riding
010	10	Bow-riding
011	20	Bow-riding
012	4	Bow-riding
013	8	Foraging
014	10	Foraging
015	10	Bow-riding

The average group sizes for the different behaviours were: travelling: 3.0 individuals; foraging: 19.6 individuals; socialising: 10.0 individuals; and bow riding: 13.0 individuals. Those results showed that the size of the social group varies depending on the behaviour. However, the analysis is not considered significant as there is not enough data to provide a significant result, only an estimation. For that reason, we conducted an analysis between the encounters of dolphins at its behaviour (Figure 4.13). In which we obtained that in 6.67% of the encounters the individuals were traveling, in 33.33% were foraging, in 6.67% socialising, and in 53.33% were bow-riding.

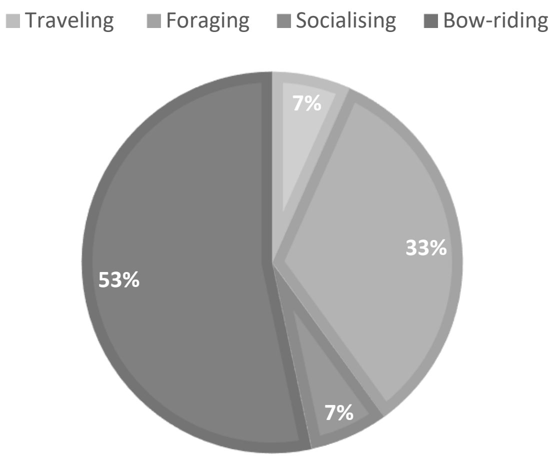


Figure 4.13. Representation of the average size of social group according to the behaviour.

Also, the data collected during the surveys showed different behaviours for the individuals when in the same group. Individuals 002 and 008, which showed the highest HWI, showed foraging behaviour on the 06th of June and bow-riding behaviour on the 28th of June.

Table 4.5. Summary of the behaviours showed by the individuals 001, 002, 008, 012, 017, 028 in the different sightings.

Date	Individual	Behaviour
06/06/2018	001	Foraging
06/06/2018	002	Foraging
06/06/2018	008	Foraging
08/06/2018	002	Foraging
24/06/2018	012	Socialising
24/06/2018	001	Bow-riding
24/06/2018	002	Bow-riding
24/06/2018	017	Bow-riding
25/06/2018	017	Bow-riding
25/06/2018	012	Bow-riding
25/06/2018	028	Bow-riding
28/06/2018	008	Bow-riding
28/06/2018	002	Bow-riding
12/07/2018	028	Foraging

4.3. Environmental parameters

All the data obtained from the different sightings of common dolphin were compared with different environmental parameters to test if there was a relationship between the presence or absence of those individuals in the study area.

4.3.1 Bathymetry

Depth

The distribution of sightings in the study area varied from a depth of 40 metres to 100 metres (Figure 4.14). The results obtained from the general linear model (GLM) tested the relationship between the presence or absence of common dolphin and water depth showed a significant increase in sightings of short-beaked common dolphin with depth.

Formula:

GLM (formula = DepthR$Sighting ~ DepthR$Depth, family = binomial, data = data)

	Std. Error	Z value	p. value
Depth	0.01746	3.395	0.000686 ***

Significance codes: ‘***’ 0.001 ‘**’ 0.01

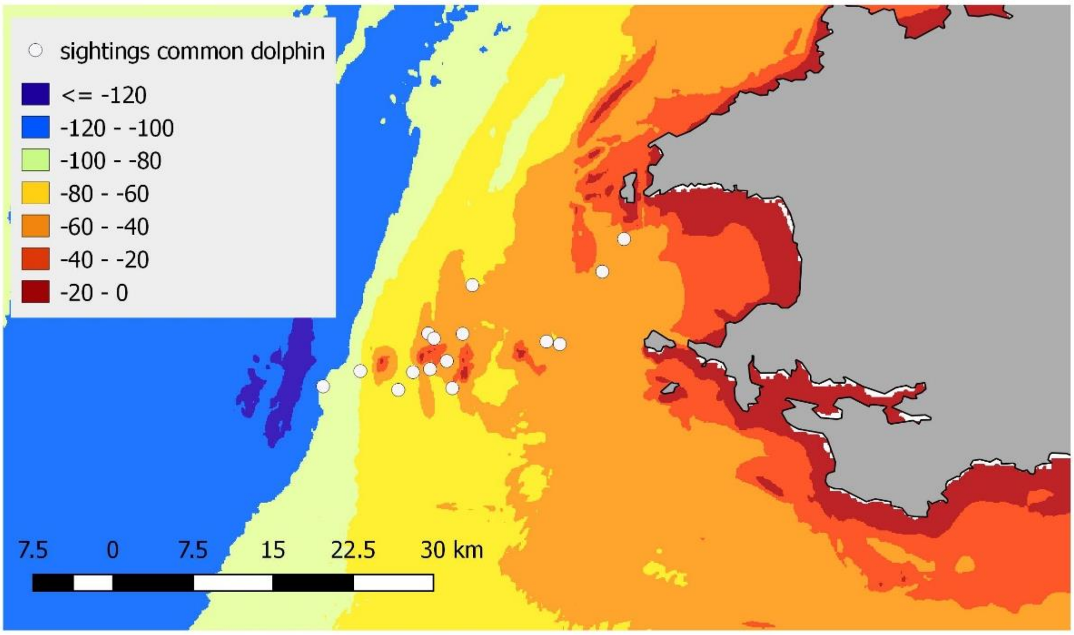


Figure 4.14. Map of the distribution of the sightings of short-beaked common dolphin in the different depths.

Anomalies

The results obtained from the general linear model (GLM) which tested the relation between the presence or absence of common dolphin and the pattern of anomalies in depth changes over the study area, showed a non-significant result between sightings and bathymetric anomalies.

Formula:

GLM (formula = DepthR$Sighting ~ DepthR$anomalies, family = binomial, data = data)

	Std. Error	Z value	p. value
Depth	0.016206	-0.226	0.821

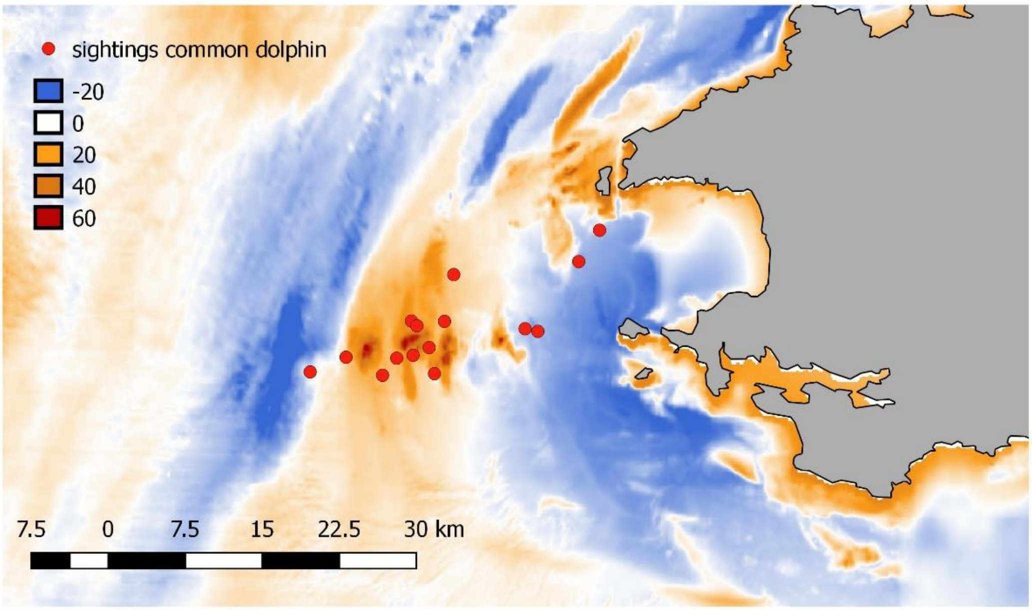


Figure 4.15. Map of the anomaly patterns of depth in the study area with the presentation of the distribution of the sightings of short-beaked common dolphin in relation.

Roughness

The results obtained from the general linear model (GLM) tested the relationship between the presence or absence of common dolphin and the roughness patterns in the bathymetry and found a non-significant result with the roughness showing no influence on the number of sightings of short-beaked common dolphin.

Formula:

GLM (formula = DepthR1$Sighting ~ DepthR1$Roughness, family = binomial, data = data)

	Std. Error	Z value	p. value
Depth	0.132684	0.007	0.995

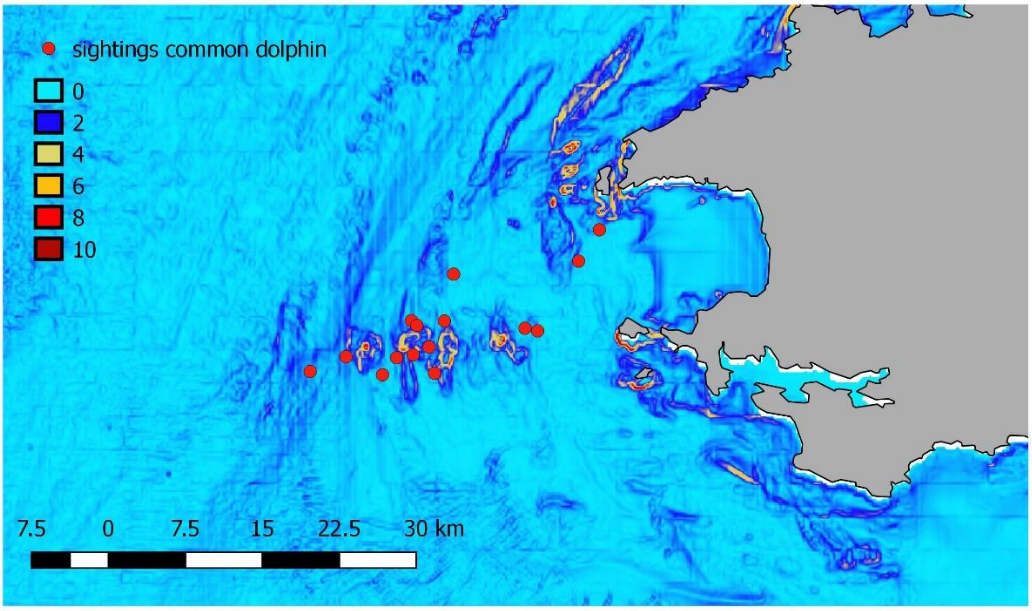


Figure 4.16. Map of the roughness of the bathymetry in the study area with the presentation of the distribution of the sightings of short-beaked common dolphin in relation.

4.3.2. Sea surface temperature (SST)

The data obtained for sea surface temperature in the study area varied from 20ºC to 25ºC. Before testing the relationship between sea surface temperature and the presence or absence of common dolphins, a test was undertaken to determine whether the data were significantly different to run a GLM.

The results obtained from the Bray-Curtis (Similarity analysis) of the transformed data (sq roots) showed a significant similarity between the data of the SST in the study area (Figure 4.17). This indicates that there was not sufficient difference between the data to test if there was a relationship between temperature and the presence or absence of individuals of this species.

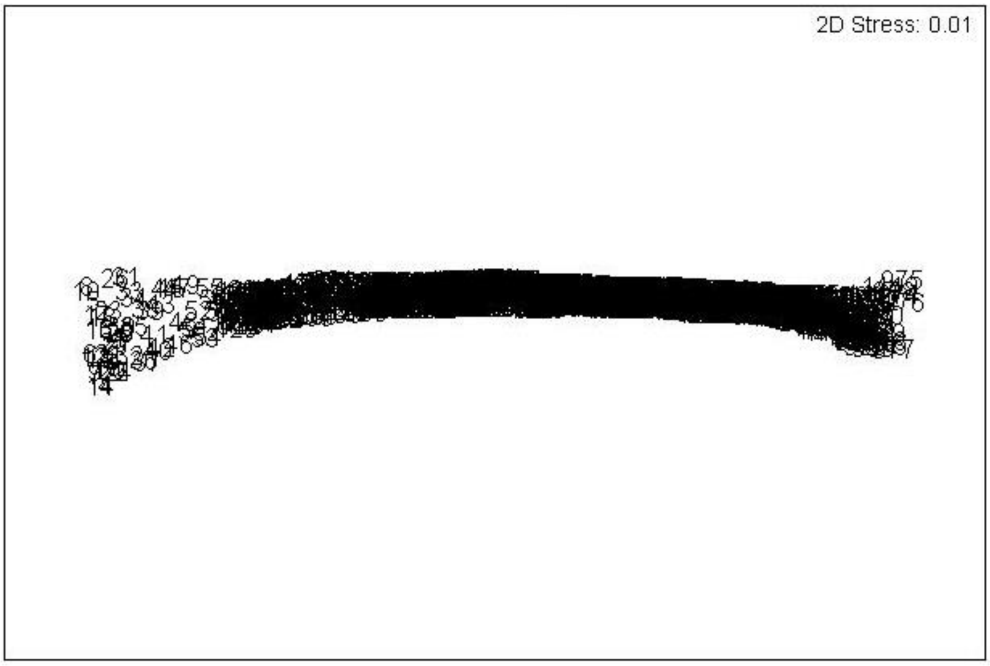


Figure 4.17. S17 Bray-Curtis similarity multidimensional scaling (MDS) plot showing similarity of the SST data.

4.2. Plastic debris abundance

During the two months of the surveys, a total of 19 items of plastic debris were collected in the study area. Most of the plastics collected were balloons (Table 4.6). No interaction was observed between plastic debris and common dolphins, but as the literature indicates, the presence of this pollutant is an important potential threat for small cetaceans like the short-beaked common dolphin in the North Atlantic Ocean.

During the transects, it was observed how the plastic debris can affect the survival of marine species, on the 28th June 2018, a northern gannet was found entangled in a fishing net, which prevented the individual from flying (Figure 4.18).

Table 4.6. Summary of data on plastic debris collected during the moths of June and July.

Date	Number of plastic debris	Comments
24/06/2018	1	Balloon
27/06/2018	1	Balloon
28/06/2018	1	Fishing net
29/06/2018	2	Balloons
30/06/2018	11	Balloons
12/07/2018	1	Balloon
16/07/2018	1	Balloon
25/07/2018	1	Small fridge

Figure 4.18. In the left picture, individual northern gannet entangled in fishing net on the island of Grassholm; and in the right picture, the fishing net after having been cut from the gannet (Photo by Ffion Rees)

5. Discussion

5.1. Short-beaked common dolphin distribution

For the understanding of marine mammal ecological processes, and for planning effective conservation measures. It is important to determine which environmental parameters are significant in the distribution, and habitat preferences of the marine mammals.

The results obtained over the 15 encounters during the 2 months of the surveys in 2018, show that short-beaked common dolphin was observed in significant number in the Celtic Deep. The sightings of common dolphin were documented during the 17 surveys and were, overall, the most regularly encountered species in the study area. The sightings of common dolphin occurred during 10 of the 17 days of surveys. The Celtic Deep is a clear area of significant sightings rates of common dolphin, in particular in the offshore area in the west of Pembrokeshire (Evans & Hinter, 2012).

During the project, the surveys were only performed during the months of June and July in which the sightings rates of this species is higher in the study area. However, as indicates in the study completed by Baines & Evans (2012) the common dolphin in the study area has been recorded every month of the year. Nevertheless, this species shows a higher abundance in summer, with a widely migration to the south from the month of December to April.

Sympatric species are different species that are present in the same geographical area, and with frequent encounters. This species to co-exist in a same area follow different resources such as the use of different feeding resources or habitat segregation (Quérouil et al., 2008).

During the surveys, sightings of different species than common dolphin were recorded, and even though during the surveys of this specific project, there was not documented any interaction between common dolphin and other species of cetaceans or of seabirds, there are different studies which recognised an association between common dolphins and different species. This association between different species can be influenced by the prey distribution and the predation pressure and is mostly related to feeding activities (Neumann & Orams, 2010). However, it has also been observed an association between different species during other activities like bow-riding (Frantzis & Herzing, 2002).

For example, in the research accomplish by Bearzi et al. (2011) in the Gulf of Corinth, located in the Mediterranean Sea. The authors found that the common dolphin was exclusively sighted in mixed groups with striped dolphins (*Stenella coeruleoalba*).

The distribution of common dolphin in most areas coincide with upwelling system areas, which implies a significant productivity of phytoplankton and zooplankton (Jefferson, et al., 2009). As mentioned in the study by Reynoso (1991) in the Gulf of California, the mackerel, sardine and anchovy have an important role in the ecology of the area. As this species represent the largest resource for the marine mammals and seabirds. A cooperative feeding strategy between the different specie requires a complex communication which could be; underwater noise or vocalizations, noisy leaps, and high leaps to visually locate the swarm (Wursig & Wursig, 1980)

5.2. Abundance of short-beaked common dolphin in the Celtic Deep

To allow the detection of population change over time it is important to have knowledge of the population parameters. However, the abundance is rarely estimated for species such as common dolphin as is a poorly gregarious species (Hupman et al., 2018).

Despite this, the results obtained by the abundance of common dolphin in the study area, are an estimation of the abundance of individuals sighted during the two months of sightings. The number obtained during those surveys is an estimation of the total abundance due the methodology used for this project, photo-ID. The species of common dolphin have a low-rate of individuals with a well-marked fin which difficulties the identification of all the individuals sighted or photographed (Hupman, 2016).

During the surveys, an estimated total number of 226 individuals of common dolphin were sighted in the study area. However, this estimation is ignoring the possibility of re-counting the same individual. From the estimated abundance of 226 individuals during the project, a total number of 51 individuals were identified and seven of those individuals were re-sighted in different sightings.

Hammond et al. (2013) estimated with a double platform line transect survey, a total number of around 56,221 short-beaked common dolphins in all continental shelf waters of the European Atlantic.

Capture-recapture methods are frequently used to estimate the abundance of the population and its distribution when comparing with a wide area (Urian et al., 2015). The results obtained by the comparison of the individuals identified in the study area and pictures received from different locations around Wales, suggests that the population of common dolphin in Wales has a wide distribution as at least, one match was found between the individual 035_18_H, and a picture received from Swansea Bay.

The social structure of a population has an important role in the ecology and biology of the species. Social animal such the short-beaked common dolphin tends to organize in groups, sometimes with preferred or avoided associates. The social groups formed by the individuals can vary their behaviour depending on environmental conditions (Hupman, 2016; Jefferson et al., 2009). During the surveys six of the 51 individuals identified were sighted in different days. However, there was not enough data to find any specific social group or, to relate the presence of different individuals with a specific behaviour.

The results obtained of the four different behaviours documented showed that even though the behaviour more observed in the different sightings was bow-riding, the individuals were riding in the bow of the boat. Foraging behaviour in common dolphin was found in a bigger social group. Which could be due to a cooperative feeding, which allows the dolphin to exploit shoaling prey with a lower energy consumption (Möller et al., 2011; Evans & Hinter, 2012). However, it is important to remark that this result is because of the sighting 002, in which an estimated abundance of 60 individuals was documented with foraging behaviour.

5.2. Short-beaked common dolphin habitat preference

Habitat use and distribution of a species with social structure, complex ecology, and behaviour, are influenced not only by abiotic and environmental factors, but also by reproductive status, behaviour, feeding strategies, and inter-specific relationships (Moura, Sillero, & Rodrigues, 2012)

The habitat preference for the common dolphin seems to be related with regions which have oceanographic characteristics related to high productivity areas, with good upwelling conditions (Cañadas & Hammond, 2008; MacLeod et al., 2018). However, not much studies have tested which of the environmental parameters is best correlated with common dolphin distribution (Moura et al., 2012). In the study area, the bathymetry and the sea surface temperature (SST) were examined to study the influence of those parameters with the presence or absence of common dolphin.

The results showed a significant influence of depth with the distribution of the common dolphin in the study area, the results showed a preference depth between 40-60 meters deep. The other environmental analysis showed a non-significant relationship with the common dolphin distribution which is possible as a result of the habitat preference for this species may be wider than the area selected for the analysis.

In the study tested by MacLeod et al. (2008) in the waters of the west of Scotland, the authors found that the most important variable related to common dolphin distribution was the distance from the coast. Also, the authors found that the SST in the coastal waters was an important parameter related to common dolphin occurrence with a preference value of 12.3ºC.

5.3. Threats of the common dolphin

There are different threats to considered in the Atlantic Ocean including contaminants, underwater noise, prey reduction, and collisions with shipping. However, the most significant threat for the common dolphin in the areas of the Celtic Deep and Bay of Biscay/Iberian Peninsula is the fishing bycatch (Murphy et al., 2017).

The threat of fishery bycatch occurs when the common dolphin is in direct contact with the fishing gear which may result in injury or death of the individual (Hamer et al., 2008). Another of the threats related to fishery is the reduction in prey availability which affects the distribution and abundance of common dolphins (Murphy et al., 2017).

In the study area the presence of fishing boats was only noticeable during two surveying days. However, this result is not significant as the presence of fishing boat was not documented during the project because it did not seem to affect in the distribution or presence of the common dolphin in the study area.

Another of the threats to cetaceans is the continued accumulation of debris in the marine environment. An estimated 6.4 million tonnes of marine litter are thrown into the ocean every year (Baulch & Perry, 2014). Borrell et al. (2001) compared with the concentrations of pollutants in common dolphins living in the eastern North Atlantic and found that the levels of contaminants in this species were lower by comparison with the concentrations detected in other species of delphinids.

In the study area a total of 19 plastic items were collected during the surveys, most of the plastics found were balloons. The presence of this pollutant in the study area suggests that even though, any sighting of common dolphin was documented in the same area were the plastics were found, there is a significant probability that this species is being affected by the presence of this pollutant in their distribution area.

5.4. Limitations and Recommendations

The study of the species of short beaked common dolphin, following the methodology described of the project, depends in many different variables which influence in the probability of sightings for this species.

The sea state during surveys affects not only the probability of the observation of cetaceans but the chance of running the transect. Also, as the platform used for this project was a touristic vessel, the number of bookings for every trip was also a variable which influenced in the probability of doing the survey. The surveys conducted for the project were non-systematic transects which is considered a limitation due the unequal coverage of the study area.

To reduce the influence of the number of booking and to increase the number of surveys, more communication with the different tourist companies is recommended.

Other limitations of the project were due to a limited number of cameras in the vessel, just one investigator (B. Tintoré) undertook photography for the photo-ID, and since the vessel was running commercial trips for tourists, this reduced the time for other studies of the population of the common dolphin. In order to derive an estimate of abundance of common dolphins in the study area, there needs to be a comparison made between the estimated number of individuals documented during an encounter, and the number of individuals identified, plus the number of individuals that were not marked, or that were of poor quality photographs, such that identification by photo-ID was not possible.

Finally, it also should be emphasised that the surveys were only carried during the months of June and July (2018) which suggests that the results obtained for this project only apply to half of the summer reason and the results could vary if the study took place during a larger period of time.

The continuation of the project will create a bigger database which will give more information about the population of this species in the study area. With a bigger database, more re-sighted individuals will be documented which will influence in the study of preference of social groups in the study area. Also, the comparison of the sightings of common dolphin with the environmental parameters will give a more precise information about the influence of the bathymetry in the distribution of common dolphin.

Collection of environmental parameters with a CTD (conductivity, temperature and depth) while the survey will give more comparable data for the analysis of the influence of those variables, and the distribution of common dolphin in the study area.

Further research in the study area should include the GPS location of different threats against common dolphins such as fishing boats and plastics. The increasement of the study area by doing a parallel study of photo-ID of the common dolphin in other areas of Wales could be interesting, as opportunistic photos by incidental encounters of volunteers in other areas of Wales suggest that the population found in the study area, can be wide distributed in different areas of the UK.

6. Conclusion

Short-beaked common dolphin showed a wide distribution in the study area and the photo-ID methodology for the project was an efficient methodology for the identification of the individuals in the study area.

From the data documented of the sightings, any social group preference was found in the area. However, different authors suggest that social animals like common dolphin tend to associate in social groups and the social group can depend on the behaviour activity or environmental parameters. Therefore:

The first hypothesis was accepted: The short-beaked common dolphin will show no preference to remain within social groups.

The estimated abundance of individuals in each sighting has shown a difference in group size according to behaviour activity. The biggest group documented was while foraging behaviour. Therefore:

The second hypothesis was rejected: There is no variation in group size according to activity.

In the study area a significant relation was found between the depth of the study area and the distribution of the common dolphin, however when study other environmental parameters such as SST, the study area was not big enough to compare the data with the sightings of dolphins. Therefore:

The third hypothesis was rejected: A positive relationship will exist between the sightings of common dolphin and sea surface temperature.

The fourth hypothesis was accepted: A positive correlation will occur between the sightings of common dolphin and bathymetry.

To conclude, different threats against cetaceans were observed during the surveys which suggests that the population of common dolphin in the study area can be influence by these threats. Therefore, the study of the population in the area is recommended to implement conservation strategies if necessary.

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8. Appendix

8.1. Photo-ID Catalogue of the Celtic Deep

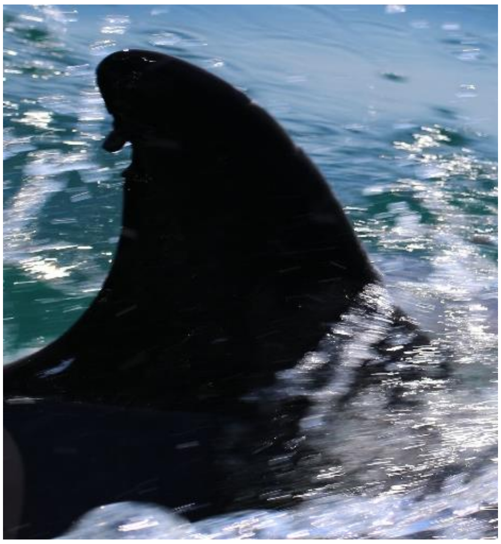
SIGHTING HISTORY

06/06/2018
24/06/2018

CATALOGUE NAME: 001_18_M
NICKNAME: David
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 2

SIGHTING HISTORY

06/06/2018
08/06/2018
24/06/2018
28/06/2018



CATALOGUE NAME: 002_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 4

SIGHTING HISTORY

06/06/2018

CATALOGUE NAME: 003_18_H
NICKNAME: Martin
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: H
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

06/06/2018

CATALOGUE NAME: 004_18_L
NICKNAME: Juan
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

06/06/2018

CATALOGUE NAME: 005_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

06/06/2018

CATALOGUE NAME: 006_18_L
NICKNAME: Alberto
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

06/06/2018

CATALOGUE NAME: 007_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

06/06/2018
28/06/2018

CATALOGUE NAME: 008_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 06/06/2018
NUMBER OF TIMES SEEN: 2

SIGHTING HISTORY

08/06/2018

CATALOGUE NAME: 009_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 08/06/2018
NUMBER OF TIMES SEEN: 1

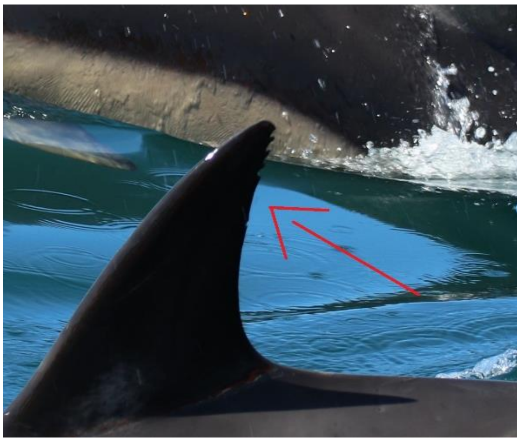
SIGHTING HISTORY

08/06/2018

CATALOGUE NAME: 010_18_H
NICKNAME: Alexander
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 08/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018



CATALOGUE NAME: 011_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018
25/06/2018

CATALOGUE NAME: 012_18_H
NICKNAME: “Bruja”
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 2

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 013_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 014_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 015_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 016_18_L
NICKNAME: Peter
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018
25/06/2018

CATALOGUE NAME: 017_18_L
NICKNAME: Jose
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 2

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 018_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 019_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 020_18_M
NICKNAME: Nunu
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 021_18_H
NICKNAME: Ame
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

24/06/2018

CATALOGUE NAME: 022_18_L
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 24/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

25/06/2018

CATALOGUE NAME: 023_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 25/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

25/06/2018

CATALOGUE NAME: 024_18_M
NICKNAME: Harvey
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 25/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

25/06/2018

CATALOGUE NAME: 025_18_H
NICKNAME: Cletus
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 25/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

25/06/2018

CATALOGUE NAME: 026_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 25/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

25/06/2018

CATALOGUE NAME: 027_18_L
NICKNAME: Carlota
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 25/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

25/06/2018
12/07/2018

CATALOGUE NAME: 028_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 25/06/2018
NUMBER OF TIMES SEEN: 2

SIGHTING HISTORY

27/06/2018

CATALOGUE NAME: 029_18_L
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 27/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

27/06/2018

CATALOGUE NAME: 030_18_H
NICKNAME: Roy
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 27/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

27/06/2018

CATALOGUE NAME: 031_18_H
NICKNAME: Henry
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 27/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

27/06/2018

CATALOGUE NAME: 032_18_L
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 27/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 033_18_L
NICKNAME: Cristina
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 034_18_M
NICKNAME: Mery
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 035_18_H
NICKNAME: Kike
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 036_18_M
NICKNAME: Almu
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 037_18_T
NICKNAME: Angie
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Top
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 038_18_L
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 039_18_M
NICKNAME: Fritz
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 040_18_M
NICKNAME: Gisfrit
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 041_18_T
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Top
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 042_18_M
NICKNAME: Paul
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 043_18_L
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

28/06/2018

CATALOGUE NAME: 044_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 28/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

30/06/2018

CATALOGUE NAME: 045_18_L
NICKNAME: Ffion
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 30/06/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

12/07/2018

CATALOGUE NAME: 046_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 12/07/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

12/07/2018

CATALOGUE NAME: 047_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 12/07/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

22/07/2018

CATALOGUE NAME: 048_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 22/07/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

22/07/2018

CATALOGUE NAME: 049_18_M
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Medium
FIRST TIME SEEN: 22/07/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

22/07/2018

CATALOGUE NAME: 050_18_H
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: High
FIRST TIME SEEN: 22/07/2018
NUMBER OF TIMES SEEN: 1

SIGHTING HISTORY

22/07/2018

CATALOGUE NAME: 051_18_L
NICKNAME: None
AGE CATEGORY: Unknown
GENDER: Unknown
LOCATION OF THE NICK/NOTCH: Low
FIRST TIME SEEN: 22/07/2018
NUMBER OF TIMES SEEN: 1

8.2. Sightings and Effort forms

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Sea Watch FOUNDATION

VESSEL-BASED SIGHTINGS RECORDING FORM

RECORD AS MUCH INFORMATION AS POSSIBLE, BUT REMEMBER THAT EVEN PARTIAL DATA MAY BE HELPFUL! CONTINUE ON SEPARATE SHEET IF NECESSARY.

Date (dd/mm/yyy) .... **Contact name / address** ....**Phone**......................................

E-mail:.. **Boat name**........................... **Journey Description**..

Sea State.......................**Swell Height**................**Visibility**.................**Trip Start Time**................... **GMT / BST End Time**..................**Observer Height Above Sea Level (m)**
Field of View: 180° fwd; 90°L; 90°R; 360° (tick)

Ref. No.	TIME BST/GMT	LOCATION (Latitude & longitude if possible)	SPECIES	CONF.	TOTAL NO.	NO. CALVES	NO. JUVES	BEARING ANIMAL	DIST. TO ANIMAL	BEHAVIOUR	REACTION	ANIMAL HEADING	ASSOC. SEABIRDS	OBSERV NAME

DATA DEFINITIONS: *Use categories provided where possible.*
Sea State: 0 = mirror calm; 1 = slight ripples, no foam crests; 2 = small wavelets, glassy crests, but no whitecaps; 3 = large wavelets, crests begin to break, few whitecaps; 4 = longer waves, many whitecaps; 5 = moderate waves of longer form, some spray; 6 = large waves, whitecaps everywhere, frequent spray; 7 = sea heaps up, white foam blows in streaks; 8 = long, high waves edges breaking, foam blows in streaks; 9 = high waves, sea begins to roll, dense foam streaks. **Swell Height:** Light = 0-1 m; Moderate = 1-2 m; Heavy = >2 m. **Visibility:** <1 km; 1-5 km; 6-10 km; >10 km.**Reference No.:** Number each sighting sequentially to allow for cross-reference with effort or additional notes. If a repeat sighting, use the same number as for the first sighting of the group. **Time**: 24-hour clock; circle BST or GMT. **Location:** Record latitude and longitude (deg., decimal min. preferred), if lat/long unavailable, note location in relation to local landmarks. **Species:** Give the best judgement of species ID; use general categories if unsure (e.g. dolphin species). **Confidence:** Definite; Probable; Possible. **Total No.:** Give range if unsure of exact number. **Calves/Juveniles:** Estimate counts of different–sized animals relative to adult body size (calves up to 50% adult size, juveniles 50-75%). **Bearing:** Degrees (magnetic). **Distance to animal:** Metres. **Behaviour:** Surfacing; Normal Swim; Fast Swim; Blowing; Feeding; Leap/breaching; Tail slap; Spy-hop; Bow-ride; Rest/Milling; Aggression; Sexual. **Reaction:** POS (attracted to boat); NEG (avoided boat); NON (no response observed). **Animal heading:** Note general direction of movement, or whether direction is variable. **Seabirds:** Note seabirds closely associated with the animals; record species of bird, if known, and number of birds.

Please return to Sea Watch Foundation, Paragon House, Wellington Place, New Quay SA45 9NR or to your Regional Group Co-ordinator

For more info contact sightings@seawatchfoundation.org.uk or call 01545 561227 or visit www.seawatchfoundation.org.uk

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VESSEL-BASED EFFORT RECORDING FORM

RECORD AS MUCH INFORMATION AS POSSIBLE, BUT REMEMBER THAT EVEN PARTIAL DATA MAY BE HELPFUL! CONTINUE ON SEPARATE SHEET IF NECESSARY.

Date (dd/mm/yyyy): .... **Vessel:** .... **Contact Name/Address:** ....

Tel/E-mail: .... **Observer names:** ....

Start Time .... **GMT / BST** **End Time** .... **Total Time** ...... **Observer Height Above Sea Level (m)** .... **Field of View:** 180° fwd; 90°L; 90°R; 360° (tick)

TIME GMT/BST	**LATITUDE** (degrees, decimal minutes)	**LONGITUDE** (degrees, decimal minutes)	**BOAT COURSE**	**SPEED** (knots)	**EFFORT TYPE**	**SEA STATE**	**SWELL HEIGHT**	**VISIBILITY**	**BOAT ACTIVITY**	**SIGHT. REF.**

DATA DEFINITIONS: *Use categories provided below where possible*

Time: 24-hour clock; specify GMT or BST. **Location:** Record latitude and longitude (deg., decimal min. preferred) every 15 minutes or when course changes, if lat/long unavailable, note location in relation to local landmarks. **Boat course:** Record course as vessel heading not course over ground (as deg. magnetic). **Speed:** Record in knots, if available. **Effort Type:** OFF = end of effort or not watching; CASW = casual watching; DEDS = dedicated search; LINE = line transect. **Sea State:** 0 = mirror calm; 1 = slight ripples, no foam crests; 2 = small wavelets, glassy crests, but no whitecaps; 3 = large wavelets, crests begin to break, few whitecaps; 4 = longer waves, many whitecaps; 5 = moderate waves of longer form, some spray; 6 = large waves, whitecaps everywhere, frequent spray; 7 = sea heaps up, white foam blows in streaks; 8 = long, high waves edges breaking, foam blows in streaks; 9 = high waves, sea begins to roll, dense foam streaks. **Swell Height:** Light = 0-1 m; Moderate = 1-2 m; Heavy = >2 m. **Visibility:** <1 km; 1-5 km; 6-10 km; >10 km. **Boat Activity:** Record No of each and type: NB = No boats, VE = unspecified vessel, YA = yacht, RB = row boat or kayak, JS = jet ski, SB = speed boat, MB = motor boat, FI = fishing boat, FE = ferry, LS = large ship , SV = seismic vessel, WS = warship. **Sighting Reference:** Refer to number(s) on Sighting Record Form.

Please return to Sea Watch Foundation, Paragon House, Wellington Place, New Quay SA45 9NR or to your Regional Group Co-ordinator

For more info contact sightings@seawatchfoundation.org.uk or call 01545 561227 or visit www.seawatchfoundation.org.uk